The Processing of Conversion in English:

Morphological Complexity and Underspecification



Jeannique A. Darby

Somerville College

University of Oxford

A thesis submitted for the degree of

Doctor of Philosophy

Approved Hilary Term 2015

Abstract

Jeannique Darby
Somerville College

Doctor of Philosophy
Hilary Term 2015

This thesis investigates a subset of the lexical items which appear to be involved in the phenomenon of CONVERSION in English. In its most canonical form, conversion involves pairs or sets of word forms which share both their phonological (and orthographic) form as well as some element of meaning, but which seem to belong to different word classes. In this study, the focus is on the relationships (or lack thereof) between monosyllabic verbal and nominal forms in conversion pairs.

The investigation takes as a starting point the patterns of linguistic behaviour within and across these pairs. The situation which is revealed is complex, but not unsystematic. Instead, it is shown that in many cases, the relationship between the nominal and verbal forms is clearly asymmetrical. In contrast to these clearer patterns, however, there are also a number of cases wherein the relationship appears to be more symmetrical in nature. In view of the complexity of the situation, the question of how to best model the linguistic behaviour of such forms has been a subject of some debate in the literature. A variety of theoretical explanations for these relationships have been proposed, though none has managed to account for the wide range of data. This study therefore suggests a mixed model, in which asymmetrically-related forms are involved in a derivational morphological process, while symmetrical forms represent inflected forms of a single lexeme which lacks a specification of word class.

However, given the fertile – and in no way settled – research background, the primary contribution of this study is an experimental exploration of how these forms and the relationships between them might be synchronically represented in the mental grammar of current speakers. To that end, three behavioural experiments are conducted with a view to uncovering how different types of conversion items are processed, and how information about their processing might inform our theoretical understanding.

The results of these experiments suggest that the processing of these forms is indeed in line with the patterns of symmetry and asymmetry found in their linguistic behaviour, and suggests that some conversion pairs may be involved in a derivational process, while others may not be pairs at all but rather a single, underspecified lexical entry. However, in addition to the results concerning the forms which display clearer patterns of behaviour, it is suggested that the patterns across the phenomenon of CONVERSION as a whole may best be understood as a continuum, rather than all suggesting a single underlying pattern of mental representation.

Acknowledgements

This project has for me completely redefined the phrase 'team effort' – which in this case is most definitely verb-based. Without the incredible, unfailing 'doing' and support of everyone listed here (and many others), this would not have been possible. In keeping with the dissertation itself, my *thank yous* are both long and long overdue, so settle in and get comfortable.

First and foremost I'd like to thank everyone who provided the financial support that allowed me the freedom to pursue this project whole-heartedly. It is no exaggeration to say that the support of Birla International through the Basant Kumar and Sarala Birla Graduate Studentship has guided the path my future will take, and I will always be grateful for the opportunities it has given me; the same thanks also go to Aditi Lahiri, for considering me for this Studentship. Additional funding provided over the years by the Faculty of Linguistics, Philology, and Phonetics; Jesus College; Somerville College; and the European Research Council has supported my experiments and provided invaluable opportunities for presenting results at conferences, which has (I hope) greatly improved this work as a result. In turn I would like to thank all my participants, as well as the audiences and reviewers at LSA 2014, LAGB 2014, and Mental Lexicon 2014 for their helpful comments and questions.

Unending thanks of course are due to my supervisor, Aditi Lahiri, who had the difficult task of keeping me on track, and managed to take this on with patience and understanding. With the uncanny ability to make it all crystal clear (at least within her office!), she has taught me so much about both language processing as well as pushing myself further than I thought I could go. I can never thank her enough. I have also been lucky to have the chance to discuss my work with my final examiners Frans Plank and Matt Husband. They somehow made it through this weighty tome and were still able to provide useful and insightful comments, which will provide me with food for thought for years to come. I am grateful for their attentive and fair discussion, as well as for their guidance and advice at earlier stages of the thesis; thanks also go to Mary Dalrymple, who not only provided detailed and helpful comments on my transfer chapter, but also advice and understanding during both my MPhil and the final stages of the DPhil. I am likewise grateful to David Cram and Sandra Paoli, who guided me through my MPhil, as well as to Kate Dobson for all her help throughout.

I am also grateful for the hands-on help I received from a number of other people along the way: to Linda Wheeldon for taking the time to give me advice on experimental design, and for helping me to tie up loose ends I had been struggling with for months; to Henning Reetz, who was always willing to help with programming experiments and statistics; and to Adam Roberts, who kindly spent hours working through my data and analyses with me, and who never hesitated to help when I needed it. I am also indebted to Swetlana Schuster and Nora Banks for their tremendous help with running participants and creating stimuli, which both of them always did efficiently and cheerfully; thank you also to Leonie Kössler for her help with gathering data for Chapter 6.

It almost goes without saying that this project would never have been completed without the help of all my friends in the Oxford LaB Lab, who shared in both the fun and the less-fun times. A million thank you's go to Holly Kennard,

without whom I might still be in the lab writing this. She provided so much kindness and support (and thesis reading!) over the years, and always tolerated my chattiness with good humour. I am also grateful to Sandra Kotzor, who always made sure I was expertly taken care of – dealing with late-night copy editing, food runs and cake, and giving me a push when I needed it. Many thanks as well to Allison Wetterlin, who helped me fight the dreaded Schweinehund with coffee, tea, cheese, meditation, and kindness. And although not in the LaB Lab, many thanks are due to the lovely Lindsay Morcom, who not only helped me get through the final stressful weeks of my thesis with encouragement and cedar tea, but also inspired me to research word classes in the first place.

Thank you of course to the other denizens of the LaB Lab, who never failed to brighten my day despite being stuck in an office/lab with me: 'EH!' to Ben Molineaux, who always took care of us at Christmas and provided many puns and cooooooffffffeeee; to Steven Kaye, who taught me about both morphology and the migrating Santa, among other things; to Hilary Wynne, who provided googly eyes, wine, and a listening ear; and to everyone else who provided help and welcome distraction during difficult times: Adam Roberts, Samantha Booth, Cong Zhang, Phil Roberts, Lara Ehrenhofer, Prerna Nadathur, Johanneke Sytsema, and Karola Graupner.

I have also been lucky to have as many wonderful friends outside of the Lab as in it, who helped to provide the best support network I could have asked for: thank you in particular to Mary Ngo, who took care of us like family for so long, and taught me how to cook; to the residents and friends of 24 Hodges Court, who were always ready for a cup of tea and a chat (or wine/rum if needed (Jesse!)): Ariel Liu, Anne-Sylvie Crisinel, Jesse van der Grient, Johnny Drain, Gemma Clucas, and (honorary Hodges-ites) Hayzell and Ilmo van der Lowe. Thank you also to the many fun people I met through JCBC and Oxfam (many of whom also helpfully participated in experiments!): in particular to my '2/stroke' pair partner of several terms, Therese Graversen, and to Ellie Berry for always being willing to listen; and to the truly lovely people of Oxfam Thursday evenings: James, James (you both know who you are!), Jonathan, Antonia, Kathy, and Daniella.

And although I miss all my Oxonian friends dearly, my transition into non-Oxford life was made so much easier by my welcoming colleagues at the IfLA in Stuttgart: Artemis Alexiadou, Giorgos Spathas, Sabine Mohr, Marcel Pitteroff, and in particular the 'J-Crew' of Gianina Iordăchioaia and Janayna Carvalho, whose moral support helped me 'solve the cucumber' of my final corrections.

Last but certainly not least, I want to thank my family – both the Darbys and Seguras – for for their unfailing support in everything we've done, even if it means us living an ocean away. Finally, I absolutely could not have done this without the love and encouragement of my husband and best friend, Nick: thank you for going on this adventure with me.

Contents

List of Figures **viii**

List of Tables **x**

1 CONVERSION: introduction and theoretical background **1**

1.1 Introduction 1

1.2 The phenomenon 2

1.2.1 Controversial cases 3

1.2.2 A note on word classes in English 8

1.2.3 Focus of the present study 11

1.3 Linguistic patterns 13

1.3.1 Semantic patterns 13

1.3.2 Syntactic patterns 33

1.3.3 Morphological patterns 34

1.3.4 A brief note on phonological patterns 36

1.3.5 Frequency 38

1.3.6 Basicness intuitions 40

1.3.7 Interim conclusion 43

1.4 Theoretical approaches 44

1.4.1 Directional approaches 46

1.4.2 A non-directional approach: category underspecification . 64

1.4.3 Mixed models 70

1.5 A working model of CONVERSION 81

1.5.1 Inflection vs. derivation 86
1.5.2 Word class and the analysis of conversion pairs 88
1.6 Conclusion 89

2 Experimental background: morphological structure in word recognition 92

2.1 Introduction 92
2.2 General background 95
2.2.1 Morphological effects in word recognition: the importance of the stem 98
2.2.2 The independence of morphology: dissociations from meaning and form 125
2.2.3 General background: summary 136
2.3 Factors in the processing of morphological structure 138
2.3.1 Inflected vs. derived 138
2.3.2 Frequency 150
2.3.3 Affix type and productivity 163
2.3.4 Stem-suffix compatibility 168
2.3.5 Levels of morphological complexity 173
2.4 Conclusion 178

3 Complexity in masked priming: Experiment 1 181

3.1 Introduction 181
3.2 Operationalising directionality 183
3.2.1 Motivations 184
3.2.2 Survey 1: Method and design 189
3.2.3 Survey 1: Results 192
3.3 Experiment 1: Visual masked priming 195
3.3.1 Method 197
3.3.2 Predictions 209

3.3.3 Results . . . 222
3.3.4 Discussion . . . 226
3.4 Conclusion . . . 232

4 Complexity in delayed priming: Experiment 2 234
4.1 Introduction . . . 234
4.2 Experiment 2: Auditory delayed priming . . . 235
4.2.1 Method . . . 236
4.2.2 Predictions . . . 247
4.2.3 Results . . . 252
4.2.4 Discussion . . . 259
4.3 Interim summary: Conversion and morphological priming in lexical decision . . . 265
4.3.1 Alternative interpretations . . . 267
4.3.2 Moving forward: methodological issues . . . 272
4.4 Conclusion . . . 273

5 Complexity and underspecification in delayed priming: Experiment 3 274
5.1 Introduction . . . 274
5.2 Operationalising directionality: revisited . . . 276
5.2.1 Motivations . . . 276
5.2.2 Survey 2: Method and design . . . 278
5.2.3 Survey 2: Results . . . 281
5.3 Experiment 3: Visual delayed priming . . . 286
5.3.1 Method . . . 288
5.3.2 Predictions . . . 296
5.3.3 Results . . . 302
5.3.4 Discussion . . . 307
5.4 Conclusion . . . 312

6 Implications for an understanding of conversion, underspecification, and morphological processing 314

6.1 Introduction 314

6.2 Basicness, complexity, and linguistic patterns reconsidered 315

6.2.1 Semantic patterns 316

6.2.2 Inflectional irregularity 330

6.2.3 Frequency patterns 331

6.2.4 Interim conclusion 338

6.3 CONVERSION, complexity and morphological processing in word recognition 339

6.4 Modelling CONVERSION, morphological complexity, and underspecification 345

6.5 Conclusions and suggestions for further research 353

Bibliography 355

A Appendix: Tables from Marslen-Wilson et al. 1994 (3rd party copyright material, not available for public consultation in perpetuity) 377

List of Abbreviations

ˈcvcv	(primary stress)
ˌcvcv	(secondary stress)
*	(ungrammatical/nonword)
AmE	American English
CNW	CELEX Nominal Weight
DM	Distributed Morphology
DP	Determiner Phrase
EEG	Electroencephalography
ENW	Experimental Nominal Weight
ERP	Event-related potential
(little) *n*, (little) *v*	(functional heads in DM)
FLH	Full Listing Hypothesis
ISI	Interstimulus interval
LP	Lexical Phrase
ms	milliseconds
N_B	Noun Base
OED	Oxford English Dictionary Online
RT	reaction/response time
SOA	Stimulus onset asynchrony
StdDev	standard deviation
'u'	Underspecified
V_B	Verb Base
$(word)_{Adj}$	Adjective
$(word)_N$	Noun
$(word)_{Prep}$	Preposition
$(word)_V$	Verb

List of Figures

1.1 Level ordering in Lexical Phonology (from Kiparsky 1982: 133) . 53

1.2 Conceptual structure of *kiss* (from Farrell 2001: 114) 65

1.3 Conceptual structure of *bag* (from Farrell 2001: 115) 66

2.1 Extended morpho-orthographic segmentation model (from Crepaldi et al. 2010: 93) 148

3.1 Extended morpho-orthographic segmentation model (from Crepaldi et al. 2010: 93) 211

3.2 Conversion pairs in the extended morpho-orthographic segmentation model 213

3.3 Conversion pairs in the extended morpho-orthographic segmentation model (with frequencies) 214

3.4 Mean RT and standard error (in ms) for all conditions (Experiment 1) 227

3.5 Mean priming effect (in ms) for all conditions (Experiment 1) . . 227

4.1 Mean RT and standard error (in ms) for all conditions (Experiment 2) 258

4.2 Mean priming effect (in ms) for all conditions (Experiment 2) . . 259

5.1 Mean RT and standard error (in ms) for all conditions (Experiment 3) 306

5.2 Mean priming effect (in ms) for all conditions (Experiment 3) . . 306

6.1 Mean concreteness as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2) 327
6.2 Mean concreteness as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3) 328
6.3 Mean concreteness as compared to mean *z*-scores, Survey 2 (Experiment 3) 329
6.4 Relative nominal lemma frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2) 332
6.5 Relative nominal surface frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2) 333
6.6 Relative nominal lemma frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3) 334
6.7 Relative nominal surface frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3) 335
6.8 Relative nominal lemma frequency as compared to mean scalar responses (Survey 2) 336
6.9 Relative nominal surface frequency as compared to mean scalar responses (Survey 2) 337

List of Tables

1.1 Common semantic relationships in conversion pairs 15

1.2 Wintu stem formation with *c'a:w*, from Farrell (2001: 116) 67

2.1 Experiment 2 example stimuli, adapted from Schriefers et al. (1991: 35) 108

2.2 Summary of results from Rastle et al. (2000), Experiment 1 133

2.3 Summary of results from Rastle et al. (2000), Experiment 2 134

3.1 Native speaker word class ratings for Survey 1 193

3.2 Makeup of Conversion condition in each list 199

3.3 Summary of Conversion prime-target combinations, Experiment 1 200

3.4 Makeup of fillers in all lists 200

3.5 Makeup of Associative condition in each list 201

3.6 Native speaker agreement ratings for Conversion stimuli 203

3.7 Conversion condition stimulus characteristics by target group . . . 204

3.8 Associative condition stimulus characteristics 207

3.9 Summary of stimulus characteristics by condition 208

3.10 Morphological steps from prime to target 219

3.11 Results of Conversion condition (Experiment 1) 225

3.12 Results of Associative condition (Experiment 1) 226

4.1 Makeup of Conversion condition in each list 236

4.2 Makeup of Semantic/Form condition in each list 237

4.3 Conversion condition stimulus characteristics by target group . . . 239

4.4 Prime suffixes in the Semantic condition 240
4.5 Semantic condition characteristics 241
4.6 Form condition characteristics 242
4.7 Suffixes in disyllabic nonwords 244
4.8 Summary of stimulus characteristics by condition 245
4.9 Results of Conversion condition (Experiment 2) 255
4.10 Results of Semantic condition (Experiment 2) 256
4.11 Results of Form condition (Experiment 2) 258
4.12 Conversion condition unaffixed surface frequencies by target group 271

5.1 Native speaker word class ratings for Survey 2 (part 1) 284
5.2 Native speaker word class ratings for Survey 2 (part 2) 285
5.3 Native speaker word class ratings for Survey 2 (part 3) 286
5.4 Makeup of Conversion conditions in each list 288
5.5 Conversion condition stimulus characteristics by target group . . . 292
5.6 Filler characteristics 293
5.7 Summary of stimulus characteristics by condition 295
5.8 Morphological steps from prime to target 297
5.9 Conversion condition target surface frequencies 301
5.10 Results of Conversion conditions (Experiment 3) 305

6.1 Mean ENWs by Dependency Base, Survey 1 (Experiments 1 and 2) 323
6.2 Dependency Base by experiment group (Experiments 1 and 2) . . 323
6.3 Mean ENWs and z-scores by Dependency Base, Survey 2 (Experiment 3) 324
6.4 Dependency Base by experiment group (Experiment 3) 324
6.5 Irregular verbs in Experiments 1-3 331

A.1 Summary of results for suffixed words, from Marslen-Wilson et al. (1994), Experiments 1-3 377

A.2 Summary of results for prefixed and suffixed words, from Marslen-Wilson et al. (1994), Experiments 4-6 378

Chapter 1

CONVERSION: introduction and theoretical background

1.1 Introduction

In English and a number of other languages, one often finds that a single phonological form (e.g., AmE /wɔk/) can be used in syntactic positions which suggest that it belongs to more than one part-of-speech category, as in *(to) walk*$_{\text{V}}$ (Verb) vs. *(a) walk*$_{\text{N}}$ (Noun).[1] Furthermore, it often seems that the meanings of these uses are closely related – in the case of *walk*, for example, the verb describes an action, while the noun describes a case of that action bounded in time. This type of alternation is known as CONVERSION, and it is a particularly widespread pattern in English. Its prevalence, along with the particular linguistic patterns which accompany it, have long made it a subject of interest. A number of different theoretical models have been proposed to account for its behaviour, and the discussion of its status in the grammar is by no means settled. It has variously been claimed to properly belong to the domain of morphology (Marchand 1964; Kiparsky 1982; Beard 1995), syntax (Farrell 2001; Arad 2003), and the lexicon (Lieber 1981a,b) – a situation which is partly reflected by the wide variety of al-

[1] This phenomenon may also be found in languages such as Dutch (Don 1993, 2005a,b), German (Lieber 1981a; Neef 2005), and Hungarian (Kiefer 2005), among others.

ternative terms used to describe it (e.g., *zero-derivation, transposition, category underspecification*, etc.). However, few studies have explored how the linguistic facts of CONVERSION might translate into how speakers process and store the kinds of word forms which appear to be involved in this phenomenon. The ultimate goal of the work presented here, therefore, is to provide additional evidence regarding the mental representation and processing of such word forms, in the hopes of likewise expanding our theoretical understanding of CONVERSION.

The structure of this chapter is as follows: first, §1.2 describes more precisely the subject under discussion, and delineates the kinds of items that are the particular focus of this thesis. §1.3 details some of the patterns of linguistic behaviour which are associated with these items, and also notes some of the questions which emerge from the consideration of these patterns as a whole. With these questions in mind, §1.4 reviews a selection of the major theoretical work on the phenomenon, noting the advantages and disadvantages each model presents as a means of explaining the patterns described in the previous section. In §1.5, I sketch an outline of the theoretical approach which underlies the experimental work in the succeeding chapters, before briefly offering some initial suggestions regarding how such work might contribute to the study of CONVERSION. §1.6 concludes with a presentation of the primary working hypotheses of this study, and a description of the structure of the investigation.

1.2 The phenomenon

Prior to the more detailed discussion in §1.4, I will avoid the unconditional use of any terms for this phenomenon which have been employed in earlier studies (e.g., *zero-derivation*). Use of these terms in the senses intended by their proponents poses some difficulty, as each of them is tied not only to a particular explanation of CONVERSION, but also to a particular theory of word-formation and lexical organisation. Therefore, for the sake of convenience, I will use the notation of small caps throughout this chapter to indicate a descriptive reference to this subject *in*

general, and to distinguish it from the particular theoretical implications which may be associated with the use of the term in itself.

Due to the differences in underlying theoretical assumptions across different approaches, there are disagreements about precisely which items and behaviours should be considered examples of the phenomenon in question, and opinions even vary among more descriptive accounts. Nevertheless, included as canonical cases in most discussions are examples like the following:

(1.1) a. *walk*$_{\text{V}}$: I *walk* to school every day.
walk$_{\text{N}}$: It's a long *walk*.

b. *loop*$_{\text{N}}$: I tied a *loop* around the fence post.
loop$_{\text{V}}$: *Loop* the rope around the tree.

c. *clean*$_{\text{Adj}}$: My room is *clean*.
clean$_{\text{V}}$: I will *clean* the room.

In these examples, we have what appear to be pairs (or sets[2]) of words which are phonologically identical and closely related in meaning, yet appear to be different in their syntactic (and inflectional) behaviour. As noted by Valera (2006: 173), theoretical discussions usually encompass all 'word pairs matching the profile given above...regardless of the relationship between them.' However, in the discussion which follows, the criteria of 'formal identity, syntactic variation, and lexical proximity' (Valera 2006: 173) will provide us with a useful working definition of CONVERSION – a definition which will, in practice, be the one followed in this study.

1.2.1 Controversial cases

Although the criteria noted above offer a helpful starting point, it is worth noting that they nevertheless do not fully capture the nuances of the situation as regards which types of items and behaviours should be considered together. Therefore,

[2]Some forms, such as *chill*, may appear in more than two types of position, e.g., adjectival (*a chill wind*), verbal (*chill the salad*), or nominal (*a chill in the air*) – cf. Morcom (2009).

in order to better understand which particular subset of possible cases of CONVERSION is under consideration, it is also necessary to briefly discuss some of the more peripheral examples. The following sections describe some of the phenomena which will *not* be fully explored in this work, but which are in fact commonly discussed alongside canonical cases.[3]

Phonological variation Many treatments include pairs of uses which are not strictly identical in form :

(1.2) $house_{\mathrm{N}}$ (/haʊs/): They bought a new *house*.
$house_{\mathrm{V}}$ (/haʊz/): We have nowhere to *house* the students.

The inclusion of such items is not entirely unfounded, given that (a) they are orthographically identical, and (b) their other patterns of behaviour often appear to be similar to those of the more central cases (cf. §1.3).[4] For this reason, a decision on their status as part of CONVERSION will not be made here; however, as will be discussed further in §1.4.3, there is additional evidence to suggest that pairs which differ in their surface phonological form may in fact be fundamentally synchronically different.

Syntactic variation On its own, the use of a form in syntactic positions characteristic of more than one word class may not be sufficient grounds for considering it to be part of CONVERSION. For example, many adjectives may be used in apparently nominal positions:

(1.3) The *poor* were oppressed by the *rich*, and no provision was made for the *old* and *infirm*.

(Zandvoort 1965: 318)

The use of an adjective as the head of a noun phrase, as in *the poor, the rich, the old and infirm* is often referred to as *partial conversion*. As noted by Quirk et al.

[3]For a concise recent review, see Bauer et al. 2013: §25.3.
[4]This voicing alternation is historically predictable – see Hayes (2009: 231).

(1985: 1559), this position is available to 'almost any adjective of a permitted class (*ie* applicable to human beings or to abstractions),' e.g., *the wealthy, the foolish, the kind*, etc. What distinguishes such cases from pairs like *clean*, however, is that 'partially converted' items fail to take on the inflectional markings of a different word class, while also retaining the ability to take adjectival inflection:

(1.4) a. I *cleaned* the room yesterday.

b. *Those *wealthies* are my friends.

c. The *wealthiest* are all attending.

(Quirk et al. 1985: 1559)

This test is not completely foolproof, however, since in some cases, neither of the uses takes inflection:

(1.5) *contrary*$_{\text{Adj}}$: Such a decision would be *contrary* to common sense.
contrary$_{\text{Prep}}$: *Contrary* to your predictions, the meeting was a great success.

(Huddleston & Pullum 2002: 1640)

Because of its phonological structure (Zwicky 1969, and references therein), *contrary* does not have inflected comparative and superlative forms when used as an adjective. English prepositions, meanwhile, do not inflect at all. Based on this quality alone, it is not clear whether such a case should be considered to be more central, or only partially converted.

Likewise unclear are cases of premodifying nouns, as in the following:

(1.6) a. a *cotton* dress

b. the *boy* king

c. the *city* life

(Zandvoort 1965: 315; Quirk et al. 1985: 1562)

This is a position characteristic of adjectives (e.g., *the old*$_{\text{Adj}}$ *king*). However,

many such nouns used in this way – even if they have the appropriate phonological structure – cannot take regular adjectival inflection:

(1.7) a. *a *cottoner* dress

b. *the *boyest* king

c. *the *citiest* life

Unfortunately, as example 1.5 indicates, this criterion may not always be applicable. Quirk et al. (1985: 1562) therefore argue that if the modifier cannot also be used in predicative position (as it can in 1.8a), then it is simply a case of partial conversion.[5]

(1.8) a. This dress is *cotton*.

b. *The king is *boy*.

c. *Her life is *city*.

Also worth mentioning are the adjectival uses of apparently verbal forms like present participles (1.9a) and past participles (1.9b):

(1.9) a. This play was *amusing*/the *amusing* play

b. The girl was *worried*/the *worried* girl

(Huddleston & Pullum 2002: 1644)

Though such forms may be used both attributively and predicatively (and may also display other adjectival characteristics, e.g., ability to be modified by *very*), they are arguably different from cases like *walk*. As Huddleston & Pullum (2002: 1644) point out, unlike the examples in 1.1, participial adjectives involve affixed forms. Furthermore, this alternation is much more regularly applied (i.e., *productive*). Nevertheless, while they are not considered in detail in this study, it is possible that such cases may be best treated as instances of CONVERSION.[6]

[5]It should be noted that there are some apparent adjectives which also cannot be used predicatively, such as *main* (*This door is *main*). Cf. Morcom (2009: 29) and §1.2.2.

[6]For a detailed discussion of the distinction between present and past participles and their identical adjectives, see Huddleston & Pullum (2002: 77-81). For a similar discussion of gerunds, see Quirk et al. (1985: 1290-91) Huddleston & Pullum (2002: 81-82) and Aarts (2007: 143-45; 210-14). Cf. also Bauer et al. (2013: 555-57) and §3.3.1.1.

Finally, some discussions also include cases of what is referred to as *secondary category conversion*, due to the lack of a change in primary word class. Common secondary category alternations include mass/count (1.10a) and transitive/intransitive (1.10b):

(1.10) a. *coffee* (Mass): I bought some *coffee* yesterday.
coffee (Count): I'd like two *coffees*, please.

b. *walk* (Intransitive): I *walked* to the park.
walk (Transitive): I *walked* the dog.

Quirk et al. (1985: 71; 1564), in fact, include patterns such as these among their examples of CONVERSION in general. They note that they do so to avoid 'imply[ing] any subordination of semantic to formal criteria,' as these pairs seem otherwise fairly similar to those which differ in their part of speech categories (cf. §1.3). However, as with participial adjectives, the question of whether to count such cases among the data of CONVERSION is quite complex, and is dependent on how the phenomenon is understood. Such alternations *within* a major word class are therefore not considered to be within the scope of the current study (cf. §1.2.3).[7]

Lexical proximity As regards lexical proximity, determining whether certain pairs are semantically 'close enough' is also not straightforward. Primarily, this criterion serves to rule out pairs like *tire*$_{\text{N}}$ (AmE, 'wheel of a vehicle') and *tire*$_{\text{V}}$ ('become tired'), whose identical pronunciations are a product of historical accident.[8] In contrast, the relationship between a pair like *slap*$_{\text{V}}$ and *slap*$_{\text{N}}$ ('a single instance of slapping') seems to be more obvious. In some pairs, however, the meaning relationship may appear to fall somewhere between these two extremes:

[7]See Bauer et al. (2013: §25.3) for a more detailed discussion of secondary category conversion.

[8]Although the same might be said for many semantically-related pairs (Balteiro 2007: 98ff.), forms like *tire*$_{\text{N}}$ and *tire*$_{\text{V}}$ cannot be argued to be semantically-related in the synchronic grammar.

(1.11) *book*$_{\text{N}}$: I am reading a *book*.

book$_{\text{V}}$: I called the theatre to *book* a ticket.

It might be proposed that one aspect of the meaning of *book*$_{\text{V}}$ has something to do with putting a note of reservation in a book, though this is not necessarily a requirement in order for *booking* to take place. It is therefore not as clear whether or not this is an example of the same phenomenon as in *walk* or *slap*. This issue is thus quite complex, but potentially crucial as the degree of semantic 'closeness' or 'distance' between two apparently related uses may in fact have important theoretical implications (cf. §1.4.3).

Given this cautious description, it will be gathered that CONVERSION is much more complex than simply 'formal identity, syntactic variation, and lexical proximity' (Valera 2006: 173). As will become clearer in §1.4, what is included in theoretical treatments often depends on how the phenomenon is defined – are these alternating pairs actually two separate lexemes, related by some historical or synchronic process (e.g., *conversion*)? If so, how can we tell when this process has taken place? Alternatively, are the apparent 'pairs' simply one lexical item used in multiple syntactic positions? How are the uses related? While this thesis does not attempt to categorise all of the controversial examples above, seeking answers to some of these questions with respect to the more canonical cases will be a principal goal.

1.2.2 A note on word classes in English

In the discussion thus far, there has been an implicit assumption which must now be clarified before proceeding. One of the key features often used to define CONVERSION is the 'syntactic variation' noted above: i.e., the usage of a form in functions characteristic of more than one (major) word class, such as nouns, verbs, or adjectives. However, with this definition comes the implication that English

makes a clear distinction between such classes – not only in terms of the kinds of syntactic functions exemplified above (reference, predication, and modification, respectively), but also in terms of a class membership more inherent to the words themselves.

As noted by Vonen (1994: 159; among others), such a distinction is well-motivated for English, particularly as concerns the categories of 'noun' and 'verb.' Across the lexical inventory, there are many forms in which certain semantic and morphological features coincide with syntactic function – so that e.g., nouns tend to be objects or places, may inflect for number, and are used in referring expressions; and verbs tend to be actions, may inflect for features like tense, and are used as predicates (Croft 2001: 63). For a large number of words in English this distinction is categorical, and the form only has one of these sets of characteristics. Thus, words like *society, life, child, lizard* are nouns, while *agree, comprehend, write* are verbs (Morcom 2009: 79; Luuk 2010: 358).

However, not all forms which might ostensibly belong to a particular class exhibit all of the characteristics of that class. For instance, as noted in the previous section, some adjectives (e.g., *contrary*) cannot take comparative or superlative inflection, or cannot appear in all adjectival positions (e.g., *This door is *main* vs. This door is *green*). Similarly, some forms which otherwise seem to be nouns do not (for one reason or another) inflect for number (e.g., *sheep*), or do not refer to objects or places (e.g., *accident*, which refers to an event). Thus, while the properties which have traditionally been used to define the major word classes in English do in many cases co-occur, other forms appear to be less 'prototypical' examples of these proposed classes.[9] A number of researchers have therefore argued that lexical items in English are organised along a continuum *within* a single word class, with more canonical forms closer to the centre of the class, and less canonical forms further away (Aarts 2007; Lakoff 1987; cf. Morcom 2009: 75). Furthermore, in addition to such variation within the classes, it has also

[9] Cf. §1.3.1.6.

been argued – often on the basis of CONVERSION forms – that the lexical classes of English in fact overlap to some extent (Crystal 2005/1967; Hockett 1958; cf. Luuk 2010: 358 and Morcom 2009: 77). Those forms which seem to exhibit properties associated with more than one class are then said to lie within this area of overlap.

As suggested by the preceding discussion, such 'overlap' forms are indeed numerous. However, this need not indicate that the language lacks a clear distinction between its word classes. To begin with, the existence of so many categorical forms like *life* and *comprehend* clearly supports such a distinction, as these forms display all and only the characteristics associated with a single class. Secondly, as pointed out by Vonen (1994: 159), even many CONVERSION forms display only one set of characteristics at a time when used in a particular syntactic function. Thus, *seal*, when used as a predicate meaning roughly 'to fasten with a *seal*,' describes an action and can take verbal inflection (e.g., I *sealed* the letter). Likewise, its corresponding referring expression describes a thing, and it may receive nominal inflection (e.g., I put two *seals* on each letter).[10] Similarly, the addition of derivational affixes often also results in the *simultaneous* shifting of semantic, morphological, and syntactic characteristics, when compared to those of the stem. For example, when the prefix *en-* is attached to the stem *rage*, it creates a word with a verbal meaning ('make someone rage') from a word with a nominal meaning. The resulting word also then takes verbal inflection (*enraged*) and appears as a predicate. There are, of course, exceptions to this pattern, as some derivational affixes seem to alter only syntactic function and inflectional class – e.g., the suffix *-ation* creates a referring expression from an action (as in *admiration*), but it does not add to or change the meaning of stem to the same degree as *en-* (Morcom 2009: 79-80). Furthermore, as we shall see, there are also a number of CONVERSION forms which seem to display this latter pattern of behaviour.

[10]These are of course only two of the various related senses of the form *seal*; issues regarding these senses and other such patterns of meaning in CONVERSION will be discussed further in §1.3.1 below.

Despite such cases like *admiration* and *accident*, which do not entirely conform to the expectations for a particular word class, there are nevertheless notably consistent differences in the behaviour of individual word forms with regards to relevant syntactic, semantic, and morphological characteristics. These general tendencies therefore suggest that there are grounds for assuming at least some degree of word class distinction in English, and it is this assumption which will underlie the theoretical arguments made in this thesis. Although a full exploration of the issues regarding such distinctions is outside the scope of this study, I will be roughly following the model sketched in Morcom (2009: 77). This model is based on a combination of arguments such as those in Crystal (2005/1967) and Aarts (2007), and assumes that lexical items may be categorised along a continuum either within a single class, or within an area of overlap between multiple classes. However, it is also assumed that these classes (and their behaviour) may be usefully distinguished, and that there are areas of each which do not overlap with those of another class.

While the assumptions outlined here will not be discussed in great detail for reasons of space, they are integral to the analyses of CONVERSION proposed both in this study and in earlier research. As such, the implications of this understanding of word classes in English for analysing the behaviour of CONVERSION will be addressed further in §1.5.2.

1.2.3 Focus of the present study

Because there has been virtually no experimental work on this phenomenon, a baseline understanding of how CONVERSION forms are processed in English is required. This thesis is thus primarily concerned with the most central cases: (monosyllabic)[11] forms which are phonologically (and orthographically) identical, with particular patterns of meaning relatedness (cf. §1.3.1) – though some reference will be made to certain other types of items which may contribute to

[11]This should not necessarily be taken to indicate that monosyllabic forms are more central cases of CONVERSION; rather, the experiments will be limited to the processing of these pairs.

our understanding of the more canonical forms.

As suggested above, the further issue of whether all uses are 'full members' of their respective word classes is rather more difficult to determine. Nevertheless, as a starting point, only those pairs which are fully entrenched in the language – in practice, those which have both uses listed separately in the CELEX Lexical Database (Baayen et al. 1993) – are included for consideration (cf. §3.2). I will be referring to these different uses of a CONVERSION form as 'nominal', 'verbal', etc., based on the above-noted fact that a form's syntactic position often coincides with other properties which suggest membership of a particular word class. The general discussion of CONVERSION alternations will also be further restricted to only those items which show an alternation between nominal and verbal uses. Although other word classes may be involved (as in example 1.1), pairs consisting of identical noun and verb stems are the most common (Quirk et al. 1985: 1550, 1560; Adams 1973: 38; Balteiro 2007: 91).

Because the goal of this study is to attempt to understand how CONVERSION is synchronically represented and processed, the focus will also be on the knowledge that present-day speakers may be supposed to possess. The discussion will therefore be primarily limited to those issues which are connected to this goal, with any considerations which are less relevant to this purpose – such as etymological origins – being dealt with only where necessary. Although the diachronic path taken by the words under consideration may indeed be reflected to an extent in their current linguistic behaviour (Raffelsiefen 1993; Clark & Clark 1979; cf. §1.3.1.2 and §1.3.3), it is assumed in this study that the historical development of each form is not *in itself* represented in the synchronic grammar of present-day speakers (cf. Plag 2003: 108-9).

In the discussion which follows, these pairs of homophonous, semantically-related nominal and verbal uses will be referred to as *conversion pairs* (cf. Kiparsky 1983: 8). Although §1.4.1.2 and §1.5 will present some arguments in favour of a morphological conversion analysis for some of these pairs, the term *conversion*

pairs in itself is not intended to be a theoretically-motivated label or a comment on the nature of these items.

1.3 Linguistic patterns

This section details the linguistic behaviour commonly found in the more central cases of conversion pairs. It is primarily intended to be descriptive, and as a-theoretical as possible – though, of course, much of the data is drawn from sources which have a particular theoretical perspective. Its structure is therefore theoretically-informed to a certain extent, and the data presented here forms the basis of many of the arguments made in the major studies on CONVERSION (cf. §1.4).

1.3.1 Semantic patterns

1.3.1.1 Common meanings

There are certain types of meanings which seem to be particularly prevalent among conversion pairs. For instance, Huddleston & Pullum (2002: 1642) note that the verbs in such pairs are often 'dynamic rather than stative' (*kick, flower*), though of course the latter exist as well (*doubt, fear*). Nouns, on the other hand, may be concrete (*bottle, hoist*) as well as more abstract (*plan, hope*), though concrete forms may be somewhat more numerous (Marchand 1969: 367).[12] Conversion pairs also tend to involve items with general as opposed to specific meanings:

(1.12) He *cupped* his hands and drank from the stream.
*He *mugged* his hands and drank from the stream.

(Quirk et al. 1985: 1529)

Also noticeably absent are verbs paired with specific names of flowers and trees, like *lily, rose,* and *pine*, despite the more general items *tree* and *flower*

[12] Cf. §1.3.1.6.

being members of conversion pairs (Marchand 1969: 368; cf. Aronoff 1980). Nevertheless, some more specific proper names and brand names may also occasionally occur, such as *Houdini* and *hoover* (Clark & Clark 1979). There are also a number of general patterns of meaning relatedness which may obtain between the pair members, some of which are summarised in Table 1.1 on the following page.[13]

From this table, it will be immediately noticed that in some of these examples, the meaning of the verbal form is described in terms of the nominal form, while in others, the reverse is true. While for the moment this is for the sake of convenience in grouping as many examples under one pattern as possible, the issue of the way in which the meaning of one form may (or may not) depend on that of the other is crucial to an understanding of the phenomenon, and will be discussed critically and in greater detail in §1.3.1.3 (cf. also §1.4).[14]

What is less obvious due to the structure of this table is the degree of flexibility in placing some conversion pairs into these different groups. In some cases, it seems that different senses of an item may be placed under different headings:

(1.13) a. *catch*$_{\mathrm{N}}$ ('That which has been *caught*'): They came home from the lake with an excellent *catch*.

b. *catch*$_{\mathrm{N}}$ ('An instance of *catching*'): He made a great *catch* which ended the game.

In other cases, we may easily place the same *pair* of nominal and verbal uses in multiple categories, describing either in terms of the other:

[13]This list is by no means exhaustive; for more detail, see the following sources: Marchand (1969: Ch. 5); Adams (1973: Ch. 4); Quirk et al. (1985: 1560-61); Cetnarowska (1993: §3.2); Plag (2003: §5.1); Balteiro (2007: 94-95). Cf. also Clark & Clark (1979).

[14]As noted by Clark & Clark (1979: 769) in their analysis of apparently denominal verbs, such paraphrases do not 'capture all the content' of the meanings of these words; additionally, many other pairs may be 'specialised in ways not capturable in general paraphrases.' The complexity of this situation will be a recurring theme throughout this chapter.

Noun	Verb	Examples
N	'To put in/on N'	*bottle, jail*
N	'To give/provide/cover with N'	*grease, plaster, staff*
N	'To remove N'	*shell, skin, dust*
'Instrument with which V is performed'	'To...with N' ('To use N for whatever activity is associated with it')	*hoist, hammer, tape*
N	'To make/change into N'	*group, cash, bundle*
'One who V-s'	'To be/act as N'	*cheat, coach, mother, chaperon*
N	'To send/go by N'	*post/mail, ship, boat, canoe*
N	'To produce/make/bring forth N'	*flower, plan, foal*
N	'To develop/secrete/emit N'	*mould, spark*
N	'To prepare/treat with N'	*pepper, salt, chloroform*
N	'To fasten with N'	*chain, buckle, button*
'An instance of V-ing'	V	*kick, clap, attempt*
'Result of the action of V/ V-ing'	V	*bite, glare, release*
'State/condition of being V-ed'	V	*defeat, dismay, surprise*
'V(-ing) as a general phenomenon'	V	*hope, sleep, travel*
'That which is/has been V-ed'	V	*answer, catch, brew*
'The period/occasion of V-ing'	V	*nap, freeze, parade*
'Characteristic quality of a thing, as established by V'	V	*feel, taste, touch*
'Place where V is performed'	V	*lounge, dump, stop*

Table 1.1: Common semantic relationships in conversion pairs

(1.14) a. *award*$_{\text{N}}$: 'That which has been *awarded*'; *award*$_{\text{V}}$: 'To give an *award*'

b. *moan*$_{\text{V}}$: 'To produce a *moan*'; *moan*$_{\text{N}}$: 'Result of/instance of *moaning*'

Interestingly, this flexibility of definition does not always seem to extend to all forms which might fall into the same semantic pattern. For instance, although both *award*$_{\text{N}}$ in 1.14a and *catch*$_{\text{N}}$ in 1.13a seem to mean 'that which has been V-ed', only *award*$_{\text{V}}$ may also be naturally expressed in terms of its nominal partner. In contrast, it would be rather awkward to define *catch*$_{\text{V}}$ as 'to perform a *catch*'. Thus, it seems that the kind of flexibility exemplified in 1.14 only applies to certain pairs of forms.[15]

Nevertheless, there also are certain categories which themselves appear to have parallel meanings, in that the nominal and verbal paraphrases seem to express the same type of relationship. Such categories have therefore been collapsed together in the table above. For example, here the instrumental meanings (i.e., 'To use N...' and 'Instrument with which V is performed') are roughly the nominal and verbal equivalents of one another. Likewise are those examples involving 'similative' (Plag 2003: 112) meanings, as illustrated by *judge* in the example below:

(1.15) *judge*$_{\text{V}}$: 'To act as a *judge*'; *judge*$_{\text{N}}$: 'One who *judges*'

As will be explored further in §1.4, the way in which the nominal and verbal meanings are related, and the flexibility of defining some conversion pairs – along with the relationships between the meaning patterns as a whole – is a crucial issue, and has important implications for both a theoretical understanding of CONVERSION, as well as an investigation of how these items are processed on-line.

1.3.1.2 Regularity, transparency, and predictability

As illustrated by Table 1.1 above, the semantic relations between members of conversion pairs are variable. Though some meaning patterns (like the instru-

[15] Cf. §1.3.1.3.

mental relationship) may be more numerous than others (Marchand 1969: 369), there is no one meaning relationship which can be used to describe all examples of even the more central conversion pairs. Indeed, as Clark & Clark (1979: 780-81) note regarding a subset of these pairs, 'Many examples don't fit neatly into these categories, and others have the characteristics of more than one category at a time.' They suggest a number of such 'untidy' examples, such as *lunch*. While the semantic relationship between $lunch_{\mathrm{N}}$ and $lunch_{\mathrm{V}}$ is fairly straightforward (i.e., $lunch_{\mathrm{V}}$: 'to eat $lunch_{\mathrm{N}}$'), it does not seem to completely parallel any of the groups listed in Table 1.1. It is also worth noting that the patterns of meaning relatedness which appear to be involved in CONVERSION do not seem as restricted as those which occur between some affixed forms and their bases (e.g., *-ify* means 'to make Adj'; cf. *null – nullify*, Plag 1999: 231-33). Still, it is true that the meanings of many pairs do indeed seem to be captured under the patterns in Table 1.1, which suggests that there is at least *some* degree of regularity across forms; however, there also appears to be a great deal of variation.[16]

The question of the relative transparency of these various meaning relations is somewhat more complicated. By *transparency*, I roughly intend to refer to how predictable the meaning of a word is based on the meanings of (parts of) its form.[17] However, where we draw the line regarding what is considered 'predictable' may to some extent be seen as a matter of definition. If, for example, we limit the phenomenon of CONVERSION to the most clearly related pairs like *walk, slap*, and *canoe*, which have parallel semantics – and if we choose not to include more peripheral cases like *book* (see example 1.11) – then we will be primarily left with those pairs which have the most transparent semantic relationships. It is possible, therefore, that in such a case the semantic transparency of these relationships may not be of any great theoretical importance, but simply a matter of definition. However, if we do choose to include pairs like *book*, as well as other

[16]However, cf. Aronoff (1980) and §6.4 for a potential means of accounting for some of this variation.

[17]Cf. Plag (2003: 46).

less clear cases like *taste, table* and *stamp* in example 1.16 below, it appears that the degree of transparency across conversion pairs might be more gradient.[18]

(1.16) a. *taste*$_{\text{V}}$: 'To perceive by the sense of *taste*'
taste$_{\text{N}}$: 'The sense of what is appropriate'

b. *table*$_{\text{N}}$: 'A piece of furniture consisting of a raised flat top supported on one or more legs'
table$_{\text{V}}$: 'To present or submit formally for discussion or consideration'

c. *stamp*$_{\text{V}}$: 'To bring down the foot heavily'
stamp$_{\text{N}}$: 'A small adhesive label used as prepayment of postage'

(adapted from the OED; cf. Marchand 1964: 12)

For each of the above pairs, it may be possible to claim that there is some type of semantic connection between these particular senses of the noun and the verb. However, the extent to which this connection is easily discernible differs for each pair.

In the case of *taste*, we might argue that this sense of the noun is connected to the verb through another nominal sense noted near the foot of Table 1.1 ('Characteristic quality of a thing, as established by *taste*$_{\text{V}}$'), which would be roughly synonymous with *flavour*$_{\text{N}}$. This 'flavour' sense may then have somehow been extended to refer to a person's ability to taste, or to judge the quality of a food item's flavour – and from there, metaphorically, to their ability to judge quality or worthiness in general. The relationship between the verb and this sense of the noun may thus not be immediately transparent in the sense of 'one meaning being composed of/referring to the other' (cf. §1.3.1.3); however, it is likely still apparent to any current native speaker of English.

In comparison, the meaning of the verb *table* seems somewhat further removed from that of the noun. It does not in any way require the existence of a particular

[18]These are, of course, only a few of a number of senses of *taste*, *table*, and *stamp*, many of which are more transparently related to other sense(s) of their respective conversion pair partners – cf. §1.3.1.3, as well as Marchand (1964: 12), Balteiro (2007: 113), and Plank (2010).

table, or even obviously refer to an action that might involve a table. However, with a little reflection, we might suggest that the verb involves a metaphorical sense of the noun, as in 'to put something on the *table*' – i.e., to present it for discussion. This connection may be reinforced by the high degree of familiarity and saliency of the particular noun.

Finally, consider the case of the nominal and verbal uses of the form *stamp*. Though these senses are etymologically related, many native speakers likely do not even associate them with one another. Upon greater reflection, they might then suggest a connection via an older type of $stamp_{\mathrm{N}}$, in the sense of 'An embossed or impressed mark, such as on a government document.' This might then be connected to the verb sense 'To mark something, either impressed in relief or by ink,' and this sense in turn to the verb meaning in 1.16c through an association with the 'bringing down of something (foot or stamp) forcefully'. However, it seems unlikely that this complex series of relations is necessary for the production or comprehension of the words $stamp_{\mathrm{N}}$ or $stamp_{\mathrm{V}}$ as given in 1.16c.

Though the situation briefly outlined above is less than clear-cut, Clark & Clark (1979: 807-8) offer a neatly summarised explanation, noting that we must first be clear about what is meant when we refer to the *knowledge* a speaker has about such relationships. They make a distinction between three different types of knowledge: (1) 'always-used information'; (2) 'usable information'; and (3) 'awareness on reflection.'[19] They suggest that a synchronic approach might include all *usable information*, but not necessarily any information from more meta-linguistic levels.[20]

Continuing this argument, however, Clark & Clark point out that even if a distinction is made between these different types of knowledge, the situation is further complicated by the fact that 'idioms [forms with specialised meanings - JD] and innovations [forms with transparent meanings - JD] can co-exist,' and

[19]They discuss a fourth type, which they call 'intellectualizable information,' but as this involves knowledge only gained by consulting a specialist (e.g., regarding Captain Boycott, from whose name the verb *boycott* derives), it is not considered here.

[20]I will return to a more in-depth consideration of this subject in §1.3.6. Cf. also §3.2.

that 'these idioms often shade off into innovations, with no clear boundary.' This kind of gradience is reflected in examples like 1.16, which have multiple senses and different kinds of relationships which obtain between them.[21] Furthermore, it seems that the non-categorical nature of these relationships does not solely affect pairs like the above, which lie closer to the periphery of CONVERSION; rather, there also appear to be relative degrees of transparency and predictability across more central cases.

For example, consider the form *grease*, whose nominal meaning is 'oily or fatty matter', and whose verbal meaning is roughly 'to smear with *grease*' (OED). Unlike the senses of e.g., *table*, it is immediately clear that these two senses are synchronically related. Likewise clearly related are the senses of the form *coach*, meaning either 'to train someone for an athletic contest' (Verb) or 'One who trains others for an athletic contest' (OED).[22] However, the relative predictability of the meanings of the forms of *grease* and *coach* seems to differ in a subtle way, in that the nominal and verbal senses of the latter only seem to involve combining the core meaning of *coach* with the functions of referring and predication, respectively. Thus, similarly to *judge* in example 1.15, the noun $coach_{\mathrm{N}}$ might be paraphrased as something like 'the *coaching* one,' while $coach_{\mathrm{V}}$ could be expressed as 'to be a *coach*'.[23] In contrast, the relationship between the two uses of *grease* is somewhat more complex – for example, the verb specifically means 'to apply N' and not, as is the case with e.g., $shell_{\mathrm{V}}$, 'to remove N'. The verb also does not have a meaning like 'to be *grease*' which is simply a straightforward predication of the object meaning.

Still, as with the less clearly related pairs in 1.16, the question of whether the meaning of a particular use is a fully predictable combination of a core meaning with a syntactic function is often more difficult to answer than such examples indicate. The two uses of *wipe*, for instance, might be understood to have a core

[21] Cf. Balteiro (2007: 203).

[22] I am of course here excluding the synchronically unrelated nominal sense which refers to a kind of vehicle.

[23] Cf. Evans & Osada (2005: 367) and §1.5.

meaning describing rubbing something clean, with the nominal sense 'an act of wiping' being a product of this meaning with the use of the form as a referring expression. However, as we shall see in the sections below, there may be other grounds for suggesting that this type of meaning relationship is not as simple as that found in the two uses of *coach* – though, of course, the evidence is not always completely clear-cut. The situation is further complicated by the fact that forms which seem to belong to the same meaning pattern (such as *award* and *catch* in §1.3.1.1) may also exhibit slightly different behaviour in terms of how far their uses seem to share a proposed core meaning. As with relative idiomaticity, it is very often not clear where to draw the boundaries between cases like these. Nevertheless, considerations like the relative predictability of meanings within and across conversion pairs – and the difficulty of determining such a measure for a particular pair – will be shown to have important consequences both for what is considered to be part of CONVERSION, as well as for how it should be described and modelled.

1.3.1.3 Semantic (in)dependence

As alluded to in the discussion above, an issue which is closely related to our understanding of predictability in CONVERSION is the question of what has been termed *semantic dependency* – that is, beyond being simply related in meaning, is the meaning of one form dependent on that of the other? Most theoretical approaches make arguments based on particular patterns of semantic dependence and independence, and the notion is crucial to an understanding of CONVERSION more generally. Indeed, the ubiquity of this idea in the literature is reflected in the table of common meanings in CONVERSION, which uses paraphrases drawn from these approaches, the majority of which define one of the forms in terms of the other. However, much like the other characteristics of meaning I have discussed thus far, the degree of semantic (in)dependence between the two forms in a conversion pair may vary. Furthermore, it is not always clear whether or not a

particular form is semantically dependent – a fact which underlies the motivation for the current study.[24]

Let us first consider a fairly straightforward example:

(1.17) *bottle*$_{\text{N}}$: 'A vessel with a narrow neck for holding liquids'
bottle$_{\text{V}}$: 'To put into a *bottle* for the purpose of storing or keeping'

(adapted from the OED; cf. Huddleston & Pullum 2002: 1641)

It seems clear from this example that the verbal meaning of *bottle* requires some reference to the nominal meaning – it is semantically dependent. The meaning of the noun, on the other hand, in no way entails the existence of the verbal meaning, and it would not be natural to define it as 'a container into which something is put when it is *bottled*' (Huddleston & Pullum 2002: 1641). This sort of asymmetry of meaning also seems to distinguish cases like *wipe* (noted above) from other cases which appear to be more semantically transparent (e.g., *coach*). Thus, although *wipe*$_{\text{V}}$ and *wipe*$_{\text{N}}$ ('an act of *wiping*') may be argued to simply describe the same concept as a predicate and a referring expression, respectively, the meaning of the verb is not as easily definable in terms of the noun – the closest approximation being the rather awkward 'to do *wipes*'.[25] If we accept the possible asymmetry of this relationship, we may also propose that the meanings of *wipe* are not as completely predictable as those of *coach*, as the meaning of the verb cannot simply be the predicate version of the meaning of the noun.

In contrast to such relationships, however, we have already begun to note that other pairs may have meanings which are mutually dependent (adapted from the OED):

(1.18) *guard*$_{\text{N}}$: 'The condition or fact of *guarding*, protecting, or standing on the defensive'; or 'One who keeps, protects, or defends'
guard$_{\text{V}}$: 'To keep in safety from injury or attack; to stand *guard* or sentinel over; to take care of, protect, defend'

[24] Cf. §1.5.

[25] This asymmetry is arguably not as clear as in the case of *bottle*. This issue will be a recurring point throughout this investigation.

One may already have an impression of a further difficulty in determining whether a relationship of semantic dependency holds, given that the same form often has multiple related senses. I will return to this point below. For now, note that both the verbal meaning of *guard* and the second nominal sense provided in fact seem to make reference to one another, with neither seeming to be independent in the same way as $bottle_{\mathrm{N}}$. Furthermore, as with the previously noted form *coach*, we may quite naturally assign these senses of *guard* to the similative group of paraphrases, i.e., $guard_{\mathrm{V}}$: 'To act as/be a *guard*'; $guard_{\mathrm{N}}$: 'One who *guards*/The *guarding* one'. These particular uses thus mutually refer to protecting and defending, and they seem to be fully predictable based on the combination of this meaning and a verbal or nominal function. Although it is true that pairs which fit a pattern like that of example 1.18 may indeed be less numerous than those with an asymmetric relationship of dependency (Plag 2003: 111; cf. Balteiro 2007), a number of pairs nevertheless appear to be mutually dependent or related in this way.

Furthermore, as noted with *award* and *catch*, the particular meaning pattern under which a form seems to fall may not always be indicative of whether and how its uses are semantically dependent. While $catch_{\mathrm{V}}$ does not seem to be definable in terms of its nominal sense 'that which has been *caught*', both forms of *award* seem to mutually refer to one another. We thus cannot assume that all forms in a particular 'class' show the same patterns of semantic dependency.

As a further example of such variation, items in the the class of 'instrumentals' (pairs meaning 'Instrument with which V is performed'/'To...with N' in Table 1.1) often seem to differ in terms of whether or not they exhibit semantic dependency. However, rather than displaying the kind of mutual dependence discussed above, some forms seem to have meanings which are more *independent* of one another. The possible distinctions within this class have therefore inspired a great deal of discussion and debate (cf. §1.4.3). Following e.g., Kiparsky (1983) and others, Arad (2003: 756) suggests that instrumentals are of two types, one in which the

verb's meaning is semantically dependent on the noun, and one in which it is not:

(1.19) a. *She *taped* the picture to the wall with pushpins.

b. *They *chained* the prisoner with a rope.

c. *String* him up with a rope!

d. She *anchored* the ship with a rock.

(Kiparsky 1983 in Arad 2003: 756)

Arad argues that the unacceptability of the sentences in 1.19a and b is due to the fact that the meanings of the verbs *tape* and *chain* 'entail the existence of the corresponding noun,' e.g., '*to tape* roughly means "apply tape".' The verbs *string* and *anchor*, on the other hand, do not require the use of the relevant nouns, as evidenced by the possibility of using some other instrument to perform the action in 1.19c and d. Instead, she suggests that the meanings of these verbs refer more to a certain manner of performing the action. The meaning relationships in such pairs also therefore seem to contrast with the more mutually dependent forms in terms of their predictability, as it is clear that the nominal meaning of e.g., *string* is more specialised than might be expected based on the meaning of the verb – that is, it refers to a particular type of thing which may be used for tying something up, and not simply any 'thing for tying'.

Though examples like these initially seem quite clear, others have argued further that the groups contrasted by Arad do not in fact differ in their patterns of meaning. For instance, Harley & Haugen (2007) point out that, for apparently dependent verbs such as *tape*, one may acceptably use an instrument which is employed in a similar manner to the nominal pair partner:

(1.20) Lola *taped* the poster to the wall with band-aids/mailing labels.

(Harley & Haugen 2007: 9)

Based on this, they suggest that *all* such instrumental pairs involve a central meaning referring to manner, rather than the verbal or nominal form being semantically dependent on its corresponding pair member. However, they do not

offer a corresponding example for *chain*, which on my own intuition seems to be necessary for *chaining* something.[26]

In any case, although such suggestions help to reveal certain semantic characteristics of conversion pairs, they also raise further questions regarding where one draws the line in terms of semantic dependency. Even in the case of $tape_{\mathrm{V}}$, we might argue that a manner of use meaning is still semantic dependency of a type, as one needs to have an idea of how $tape_{\mathrm{N}}$ is typically used in order to understand the manner that is referred to by the verb (cf. Clark & Clark 1979). On the opposite end of the spectrum, one may also speak of *bottling up one's anger*, which of course does not require a literal *bottle*. If the existence of a literal *bottle* is what is required here in order to establish semantic dependency, then the verb may arguably not be semantically dependent on the noun. One might point out that this sense of the verb is more metaphorical, and perhaps cannot be subjected to this test. However, one might also note that the notion of *bottling*, even if it does not involve a literal *bottle*, nevertheless evokes some element of the meaning of $bottle_{\mathrm{N}}$, in terms of it being a (fairly closed off) container into which one puts things, etc.[27]

Furthermore, as alluded to above, the polysemous nature of the forms in conversion pairs (and in the language generally) may mean that we cannot simply say that either 'the noun' or 'the verb' is the semantically dependent use. As pointed out by numerous researchers (e.g., Marchand 1964; Balteiro 2007; Plank 2010), some senses may seem to be semantically dependent in one direction, while others are dependent in the other:

(1.21) $taste_{\mathrm{N}}$: 'a bodily sense, the organs of which are situated chiefly in the mouth' (from the OED 1989)

$taste_{\mathrm{V}}$: 'to perceive by the sense of taste'

$taste_{\mathrm{N}}$: 'the act of tasting,' e.g., *I have had a taste of the pleasures of life*

(Marchand 1964: 12)

[26] Aside from metaphorically – see below.

[27] Cf. Štekauer (1996).

In sum, while there do indeed seem to be many such cases of CONVERSION in which the meaning of one form contains, refers to, or entails the meaning of the other, there is in fact a range of variation across pairs with regards to the precise nature of this dependency, and whether or not it might be argued to exist. An investigation of how this phenomena is mentally represented must therefore be aware of the difficulties in determining such relationships, and must take into account the possible need for more fine-grained distinctions.

1.3.1.4 Semantic range and restrictions

Another semantic pattern which may occur in a conversion pair concerns the semantic range which each member of the pair may have. It is sometimes the case that one form has a wider range of meanings or appropriate contexts. Marchand (1964: 14) notes, for example, that while the noun *'convert* specifically connotes 'a person who has been *converted* to a religious or other belief,' the verb *con'vert* has a much wider range of meanings, such as converting money, measurements, etc. Likewise, Quirk et al. (1985: 1528) list several different senses of *paper*$_{\mathrm{N}}$:

(1.22) *paper*$_{\mathrm{N}}$:

a. material in thin sheets made from wood or cloth

b. a newspaper

c. a piece of writing for specialists

d. wallpaper

(Quirk et al. 1985: 1528)

The verbal meaning of *paper*, however, primarily refers to sense d, and means roughly 'to put wallpaper on (the wall).' Interestingly, this pattern of meaning restriction seems to co-vary with the difference between a noun which is phonologically identical to a verb, and a noun formed from the verb by the addition of *-ing*. Thus, as observed by Cetnarowska (1993: 113), the form *drawing* may

refer to any of the senses of *draw*$_{\text{V}}$; however, the bare noun *draw* is much more restricted, and only refers to 'the drawing of cards or lots' (Plag 2003: 113).

Furthermore, which of the two forms is more restricted may also vary across different pairs, as in the forms of *bin* and *dump* below:

(1.23) a. *bin*$_{\text{N}}$: 'a receptacle for rubbish/something undesirable'
bin$_{\text{V}}$: 'to get rid of something undesirable by putting it in a *bin*'

b. *dump*$_{\text{V}}$: 'to get rid of something undesirable'
dump$_{\text{N}}$: 'a place where one *dumps* something undesirable'

(Plank et al. 2011: 26)

While the meaning of *bin*$_{\text{V}}$ seems to be restricted to putting things in a *bin* (**They binned their litter in a pond*), the meaning of *dump*$_{\text{V}}$ is not subject to the same limitation (*They dumped their rubbish in a pond*). It will be noted, however, that the evaluation of these restrictions is based on a determination of semantic dependency; as such, we must be cautious in drawing conclusions on this matter.

Of course, although many pairs such as these seem to have different ranges of meaning, there are also a number of forms for which this is not the case. Recall, for instance, the two forms of *coach*. While the primary meaning in this pair denotes training for an athletic competition, there is also another, somewhat newer sense which refers to a kind of personal counselling (e.g., as in *life coach*). This sense too may nevertheless apply equally to both the nominal and verbal uses of the form – i.e., anyone who *coaches* in either sense is still a *coach* – and both pair members have thus retained a similar semantic range.

However, as with the other patterns of meaning and meaning relatedness, the multitude of senses among members of conversion pairs means that we may also find that a certain form is less restricted than its corresponding pair member in one sense, and more restricted in another. Consider the verb *plague*. If we think of the nominal sense which usually follows the definite article, e.g., *the plague*, we might consider the noun to have a more restricted range of meaning, given that

this sense refers specifically to the disease caused by *Yersinia pestis*, or perhaps to the outbreak of this disease in Europe which is known as *The Black Death*. However, when the noun follows the indefinite article, e.g., *a plague*, it seems to have roughly the same semantic range as *plague*$_{\text{V}}$ (cf. Balteiro 2007: 138).

The kinds of patterns described above are widely noted in the literature, albeit generally briefly.[28] Although methodological motivations in the later experimental work (cf. §3.2.1) mean that this pattern will not be a primary concern in further discussion, it should nevertheless be kept in mind, particularly with regard to its connection with factors like frequency (Plag 2003: 111; cf. §1.3.5).

1.3.1.5 Semantic-conceptual complexity

A thorough treatment of the issues involved for an understanding of semantic and conceptual complexity, even those restricted to conversion pairs, is outside the scope of this project. However, it is still important to take some of these issues into consideration. For example, it has often been suggested that one form in particular conversion pairs is either more semantically complex or more conceptually complex. Thus, much like the other examples above which seem to display a degree of semantic dependency, the apparently dependent form also seems to have some additional element of meaning:

(1.24) *buy*$_{\text{V}}$: 'to purchase'
buy$_{\text{N}}$: 'a thing which one *buys*'

(Plank et al. 2011: 16)

In this sense, one might argue that *buy*$_{\text{N}}$ is semantically more complex. Of course, it is not always clear in every case whether there even is any difference in complexity, and if so, which form is more complex. In particular, the relative complexity of many of the similative forms repeatedly mentioned above (e.g., *guard, judge*) may be difficult to ascertain, as neither meaning seems to have any additional 'elements' over and above that of the other – is 'one who *judges*' more complex

[28] Cf. §1.4.1.1A.

than 'be/act as a *judge*'? What about the two uses of *hug*, where the nominal use requires an event of hugging, and the verbal use requires the existence of a hug?

As will be discussed in more detail below (cf. §1.4.1.1), some researchers have argued that difficult cases may be clarified by the use of analogies based on morphologically-related affixed and unaffixed words. The assumption here is that forms with affixes should also have additional elements of meaning:

(1.25) a. *search*$_{\text{N}}$: 'an examination or scrutiny for the purpose of finding a person or thing'
search$_{\text{V}}$: 'to conduct/subject to a *search*'

b. *scrutiny*$_{\text{N}}$: 'investigation, critical inquiry'
scrutinize$_{\text{V}}$: 'to subject to *scrutiny*'

(adapted from the OED 1989; Kiparsky 1983: 8)

However, one often finds that this type of analogy may equally apply in reverse:

(1.26) a. *search*$_{\text{V}}$: 'to explore, examine thoroughly'
search$_{\text{N}}$: 'an act of *searching*'

b. *investigate*$_{\text{V}}$: 'to search or inquire into'
investigation$_{\text{N}}$: 'the action of *investigating*'

(adapted from the OED 1989; Kiparsky 1983: 8)

Furthermore, the use of such analogies relies on the assumption of a principal of *iconicity of complexity* – that is, that greater complexity in meaning is accompanied by greater complexity in form (Haspelmath 2008: 2). Of course, if we accept that some forms in conversion pairs are more semantically complex, then these forms violate this principal from the start.[29] Additionally, as pointed out by both Haspelmath (2008: 11-12) and Plank et al. (2011: 28), it is easy to find sets of words which seem to express similar concepts, but which differ in which concept is expressed with greater morphological form.

[29]Though cf. §1.4.1.1.

(1.27) a. *long*$_{\text{Adj}}$ (property) : length$_{\text{N}}$ (abstract quality)

b. *beautiful*$_{\text{Adj}}$ (property) : *beauty*$_{\text{N}}$ (abstract quality)

Initially, it may seem that an abstract quality is more difficult to conceptualise than a descriptive property. Equally, however, the descriptive property might be said to entail a scale of measurement of the abstract quality, so that the corresponding adjective might mean 'noteworthy in terms of *length*/*beauty*' (Haspelmath 2008: 11). In either case, the forms in example 1.27 do not both structurally correspond to one or the other of these interpretations.

Examples like the above also raise a further question regarding just how one determines what should be considered to be more semantic or conceptually complex. For example, should we consider an end state which entails a change-of-state, e.g., *roast*$_{\text{N}}$, to be more or less complex than the corresponding change-of-state, e.g., *roast*$_{\text{V}}$ (Plank et al. 2011: 15)? While one might suggest that a change-of-state is *generally* more complex than an individual state, involving as it does several sub-states, it is not clear whether this would still be the case for an end state like *roast*$_{\text{N}}$, which also seems to presuppose prior sub-states.[30]

To summarise this brief discussion, it seems that semantic-conceptual complexity – in conjunction with the various other semantic patterns brought up in the literature – may be difficult, though perhaps not always impossible to establish. However, as we shall see in §1.4 (cf. also §6.2.1), any differences in meaning within and across conversion pairs which *can* be established to some degree may still turn out to play a role in our theoretical understanding of CONVERSION.[31]

1.3.1.6 Word class prototypicality

The final pattern I will discuss with regards to the semantics of conversion pairs concerns how semantically prototypical a particular form is as an example of its

[30]There is processing evidence which is in line with the theory that events are more semantically complex than states (Gennari & Poeppel 2003); however, as eventive verbs in conversion pairs far outnumber stative ones (cf. §1.3.1.1 and §1.3.1.6), this issue will not be dealt with directly. I thank an anonymous LAGB 2015 reviewer for bringing this issue to my attention.

[31]Cf. Plank et al. (2011).

apparent word class (i.e., noun or verb). As suggested in §1.2.2, there is a large body of research regarding the distinctions between different word classes (or the lack thereof), as well as on the correlation between different functional and semantic characteristics (cf. references in e.g., Sasse 2001; Croft 2001; Morcom 2009; Rijkhoff & van Lier 2013). The situation is, of course, far more complex than the rough approach outlined above. Nevertheless, as many researchers have noted, the types of meanings associated with the major word classes in English seem to be relatively consistent (cf. Morcom 2009: 43; Hengeveld 1992), and may therefore be approximated as follows:

(1.28) a. Nouns denote OBJECTS (persons, things, places)

b. Adjectives denote PROPERTIES

c. Verbs denote ACTIONS

(Croft 2001: 63; cf. Quirk et al. 1985: 74)

It has also been argued that there are degrees of prototypicality within even the central groups of OBJECTS and *actions* themselves, with more concrete objects and more 'effective action[s] involving motion' being more prototypical (Morcom 2009: 65; cf. Givón 2001; Hopper & Thompson 1984; Lakoff 1987). Of course, it is easy to find other examples which do not directly correlate with this grouping – e.g., *movement* functions as a noun but refers to an action. Still, if we take these semantic groups as the most prototypical meanings associated with these word classes, we find a range of degrees of prototypicality within and across conversion pairs. We find, for example, pairs in which both the noun and the verb seem to be objects and actions respectively, such as *bottle* (example 1.17 above). Conversely, there are pairs in which neither of the uses seems to fit neatly into the semantic classes above – many pairs concerning the emitting of sounds, for example *chirp, croak, bark*, etc. The nominal forms in such pairs are not concrete entities in the same way as $bottle_{\mathrm{N}}$; likewise, the verbs, despite being dynamic rather than stative, do not evoke the same sense of action or motion as does the verb $bottle_{\mathrm{V}}$.

In addition to such pairs in which both members appear to have the same level of prototypicality, there are also pairs whose members differ from one another on this parameter. Action-oriented forms like *kick* and *hit* naturally have very prototypical verbs. Their nominal forms, on the other hand, do not refer to any kind of concrete entity, but rather to an element of this same action. Additionally, although verbs like *bin* and *bottle* do indeed refer to actions, it might also be suggested that they are less prototypical verbs than *kick* or *hit*, since in a way the former seem to involve something of the meaning of the corresponding nominal form (Plank et al. 2011: 25).

As compared to the other semantic patterns mentioned thus far, discerning the relative prototypicality of members of conversion pairs is relatively straightforward. However, given the complexity of the relationships between these semantic groups and word class labels like 'noun' and 'verb,' it is not always clear exactly what we can conclude from this information – after all, a less prototypical member of a particular class may nevertheless belong to that class (e.g., *movement* may only be used in nominal positions with nominal inflection). Additionally, as noted in §1.3.1.1, most of the verbal uses involved in conversion pairs in fact refer to dynamic events. This therefore lends the majority of these verbs at least some degree of prototypicality, although there is variation within the group; the same cannot be said for the group of nouns (e.g., $kick_{\mathrm{N}}$ is not very object-like at all). Furthermore, it is worth noting that the relative prototypicality of members of a conversion pair often does not seem to align with the pair members' other characteristics. For instance, although the form *dump* has both a prototypical verbal meaning and a prototypical nominal meaning (example 1.23b), it seems to exhibit an asymmetrical relationship of semantic dependency (Plank et al. 2011: 25-26). One cannot, for example, define $dump_{\mathrm{V}}$ as 'to put in a $dump_{\mathrm{N}}$'. Conversely, a form like *grin* is more prototypical in its verbal use ('to smile widely') than in its nominal use ('a wide smile'), which does not refer to a very object-like phenomenon. However, the relationship between these meanings themselves

(taken from the Oxford Advanced Learner's Dictionary; Hornby & Turnbull 2010) instead suggests a kind of symmetry.[32]

As will be re-examined in detail in Chapter 6, it seems that there is a complex relationship between the relative word class prototypicality of conversion items and these items' other semantic (and non-semantic) characteristics. Although it is not prominently mentioned in the theoretical literature, it is possible that this factor may yet have implications for speakers' treatment of conversion pairs (§1.3.6 and 6.2.1.2).

1.3.2 Syntactic patterns

In addition to their use in positions characteristic of both nouns and verbs, forms involved in CONVERSION also display several interesting syntactic patterns. In parallel with apparent differences in semantic range (§1.3.1.4), members of certain conversion pairs sometimes have a smaller 'syntactic range' than their corresponding pair partner. Thus we find that the verb *neighbour* appears only as *neighbouring*, the nominal form of *remain* only as *remains*, and the noun *halt* only in the phrase *come to a halt* (Marchand 1964: 14; Balteiro 2007: 124).[33] In contrast, their accompanying forms (noun, verb, and verb, respectively) do not have the same restrictions.

In addition to such cases, however, it is also worth noting some of the pairs whose members show certain distinct syntactic patterns. For example, in line with the semantic contrast between *drawing* and *draw* mentioned above, Cetnarowska (1993: 113) further observes that if a verb form may be used both transitively and intransitively (e.g., *beat* in *They beat the prisoners* vs. *My heart beats*), the *-ing* form will correspond to the transitive sense (*the beating of the prisoners*), while the noun in the conversion pair will correspond to the intransitive (*the beat of my heart*). Neither of these forms allow the use of both.[34]

[32]For further information about this source, see §6.2.1.1.

[33]Such examples may arguably fall outside the realm of CONVERSION proper, and may in fact be cases of *partial conversion* – cf. §1.2.1.

[34]Cf. Plag (2003: 113).

Although these kinds of patterns are somewhat restricted in terms of how often they apply, they may still be of use in finding a systematic explanation for the behaviour of those conversion pairs which *do* fall into such groups. They may therefore provide us with an additional means of understanding the nature of CONVERSION in general.

1.3.3 Morphological patterns

A number of patterns which may be considered morphological in nature also obtain among conversion pairs – a fact that is of importance to many of the theories to be discussed in §1.4. In fact, we have already seen a pattern of this sort above, in some of the semantic and syntactic differences between affixed forms with *-ing* and the unaffixed nominal forms in conversion pairs (§1.3.1.4 and §1.3.2). However, we also find certain patterns of morphological variation within the phenomenon of CONVERSION itself. It seems to be the case, for example, that if one form in a conversion pair is irregularly inflected, then the other takes regular inflection by default; otherwise, both forms are regular.

(1.29) a. *sting*$_{\text{V}}$ (irregular past tense *stung*)
sting$_{\text{N}}$ (regular plural *stings*)

b. *cage*$_{\text{N}}$ (regular plural *cages*)
cage$_{\text{V}}$ (regular past tense *caged*)

Occasionally, one of the forms will also show variation across speakers and dialects in terms of whether it is considered regular or irregular (e.g., *dived* vs. *dove* /dəʊv/; *sneaked* vs. *snuck*). While the general pattern of a single irregular form is obviously affected by the rarity of English nouns with irregular plurals, we also find more suggestive cases like the one below. In this example, the form *ring* has two verbal uses alongside its nominal one, one of which is irregular while the other is regular:

(1.30) *ring*$_{\text{V}}$: 'to give out a clear, resonant sound' (past tense *rung*)
ring$_{\text{V}}$: 'to put a *ring* on or in' (past tense *ringed*)
ring$_{\text{N}}$: 'a circular band/item of jewellery'

(adapted from the OED 1989 and Plag 2003: 109)

Note that the sense which is apparently dependent on that of the noun is also the one which takes the regular past tense suffix; the unrelated, independent sense, in contrast, is irregularly inflected. There is further experimental evidence which confirms the strength of this pattern in the grammar of speakers, whereby (a) only one of the forms is irregular, and (b) forms which seem to be semantically-dependent are regular (Kim et al. 1991) – with the irregular forms consequently being those which do not depend on the other form for their meaning. Anecdotally, we might also note that relatively recent, dependent verbs like *Google* and *Skype* (which roughly mean 'to use *Google*/*Skype*,') are also regularly inflected (*Googled, Skyped*).[35]

In addition to the above patterns found within CONVERSION, it is also worth noting what is not found. Similar to derivational processes in English, for instance, there seem to also be arbitrary gaps in CONVERSION, and there is not always an immediately obvious reason why this should be. Thus one can *summer*$_{\text{V}}$ or *winter*$_{\text{V}}$ in a locale, but not *spring*$_{\text{V}}$, *autumn*$_{\text{V}}$, or *fall*$_{\text{V}}$ (Plag 2003: 115).[36] Furthermore, conversion pairs which alternate between two forms containing Germanic suffixes are relatively rare, e.g, *(*to*) *curiousness*$_{\text{V}}$, *(*to*) *ruler*$_{\text{V}}$ (Marchand 1969: 372; Huddleston & Pullum 2002: 1642; Plag 2003: 115; Don 2005a: 13). Although some cases exist, (e.g., *blinker*$_{\text{V}}$; Bauer et al. 2013: 504), it is far more common to find conversion pairs among forms with Romance suffixes (e.g., *bandage*$_{\text{V}}$, *inventory*$_{\text{V}}$; Bauer et al. 2013: 504, Don 2005a: 13). This may partially be a matter of definition, however, as if one chooses to include participial forms like *amusing* and *worried*, or gerunds like *swimming* (cf. §1.2.1), such alternations

[35]Based on my own intuitions, it seems that these verbs may be in the process of undergoing semantic extension, as e.g., *Skyping* someone may no longer require the use of *Skype* as such.

[36]Of course, *spring* and *fall* may be used as verbs with other meanings.

are much more common. Another pattern which may be of further interest concerns the stratum of forms that are usually involved in CONVERSION. In general, it is less common to find (unaffixed) forms of Latin or French origin showing this kind of alternation. Instead, we find nouns like *hospital* being related to verbs like *hospitalize*, and verbs like *arrive* related to nouns like *arrival* (Marchand 1969: 364; Farrell 2001: 118).

As has been noted, such patterns, and their relationship to the other types of variation outlined above and below, have provided fodder for discussion and debate about the role of CONVERSION in the grammar. Their possible implications will be further explored in the theoretical review below, and in §1.5 in particular.

1.3.4 A brief note on phonological patterns

As mentioned in §1.2.3, this study will primarily deal with conversion pairs whose uninflected forms are monosyllabic and phonologically-identical. Nevertheless, it is worth pointing out a particular pattern associated with stress-alternation in disyllabic forms. As has been noted by numerous researchers (Hayes 1981; Kiparsky 1983; Myers 1984; Arad 2003; Don 2005b), polysyllabic pairs which might otherwise appear to belong to CONVERSION fall into two groups according to whether or not the nominal and verbal forms differ in their primary stress:

(1.31) a. $'combine_{N}/com'bine_{V}$
$'object_{N}/ob'ject_{V}$
$'contest_{N}/con'test_{V}$

b. $con'sent_{N}/con'sent_{V}$
$sup'port_{N}/sup'port_{V}$
$'contact_{N}/'contact_{V}$

In the first set of forms, each of the uses bears the stress appropriate to disyllabic members of its word class – the penultimate syllable for the nouns (cf. $student_{N}$), and generally the final for the verbs (Stockwell & Minkova 2001: 172; cf. Chomsky

& Halle 1968).[37] In the second set of forms, both the noun and the verb have primary stress on the same syllable, though it may be either on the penultimate (*contact*) or the final (*consent*). Furthermore, as the studies listed above argue, those conversion pairs which share a stress pattern also seem to be more closely related in meaning. Compare, for example, the forms *contest* and *consent*:

(1.32) a. ˈ*contest*$_{\text{N}}$: 'struggle for victory; competition'
*con*ˈ*test*$_{\text{V}}$: 'to dispute or debate keenly'

b. *con*ˈ*sent*$_{\text{V}}$: 'to agree, comply, yield'
*con*ˈ*sent*$_{\text{N}}$: 'voluntary agreement or acquiescence'

(adapted from the OED 1989)

However, other pairs do not appear to fit into this pattern. Thus, we find examples like ˈ*convert*$_{\text{N}}$ ('a person who has been *converted* to a religious or other belief') which seems closely-related to *con*ˈ*vert*$_{\text{V}}$ (Marchand 1964: 14; cf. §1.3.1.4). Likewise, both the nominal and verbal form of *hammer* are stressed on the initial syllable, and yet these forms have been argued to be semantically more 'distant' due to the fact that the action of *hammering* does not entail the use of a *hammer* (cf. §1.3.1.3).

Finally, there are also occasional 'conversion triplets' in which two forms share the same stress pattern, and the third differs. Those which have the same stress pattern also seem to be comparatively more closely related in meaning:

(1.33) *pro*ˈ*test*$_{\text{V}}$: 'to express disapproval or dissent; to object'
ˈ*protest*$_{\text{N}}$: 'the expression of dissent, typically by means of a public demonstration'
ˈ*protest*$_{\text{V}}$: 'to make the subject of a public *protest*'

(adapted from the OED 1989; cf. Kiparsky 1982: 142)

[37] Though this is subject to other factors, such as the heaviness of the syllable. Cf. Stockwell & Minkova (2001). For a useful corpus study regarding this issue, see Sereno 1986, discussed in Sereno & Jongman 1995.

Although, as stated, I will not be dealing with such forms experimentally, they are important for a full understanding of several of the theories to be described, in particular those which take a more 'mixed' approach (§1.4.3). I will therefore return later to a discussion of the potential theoretical implications of these patterns.

1.3.5 Frequency

As might be expected with a continuous measurement like language-wide frequency of use – whether determined via corpora or subjective speaker surveys (Forster & Bednall 1976) – we find a range of frequency relationships within and among conversion pairs. However, in general, one of the uses will be more frequent than the other, as in the case of *father* in example 1.34a below. In contrast, there are other pairs, such as the nominal and verbal forms of *judge* (1.34b), which may be more similar in frequency.

(1.34) a. *father*$_{\text{N}}$: 'a male parent' (∼300 occurrences per million)
father$_{\text{V}}$: 'to become the *father* of' (∼.95 occurrences per million)

b. *judge*$_{\text{N}}$: (∼59 occurrences per million)
judge$_{\text{V}}$: (∼40 occurrences per million)

(adapted from the OED 1989; lemma frequencies from CELEX)[38]

Such examples highlight a common pattern in CONVERSION: the co-occurrence of frequency and semantic dependency or complexity. In essence, it often seems to be the case that the form which is dependent is less frequent, whereas frequencies are much closer when neither form appears to be more dependent than the other.

Observing this pattern, Plag (2003: 111) argues that semantically dependent forms are more semantically complex, and thus 'tend to have a narrower range of meaning.' He suggests that this more restricted set of appropriate contexts is

[38]Lemma frequency includes the frequency of all inflectional variants of the form in question. For a more detailed explanation of the different kinds of frequency measures used in this study, see §2.3.2.

what leads to dependent forms having a lower overall frequency. Likening this phenomenon to the difference between an affixed form and its stem, he notes that affixed forms also tend to be more semantically complex, as well as less frequent than their stems. However, as suggested by the analogies in the discussion of semantic-conceptual complexity (§1.3.1.5), this pattern is not without exceptions: while *long* is indeed more frequent than its affixed form *length*, the adjective *beautiful* is also more frequent than the corresponding noun *beauty* (Haspelmath 2008: 12). Similarly, there are exceptions to the general tendency for frequency to correspond with semantic relationships, so that $guard_{\text{V}}$ is less frequent than $guard_{\text{N}}$ despite not being asymmetrically semantically-dependent (example 1.18), and $grease_{\text{V}}$ is similar in frequency to the nominal form. Nevertheless, this connection between semantics and frequency is fairly robust.[39]

In addition to this CONVERSION-specific frequency pattern, it is also useful to note here a particular distributional difference which occurs across the language: the contrast between the frequencies of nominal and verbal stems. In English, nouns have a stem form (often unaffixed), and, at most, inflect for the plural and the possessive. Verbs, on the other hand, have a far larger number of inflected forms (various presents, past tense, participles, etc.). This leads to a strong pattern of relative frequencies, in that the nominal stem is far more frequent than its inflected forms, while the verbal stem is far less frequent (Sereno & Jongman 1992 in Sereno & Jongman 1997: 428). This pattern is strongly confirmed by the frequency data in the current study (see §3.3.1.2A), and plays a role in the methodology of Experiment 3 (Chapter 5) in particular.[40] On the whole, the robustness of the frequency patterns in CONVERSION – in addition to its strong effect on word recognition (cf. §2.3.2) – means that it is crucial to a full understanding of this phenomenon.

[39]See also the section on basicness intuitions below.
[40]See also §6.4.

1.3.6 Basicness intuitions

Throughout the discussion above, I have alluded to (though not fully discussed) the issue of basicness – or, perhaps more accurately, complexity. We have seen that there may be a number of asymmetries between the two forms within a conversion pair. One form may be more semantically dependent, complex, or restricted; one form may take irregular inflection, while the other is regular; one may have a meaning more prototypical of its word class; one may be more restricted syntactically, or may be less frequent, etc.[41] In line with these patterns, we also find a tendency towards asymmetry in terms of how speakers think about the nominal and verbal forms with respect to one another. In other words, when a native speaker is asked about a particular conversion pair, he or she will often have an intuition as to which of the two uses is the more *basic*, and likewise which form is potentially less basic in some sense.

Essentially, this intuition seems to be based on the notion that one of the forms (the less basic one) is somehow analysable as arising, or being formed, from the other.[42] But what is the information which is used in making this judgment? Plag (2003: 109) suggests that relationships of semantic dependency are 'chiefly responsible for the intuitive feeling.' Evidence from historically *back-derived* forms seems to support this idea. Consider, for example, the verb *revise* and its morphological relative *revision*. In line with the morphological form of these words, the verb seems to be the more basic of the two, while the noun (meaning 'an act of *revising*') is semantically dependent, in addition to being more morphologically complex. In contrast to this pair, however, is the word *television*$_{\mathrm{N}}$ and its 'back-derived' verb *televise*$_{\mathrm{V}}$. Although their forms are parallel to those of *revise*$_{\mathrm{V}}$ and *revision*$_{\mathrm{N}}$, their meaning relationship is not. Instead, *televise* seems to mean 'put on *television*,' and is thus felt to be semantically dependent. The longer word *television* might then be judged to be more basic (Marchand 1963b:

[41] Though cf. §6.2.1.2 regarding the possible complications concerning word class prototypicality.

[42] Cf. §1.4.1 below.

174).

Though not necessarily disputing the relevance of semantic dependency, other researchers have suggested that it is differences in the frequency of use across the nominal and verbal forms which give rise to these basicness intuitions. Farrell (2001: 123, fn. 23), for example, suggests this as a possibility (cf. §1.4.2; also Kim et al. 1991), while Teddiman (2012) offers some experimental evidence in favour of this argument (cf. §2.3.2). Both propose that the more frequent form may be generally felt to be more basic. However, as indicated in the discussion of §1.3.5, frequency often seems to coincide with apparent semantic dependency. Additionally, both of these characteristics seem to point in the same direction, with those forms which appear to be semantically dependent tending to also be less frequent, and these same forms felt to be less basic. Furthermore, as Plank et al. (2011: 61) points out, the nature of frequency of use means that it is not entirely clear how we should view its relationship to basicness, if there is one: does greater frequency lead to greater perceived basicness, or does basicness cause a form to be used more frequently?

Although from these discussions it is not entirely clear precisely what kind(s) of information basicness makes use of, or how these different characteristics might interact to contribute to speakers' intuitions, it nevertheless seems as if basicness judgments may capture certain nuances of how many of the patterns described in the above sections may correlate.[43] A cursory analysis of these patterns suggests that it is where all of these factors are in agreement with one another that intuitions of basicness are strongest.[44] Thus, in a pair like *bottle*, the noun intuitively seems to be more basic. As noted, the nominal form also has a prototypical noun meaning and is more frequent than the verbal form (∼116 vs. 6 occurrences per million, respectively); the meaning of the verb, meanwhile, seems to be relatively more semantically dependent. Conversely, as we have seen, it is sometimes the

[43] A portion of this thesis (§6.2) is in fact dedicated to exploring what might underlie these intuitions.

[44] Cf. the analysis of Balteiro (2007) regarding where the various linguistic patterns agree and disagree.

case that these patterns are not asymmetric, and the word forms in the conversion pair seem to be similar to one another on a variety of parameters. Depending on the theory one proposes for CONVERSION (cf. particularly §1.4.1), this symmetry may cause problems for analysis. However, it is precisely this sort of issue which has led researchers like Zandvoort (1965: 315) to suggest that '[i]n doubtful cases, it is the linguistic sense of native speakers...that forms the ultimate test.'

Finally, before proceeding to a summary of the linguistic patterns in CONVERSION, and subsequently the models advanced to account for these patterns, I would like to return to the question raised by Clark & Clark (1979: 808), regarding what should be considered to be part of speakers' synchronic knowledge.[45] Recall that Clark & Clark suggested limiting a synchronic description to a level of speakers' knowledge they refer to as 'usable information' – such as the fact that speakers may use the verb *taxi* to refer to 'travelling by $taxi_{\text{N}}$' (although this use might be limited to making a contrast with other modes of travel). Above this level, and outside Clark & Clark's description, is what they call 'awareness on reflection.' Given the line Clark & Clark tentatively draw between these two levels, one might reasonably ask which level basicness intuitions belong to: are they only available upon reflection, or might they be 'usable' or 'always used information' (the lowest level)? I would like to initially propose that most basicness intuitions belong to the lower two levels, though some may perhaps only arise through higher level meta-linguistic reflection. In support of this proposal are the results of Teddiman (2012), who successfully elicited word class judgments in a time-constrained task, finding that they were correlated with frequency (cf. §2.3.2). Furthermore, if basicness intuitions are indeed based in part on some level of usable information based on analysability, then they may turn out to play a role in the formation of new words. Regarding analysability, Quirk et al. (1985: 1533) suggest that we perhaps ought to consider the issue in terms of *motivatedness*. They argue that '[w]hen we become acquainted with a new word,

[45] See §1.3.1.2 above.

we can often judge it, with hindsight as it were, as obviously well-motivated in its formation.' As an example of motivatedness, they give the form *workaholic*, which is clearly based on a combination of *work* and *alcoholic*. However, I would argue that this judgment of motivatedness need not be restricted to 'hindsight,' as speakers clearly incorporate such patterns into their grammar and make them 'usable' for forming new words (e.g., *chocoholic*, *shopaholic*, etc.). The patterns from conversion pairs may be observed to behave in the same way – recall the verbs *Google* and *Skype*. If the general relationship pattern is frequent enough, speakers would not necessarily need to reflect upon these form-meaning relationships, but instead may simply internalise them and use them to extend the lexicon.[46]

Although the brief consideration of basicness intuitions provided here is relatively abstract in comparison to that of the other linguistic patterns, one of the goals of the current study will be to explore this issue further, in the hopes of contributing to a more concrete understanding of its nature. I will thus return to a more detailed consideration of this subject in the chapters to follow.

1.3.7 Interim conclusion

To briefly summarise the overarching theme of the discussion thus far, it seems that there is a fair amount of variation in the linguistic behaviour of conversion pairs, both within individual pairs and across the phenomenon as a whole. Nevertheless, this variation is not completely unsystematic. Instead, we repeatedly find asymmetries at all levels of behaviour, a number of which (as I have noted) may coincide. Still, this does not mean that the patterns of CONVERSION are completely clear-cut: in most of the areas where asymmetry is found, there also appear to be more uncertain or more symmetrical cases. Within these more symmetrical cases, there is a further division between a) those pairs whose alternative uses seem to differ from one another in only minimal ways; and b) those pairs

[46] Cf. Aronoff (1980) and §6.4.

whose uses behave more idiosyncratically, and differ from one another even more than in the asymmetrical pairs. However, despite these systematic differences, it is not always unequivocally clear where the boundaries between these different cases should be drawn.

Although this discourse has been attempted in more descriptive terms, I have hinted here and there at some of the solutions which might be proposed to account for both the systematicity of these patterns, as well as the areas of uncertainty. In an effort to further illuminate the possible answers to these problems, the remainder of this chapter will be devoted to a more detailed examination and criticism of earlier theoretical models of the phenomenon of CONVERSION.

1.4 Theoretical approaches

As noted in the introduction to this chapter, proposed analyses of CONVERSION have come from a wide range of perspectives. Previous studies have presented interpretations rooted in diverse frameworks, from strongly traditional and lexicalist approaches (§1.4.1.1) to more cognitively-oriented ones (§1.4.2) and piece-based syntactic approaches (§1.4.3.2). A major distinction that may be made between these different analyses concerns whether they assume that the relationship between the nominal and verbal forms is synchronically *directional*. In other words, is there an asymmetrical relationship between the two forms, in which one form may be understood as being formed on the basis of the other? Is the former one therefore somehow less basic than the other?

To highlight the different answers to this question, I have chosen to contrast *directional* models, which consider one item in a conversion pair to be formed from the other, with synchronically *non-directional* models, which do not consider the forms to be related in this way. In addition to these contrasting viewpoints, however, other researchers have suggested that the behaviour of conversion pairs calls for an analysis in which both directional *and* non-directional relationships must be acknowledged. These researchers therefore advance what I will refer to

as 'mixed models' (§1.4.3).

In the discussion of the various theories which follows, I will restrict the focus to models of the phenomenon in English. On the one hand, it is true that models of conversion pairs in languages where the situation seems much clearer, such as Dutch (Don 2005b) and Hebrew (Arad 2003), may indeed be indicative of the possible ways of understanding the behaviour of CONVERSION in English. However, because English as a whole differs in the (overt) 'richness' of its morphological system, this has led to a proliferation of alternate possibilities that have not always been proposed for other languages. We also cannot rule out the possibility that the way conversion pairs are treated in English is language-specific, particularly in light of the fact that CONVERSION is closely connected to the language's overall system of word classes – a system which notably differs across languages.[47]

Even within English alone, the theory of CONVERSION is well-researched, and there are a number of comprehensive reviews of earlier studies. I have therefore only outlined the major works in the area, as well as several that are necessary for understanding the context of the approach taken in this study.[48] I will begin by exploring some of the more well-known directional approaches of *zero-derivation* (§1.4.1.1) and *transposition* (§1.4.1.2), noting some of the characteristics these two theories share. This will be followed by a discussion of the non-directional cognitive approach of *category underspecification* (§1.4.2). Finally, I will review and consider mixed models set within both a word-based lexicon (§1.4.3.1) and within the framework of Distributed Morphology (§1.4.3.2).[49]

[47] Cf. §1.2.2 and 1.5.2.

[48] For several recent summaries, see Lieber (2005); Balteiro (2007); Umbreit (2010); and Martsa (2012).

[49] The two additional major approaches of *relisting* (Lieber 1981a, 1992, 2005) and *conceptual recategorization* (Štekauer 1996) have not been included here for reasons of space; however, as we shall see, their non-morphological nature means that they do not fully account for some of the behaviour observed across cases of CONVERSION.

1.4.1 Directional approaches

1.4.1.1 Zero-derivation

The theory of zero-derivation is perhaps one of the most widely-known approaches to the data under discussion. Most notably proposed in the articles of Marchand (1963a, 1964), the zero-derivation model posits the existence of a phonologically null affix, which may attach to the 'basic' (or base) form in a conversion pair, thereby creating a new word which belongs to a different word class:

(1.35) $[father_{\mathrm{N}}] \rightarrow [father_{\mathrm{N}} + \emptyset]_{\mathrm{V}}$

Marchand motivates this phonologically empty morpheme on the basis of proportional analogies with overtly marked derivational processes:

(1.36) $[answer_{\mathrm{V}}] \rightarrow [answer_{\mathrm{V}} + \emptyset]_{\mathrm{N}} = [arrive_{\mathrm{V}}] \rightarrow [arriv_{\mathrm{V}}\text{-}al]_{\mathrm{N}}$

(Marchand 1963a: 176, 186)[50]

The theory behind this assumption is that the addition of an element of meaning should lead to the addition of form, as long as the particular meaning element in question is expressed by added form elsewhere in the language (Marchand 1969: 360). In the example above, the overt affix *-al* appears to express the same meaning ('an instance of V-*ing*') that is expressed by no overt change in the form *answer*. Marchand therefore suggests that conversion pairs, which do not show a difference in form, are subject to the same morphological process as words which do. According to this view, zero-derivation is no different from other types of affixal derivation.

(A) Marchand (1963a, 1964) Key to Marchand's description of zero-derivation is the development of criteria for deciding which of the two uses of a particular form is basic, and which is derived by means of a zero affix. To that end, he argues that the following seven criteria can be used to determine basic and derived status:

[50]Note that Marchand proposes that the zero affix may attach to either a noun (1.35) or a verb (1.36).

(1.37) *Criteria for direction of derivation*:

a. semantic dependence

b. frequency/'range of usage'

c. semantic range

d. semantic pattern

e. phonetic shape

f. morphologic type

g. stress

(Marchand 1964: 10)

The first criterion, semantic dependence, he claims 'is as often as not sufficient in itself' to determine the direction of derivation (Marchand 1964: 10). Marchand determines semantic dependence by paraphrasing definitions of both uses of the form in question:

(1.38) a. saw_{N}: 'a cutting instrument with a blade, having a continuous series of teeth on the edge'

b. saw_{V}: 'use a saw, cut with a saw'

(Marchand 1964: 12)

According to Marchand, because the form saw_{V} is semantically dependent on the meaning of the noun, it must be composed of the noun plus a zero affix.

The next criterion is 'range of usage'. For Marchand, this encompasses both differences in frequency and syntactic restrictions. He argues that $author_{\mathrm{N}}$ is more basic than its corresponding verb because it occurs more frequently, although he provides no numerical frequency data (Marchand 1964: 13). He also notes the more restricted verbal forms of *neighbour* (only used in *neighbouring*), as well as $hunger_{\mathrm{V}}$, pointing out that the use of *hunger* as a verb is usually found in more literary contexts. Because these verbs are more restricted in their usage, they are said to be derived from the nouns (Marchand 1964: 14). In a similar way, the

relative semantic range of both the verbal and nominal forms is used to argue for a direction of derivation, with the form which has a 'smaller field of reference' being considered to be derived from the other. Though he does not elaborate on why differences in frequency, syntactic, or semantic range should lead one to conclude that the more restricted form is derivative, one imagines that his argument would be similar to that of Plag (2003: 111), who suggests that greater complexity of meaning in a word restricts the set of appropriate contexts in which it can appear (cf. §1.3.5).

The final semantic criterion concerns what Marchand (1964: 15) calls 'semantic pattern.' He argues, without much detail, that '[c]ertain words have characteristic meanings which mark them as derivatives.' He defines nouns like *cheat* and '*convert* as 'one who cheats (habitually)' and 'one who has been *converted*,' while the verbs *baby* and *father* are said to mean 'treat as a *baby*' and '*act as a father*,' respectively (Marchand 1964: 15). Marchand thus claims that these patterns may be used to determine the direction of derivation in pairs whose meanings fit these templates.

The last three criteria concern characteristics of the particular forms in conversion pairs. A word's phonetic shape, says Marchand (1964: 16), can indicate whether the verb or the noun is to be considered basic. He notes by way of example that English words ending in /ʃən/ tend to be nouns (e.g., *probation*); therefore, any verbs with this ending (e.g., *station*) are likely to be derived. Similar to this is the criterion of morphologic type, which he argues can help decide the direction of the relationship between zero-derived compound words. Certain patterns (e.g., *keyboard*: noun/noun) are said to be characteristic of nominal forms, so verbs that fit these patterns (e.g., *snowball*) must also be derived (Marchand 1964: 16).

The final criterion, stress patterns, concerns polysyllabic words. Marchand summarises it as follows:

> If the substantive is distinguished from the verb by stress, it must be considered a derivative from the verb, unless content criteria preclude such an analysis.
>
> (Marchand 1964: 17)

This argument is based on another claim, which is that verbs derived from nouns 'retain the [nominal] stress pattern.' However, it is clear that Marchand does not consider this to be a particularly strong criterion, given that he subordinates it to semantic considerations. Though other work by Marchand (e.g., 1969) additionally discusses the various semantic groups that undergo zero-derivation, he continues to apply the above seven criteria to determine the direction of derivation, occasionally using historical evidence to settle ambiguous cases (Marchand 1963a: 183).

Although Marchand does not necessarily explain his reasoning for why each of these criteria should indicate derivation by a zero affix, they do highlight several of the tendencies in the relationships found in conversion pairs. As we have seen, in some cases, semantic dependency may be fairly obvious: one would never, for instance, define eye_{N} as 'organ with which one $eyes_{\mathrm{V}}$'. The nominal form in this pair is also intuitively felt to be basic. Likewise, pairs which display this kind of dependency relationship may also differ in their relative semantic range and frequency in a way that seems consistent with Marchand's assertions.

Additionally, if we accept the argument of Plag (2003: 111) regarding the relationship between derivedness and certain other characteristics (like semantic dependency, semantic complexity, and semantic, syntactic, and frequency restrictions), then a derivational interpretation of conversion pairs would seem to be appropriate.[51] Assuming a directional morphological relationship may also point to an explanation for certain patterns which seem to be morphologically-conditioned, or are similar to those of other derivational processes. For instance, the idiosyncratic nature of derivation as regards semantic transparency and arbi-

[51] However, cf. the above-mentioned sections for problems with this argument.

trary gaps in applicability has often been noted (Plank 1994: 1675; Haspelmath 2002: 71; Plag 2003: 15-17); these characteristics also seem to apply to CONVERSION. Furthermore, a morphological account may be able to explain the tendency for the words in conversion pairs to be Germanic in origin rather than Latinate, as well as to be unaffixed if they are Germanic – if CONVERSION is a morphological process, then it is conceivable that it may be subject to certain lexical constraints which affect other morphological processes (e.g., *-ity* selects for certain Romance stems).

However, as §1.3 will suggest, attempting to apply this model to a wider range of conversion pairs reveals numerous theoretical and practical problems, beginning with the assumptions underlying Marchand's theory of the zero morpheme. Firstly, recall that Marchand (1969: 360) argues that if semantic content is added (e.g., in example 1.36, 'V' becomes 'an instance of V-*ing*'), formal content must be added as well. In the case of overt affixation, this may be a suffix such as *-al* in *arrival*; in cases of zero-derivation, a phonologically empty affix is attached instead. However, as shown in §1.3.1.5, the assumption that additional content corresponds to additional form does not always hold even in cases of overt derivation – compare, for example, *beauty/beautiful* and *prettiness/pretty*. As pointed out earlier, whether one argues that the quality or the property is more semantically complex does not matter; in either case, it appears that additional form and additional content may not necessarily be in parallel (Plank et al. 2011: 86). That this is the case is further confirmed by Marchand (1963b) himself, in his discussion of backformation (cf. §1.3.6).

This same problem applies to Marchand's argument that analogy with overt derivation supports the existence of a zero morpheme (see example 1.36). Recall, for instance, examples 1.25 and 1.26 in §1.3.1.5, which suggested that the noun *search* may parallel either the unaffixed *scrutiny* or the complex form *investigation*. In such examples, it seems that analogy cannot help to determine the direction of derivation, nor does it support the attachment of a zero morpheme

to a particular form. Furthermore, there are other conversion pairs which seem to have no analogical counterparts:

(1.39) a. $out_{\text{Prep}} \rightarrow out_{\text{V}}$

b. $hail_{\text{Interjection}} \rightarrow hail_{\text{V}}$

(Pennanen 1971: 47-8 in Štekauer 1996: 38)

It is unclear in such cases how analogy would determine which member of a pair bears the zero affix.

The directionality criteria proposed here also encounter similar problems. While the main criterion of semantic dependency is easily applied to pairs like $eye_{\text{N}} \rightarrow eye_{\text{V}}$, we have seen above that this is not straightforwardly applicable to all conversion pairs. Additionally, as Štekauer (1996: 128) points out, in some cases it depends on how one defines the items in question. One might just as easily reverse the direction of derivation given in example 1.38, and say that saw_{V} means 'to cut with a toothed instrument' and saw_{N} means 'an instrument for *sawing*.' Much like a number of the other pairs with instrumental meanings (cf. §1.3.1.3), one may also conceive of saw_{V} without the corresponding noun – one may, for instance, saw meat with a knife. Using Štekauer's paraphrases in particular would suggest that the nominal form is semantically dependent on, and therefore derived from, the verb – the reverse of the direction established by Marchand's definitions. In addition to this difficulty, there are also those pairs for which it is not possible to unequivocally determine semantic dependency (e.g., *guard*).

The criterion of semantic pattern is also not entirely helpful in this respect. While Marchand gives examples of items that might have characteristic semantic patterns (e.g., *cheat, father*), he does not outline in detail what he considers a characteristic semantic pattern. Even if further details were given, the criterion still appears to be based on how one defines the words in question. As such, it is difficult to apply objectively. Furthermore, as noted in §1.3.1.1, some patterns which are common across conversion pairs may not even necessarily suggest a

particular direction, and relationships may seem to vary even within a single pattern (e.g., instrumental meanings). The wide range of meanings found across conversion pairs – arguably more diverse than those found in overt affixation (Plag 1999: 231-33; cf. §1.3.1.2) – also does not seem to be entirely in line with a derivational analysis for all such pairs.[52]

Finally, Marchand's claim that stress differences may reveal the direction of derivation leaves certain questions unanswered. Why, for instance, does stress only shift when a noun is derived from a verb? Why does stress-shift not also apply in cases where it conceivably might, e.g. *re'verse*$_{\text{V}}$ → *re'verse*$_{\text{N}}$? Marchand's model does not offer any reasons why there should be such differences, nor does he offer a reason why semantics should outrank stress-shifting. An additional pattern which he does not account for is the apparent correlation of meaning with stress pattern in some cases (§1.3.4). If cases with stress-alternation as well as those without are both examples of zero-derivation, then why should they appear to differ with respect to their patterns of semantic dependency?[53]

Despite the many issues noted here, it may be said that Marchand's work points to certain consistencies in the ways that members of conversion pairs may be related to one another. For some pairs, like *eye*$_{\text{N}}$/*eye*$_{\text{V}}$, assuming a direction of derivation would be relatively straightforward. However, for other pairs it is not so clear, and Marchand's claim do not definitively lead us to conclude that CONVERSION is best explained as a case of derivation by a zero affix. We must therefore look elsewhere for a more complete explanation of the data.

(B) Kiparsky (1982) In an influential article on lexical phonology and morphology, Kiparsky proposes a 'level-ordered' system to explain how morphological and phonological processes act on an underlying form to produce a potentially complex form.[54] Using the model illustrated in Figure 1.4.1.1, he also offers an account of the behaviour of conversion pairs, which he likewise assumes

[52]Though cf. §6.4.
[53]See Kiparsky (1982) below and §1.4.3.1.
[54]A modified version of this model will be discussed further in §1.4.3.1.

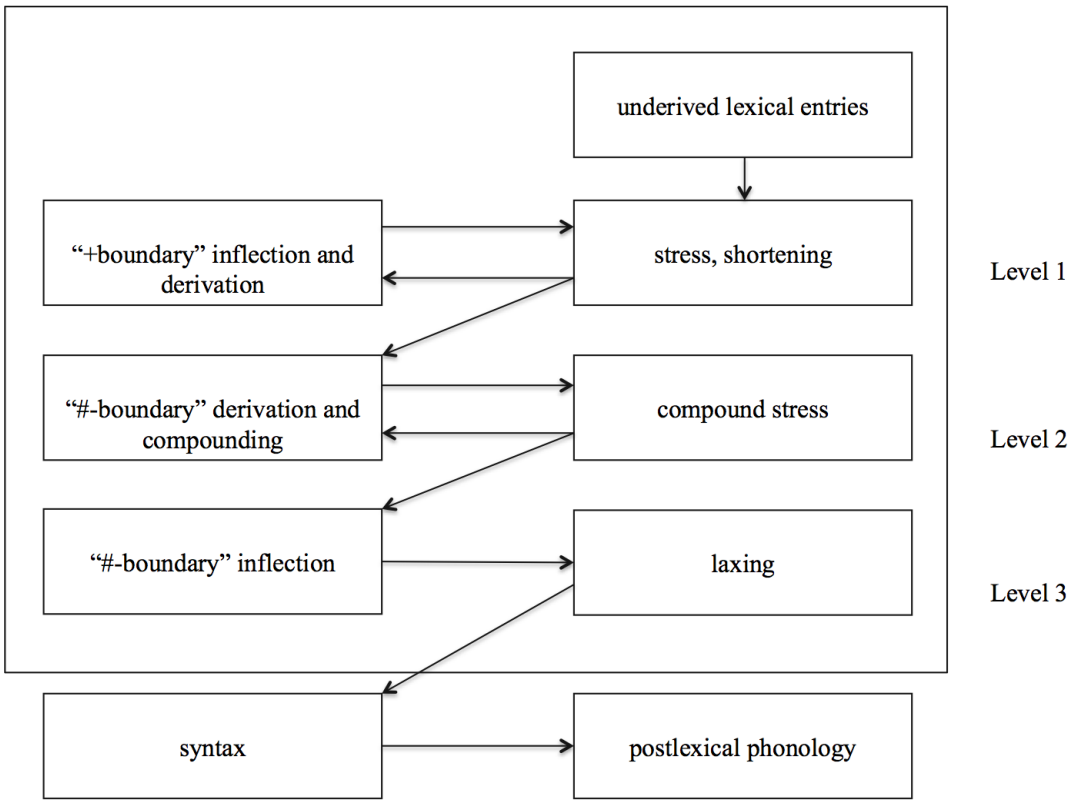


Figure 1.1: Level ordering in Lexical Phonology (from Kiparsky 1982: 133)

are related by a zero morpheme.[55]

To Level 1 of this system he assigns affixes like *-al, -ous*, and *-ity*, and any morphological process that changes the stem – including irregular inflection, as in *teeth* and *lice*. Level 2 includes non-stem-altering derivational affixes like *-hood* and *-ness*, while regular inflection occurs on Level 3 (Kiparsky 1982: 132-33). The levels are cyclic, but one may only proceed 'downward' through the levels – i.e., from 1 to 2 to 3.[56]

In support of this model, Kiparsky explains how the patterns of zero-derivation fit into these ordered levels. The phonologically unmarked Level 1 derivation of certain nouns from verbs is thus represented as follows:

[55]Figure reproduced with permission from Paul Kiparsky.

[56]There are also certain phonologically-motivated constraints on cyclicity; cf. the paper and references therein.

(1.40) Insert /∅/ in environment $[V_n__]_{\text{Noun, +Agent}}$

where V_n = *guide, bore, gossip*

(Kiparsky 1982: 135)

He claims that 'all word-formation is endocentric'; in other words, 'the category of a derived word is always non-distinct from the category of its head' (Kiparsky 1982: 133).[57] In derived words in English, it is generally the rightmost morpheme (usually a suffix) which heads the word and determines its word class. For example, because of the nominal *-ion* suffix attached to the base $instruct_V$, the word *instruction* is a noun (Williams 1981: 248). Thus, the category of the word as a whole is the same as the category of the head. It is this assumption of endocentricity that necessitates the presence of a zero affix, which can act as a head in this environment. If there were no zero affix, this would leave a disallowed structure $[V_n]_{\text{Noun, +Agent}}$, where the category of the word ($_{\text{Noun, +Agent}}$) would be different from the category of the verbal head (Kiparsky 1982: 135).

As evidence for this particular process of zero-derivation occurring at Level 1, Kiparsky points to the tendency of these verbs to disallow the addition of the *-er* agentive affix, which should attach to verbs at Level 2:

(1.41) a. spy_N: **spier*

b. $guide_N$: **guider*

(Kiparsky 1982: 135)

Zero-derivation, having occurred on a previous level, is argued to block this process. However, Kiparsky notes that *-er* is allowed to attach to certain other verbs that also undergo zero-derivation. When this affix *is* allowed, there is a semantic difference between the zero-derived form and the suffixed form:

[57] Cf. Williams (1981); Spencer (1991); and Anderson (1992: Ch. 11).

(1.42) a. *cook*$_{\text{N}}$ (person): *cooker* (device)

b. *drill*$_{\text{N}}$ (device): *driller* (person)

(Kiparsky 1982: 135)

In such cases, zero-derivation does not block the attachment of *-er*; instead, each performs slightly different functions.

Although Kiparsky assigns Verb → Noun derivation to Level 1, Noun → Verb derivation is said to occur on Level 2:

(1.43) Level 1: *stand*$_{\text{V}}$ → *stand*$_{\text{N}}$

Level 2: *grand*$_{\text{Adj}}$ + *stand*$_{\text{N}}$ → *grandstand*$_{\text{N}}$

grandstand$_{\text{N}}$ → *grandstand*$_{\text{V}}$

Level 3: *grandstand*$_{\text{V}}$ → *grandstanded*

(Kiparsky 1982: 138)[58]

The verb must be derived from the noun before Level 3 in order to receive regular inflection. This leaves Levels 1 and 2 as possible locations for deriving denominal verbs. However, Kiparsky argues that Noun → Verb derivation cannot occur on Level 1. As evidence, he claims that polysyllabic deverbal nouns may have a different stress pattern from their apparent bases, but that verbs zero-derived from nouns may not:

(1.44) a. *tor*ˈ*ment*$_{\text{V}}$ → ˈ*tor*ˌ*ment*$_{\text{N}}$

b. ˈ*pattern*$_{\text{N}}$ → **pat*ˈ*tern*$_{\text{V}}$

(Kiparsky 1982: 140)

Stress assignment occurs on Level 1, therefore deverbal nouns must also be derived on Level 1. If one assumes that verbs are derived from nouns on Level 2, it is then predicted that such verbs cannot have their stress reassigned, and must therefore retain the stress pattern of the nominal base (Kiparsky 1982: 140). Kiparsky claims that this ordering may also account for the fact that Noun → Verb zero-derivation is (apparently) more productive than Verb → Noun: more productive

[58]The two processes located on Level 2 in this example are the result of cyclicity.

processes are located on the later levels, where they apply to all items that are not subject to special rules (Kiparsky 1982: 136, 140).

Organising zero-derivation into this level-ordered system makes a further prediction about compounding. If Verb → Noun derivation occurs on Level 1, and compounding on Level 2, we should expect that compound nouns can form zero-derived verbs on that same level, but that compound verbs cannot return to Level 1 to undergo zero-derivation to nouns. Kiparsky's examples seem to support this prediction as well:

(1.45) a. *to grandstand, to wallpaper, to snowball, to quarterback*

b. **an air-condition, *a stage-manage*

(Kiparsky 1982: 141)[59]

A number of other zero-derivation asymmetries also appear to be predicted by this system. By adding the stipulation that 'zero suffixes cannot be added to suffixed forms' within the same level, the model can explain the following patterns:

(1.46) Verbs may be zero derived from nouns that have Level 1 suffixes.[60]
to pressure, to picture, to commission, to proposition, to engineer, to reference

(1.47) Level 2 suffixes may attach to zero-derived verbs.
placement, commissionable, riveter, masquerading

(1.48) But, according to the stipulation, verbs cannot be zero-derived from nouns that have Level 2 suffixes.
**to singer, *to freedom, *to promptness, *to championship*

(Kiparsky 1982: 141-42)

These patterns of derivation and blocking appear to be in agreement with the level-ordering Kiparsky proposes.

[59]My intuition on *to air-condition* and *to stage-manage* is that they are actually examples of backformation from the nominal compounds ending with *-er*, rather than verbs formed by compounding.

[60]Although these are the examples Kiparsky provides, several of these examples do not actually seem to me to be synchronically suffixed, e.g., *picture*.

The final zero-derivation pattern discussed is the lack of 'convincing' cases of Noun → Verb → Noun derivation. This is not simply due to a restriction on attaching zero to a zero-derived word, as Kiparsky argues that Verb → Noun → Verb derivations exist:

(1.49) *pro'test*$_{\text{V}}$ → *'protest*$_{\text{N}}$ → *'protest*$_{\text{V}}$ 'to stage a protest'

(Kiparsky 1982: 142)[61]

In this system, this makes sense: if zero-derivation of nouns from verbs takes place on Level 1, it cannot occur after Noun → Verb derivation, which occurs on Level 2.

(1.50) *pattern*$_{\text{N}}$ → *pattern*$_{\text{V}}$ → **pattern*$_{\text{N}}$

(Kiparsky 1982: 142)

Although there are some examples which initially appear to be Noun → Verb → Noun zero-derivations, Kiparsky argues that these are instead two separate nouns being derived from the verb.[62]

(1.51)

discharge$_{\text{V}}$	→	*discharge*$_{\text{N}}$	'that which is is discharged
	→	*discharge*$_{\text{N}}$	'act of discharging'
paddle$_{\text{V}}$	→	*paddle*$_{\text{N}}$	'implement for paddling'
	→	*paddle*$_{\text{N}}$	'act of paddling'

(Kiparsky 1982: 142)

His assumption that the verb is the underived form in these cases is based on analogy with the meanings of certain non-zero-derivations, such as *spittle* ('that which is spat') and *mixer* ('an implement for mixing'). The level-ordered system also demands that some of these verbs be basic since Level 1 inflection is allowed to apply to them, e.g., the past tense of *spit* is *spat* (Kiparsky 1982: 143). This

[61] Cf. example 1.33.

[62] Though cf. Martsa (2012: 22, fn. 12) for possible counterexamples.

point provides a useful test for direction of derivation: if the verb in a conversion pair is irregularly inflected, and the noun is regular, the verb cannot be derived from the noun on Level 2, or it would have escaped Level 1 inflection. Thus, the noun must be the derived item.[63]

Kiparsky's analysis of CONVERSION offers a model which makes strong predictions for what kinds of patterns and relationships we should expect among conversion pairs. Like Marchand's approach, the derivational approach to conversion pairs in Level-Ordering is also in line with the apparent meaning dependencies which some forms show in relation to their pair partners, as well as other potentially derivational features that we have noted, such as semantic complexity and differences in range of use. Still, as noted, such asymmetries do not always directly correspond with the difference between an affixed form and its base, nor do conversion pairs always display such asymmetries in the first place. That said, certain other characteristics of conversion pairs, such as variations in idiomaticity, arbitrary gaps, and the relative rarity of unaffixed Latinate forms again support a derivational interpretation.

Moreover, in contrast to Marchand, Kiparsky's model also accounts for several additional patterns. For instance, the stipulation against adding zero suffixes to suffixed forms within a level accounts for both the lack of Germanic-suffixed forms among conversion pairs (example 1.48), and the existence of such forms containing Romance suffixes (example 1.46). Kiparsky's division of zero-derivation into these levels also provides a possible explanation for why some pairs show stress alternation, while others do not. The distinction made between Verb → Noun derivation on Level 1 and Noun → Verb derivation on Level 2 is also in line with stress 'triplets' like the various forms of *protest*. Additionally, as noted above, it may make certain predictions which would help decide the direction of derivation for otherwise unclear conversion pairs, if such a direction exists. However, as this cautious assessment will suggest, this model also has several problems with both

[63] Cf. §6.2.2.

its basic assumptions and some of the evidence that is said to support it.

Firstly, while it does not preclude a zero morpheme analysis, Kiparsky's argument also does not provide convincing evidence to support the morpheme's existence. The necessity of the zero affix in his model is based on the assumption of endocentricity. Although exocentric compounds exist in English (e.g. *saber-tooth*), these are dealt with by explaining that they have zero affixes attached which become the head, taking on the features characteristic of the whole compound. The line of reasoning here seems somewhat circular: zero affixes must exist because all word-formation is endocentric; apparent counterexamples are endocentric because they have a zero affix. Despite this issue, as pointed out by Don (1993), Kiparsky's model does not actually hinge upon the existence of a zero morpheme (Don 1993: 35, in Lieber 2005: 419). However, Level-Ordering itself still leaves several questions unanswered with regards to conversion pairs.

A number of these questions are shared with Marchand's approach. Why, for instance, does there seem to be a wider range of meanings in zero-derivation, as compared to those of overt affixations? A further issue is the implication, not made explicit, that the assignment of many of the examples to one direction of derivation or the other is based on semantic content. While the phonological evidence in polysyllabic forms seems relatively clear under this model, we have seen in §1.3.1 that the use of semantic criteria for determining the direction of derivation may be problematic, or at the very least difficult to apply, leaving a number of cases unsolved. Furthermore, even if one chooses to use intuitive paraphrases, it seems as if patterns of semantic dependency may not always be in line with the ordering proposed here. Thus, if pairs with stress-shift should be Verb → Noun, why does the nominal meaning sometimes appear to be more independent from the verbal meaning (example 1.32)? Likewise, why do some nouns which appear to be semantically dependent on verbs still have the same stress patterns as the base (e.g., *con'sent*)? When all we may rely on in monosyllabic forms are the patterns of meaning, it is difficult to see how we can ensure that such evidence is

foolproof.

Although the Level-Ordering explanation of zero-derivation described here leaves us with a number of questions, it also makes several useful predictions about certain morphological and phonological patterns in conversion pairs. However, like Marchand's approach, it does not account for the wider degree of variation found across conversion pairs. In such cases, other models – in particular the amended version in §1.4.3.1 – may provide more insight.

1.4.1.2 Transposition

In the discussions of his proposed framework of *Lexeme-Morpheme-Base Morphology*, Beard (1995; Beard & Volpe 2005) offers an alternative morphological analysis of CONVERSION. The framework advances three primary hypotheses, but of these the Separation Hypothesis is perhaps the most relevant to an analysis of conversion pairs.[64] Under the Separation Hypothesis, derivation is considered to be separate from (surface) affixation.[65] In support of this theory, Beard presents examples like the following:

(1.52) a. *syntact-ic-al*

b. *The annoy-ing*$_{\text{Adj}}$ *boy is annoy-ing*$_{\text{V}}$ *everyone.*

c. *runn-er, correspond-ent, violin-ist*

(adapted from Beard & Volpe 2005: 190)

In (1.52a), the suffix *-al* is semantically empty, and does not seem to perform any derivational or inflectional function. In contrast, the suffix *-ing* in (1.52b) appears to have two different functions. Finally, (1.52c) is an example of one function (agentive nominalisation) being performed by several different affixes.[66]

[64]The other two are outlined in Beard & Volpe (2005: 189-90): '*The Unitary Grammatical Function Hypothesis* claims that there are 44 universally available grammatical functions used for both inflectional and lexical derivations; *The Base Rule Hypothesis* claims that the universal categories of word and clause structure must originate in a base component in order to explain both lexical and syntactic (=inflectional) derivation most economically.'

[65]Note that the framework of Distributed Morphology also proposes the separation of phonological form and underlying structure; cf. Harley & Noyer 1999 and §1.4.3.2.

[66]Precisely what is occurring in 1.52b is of course a matter of debate – cf. the brief mention of participial adjectives in §1.2.1, as well as Huddleston & Pullum 2002: 77-81.

In these examples it seems clear that derivational functions and affixation do not always directly correspond. The frequency of such cases as these, Beard argues, supports a model in which the process of derivation is treated separately from the process of phonological realisation (Beard & Volpe 2005: 191).

With this hypothesis in mind, Beard proceeds to explain how such a model would treat the phenomenon of CONVERSION, which he describes as a type of *transposition*, or word class change. It is first assumed that lexical entries contain a list of the features inherent to their particular lexical class, e.g., verb class and transitivity for verbs, animacy for nouns (Beard 1995: 178; Beard & Volpe 2005: 198). The entry also contains ± values for these features (Beard & Volpe 2005: 194-5). Regarding the use of these features in transposition, Beard states that

> The lexicon may transpose any member of any lexical class (N, V, A) to any other major lexical class by providing it only with the lexical G[rammatical]-features of the target class and neutralizing (but not deleting) the inherent G-features of the base.

(Beard 1995: 177)

If the process accompanying this change of word class is indeed separate from affixation, we should predict that some cases of transposition will involve affixation, while others will not. This prediction seems to be borne out:

(1.53) a. *crystal – crystallize* a'. *clot – (to) clot*
b. *carbon – carbonate* b'. *salt – (to) salt*

(Beard 1995: 180)

The affixed examples and their unaffixed counterparts, Beard argues, have semantically 'identical derivations.' He accounts for the semantic difference between the base and the derived form in terms of their feature values. Thus, for *crystallize* and $clot_{V}$, the noun class features of the base have been neutralised, and a value for the verbal feature of Transitivity has been added – in this case [-Transitive]. This, he says, causes the derived verbs to have the meaning BECOME(XY) – i.e, 'become *crystals*' or 'become *clots*.' In the case of *carbonate* and $salt_{V}$, the

Transitivity feature is assigned a positive value, and the resulting verbs thus have a CAUSE(XYZ) interpretation, as in 'cause to contain *carbon* (bubbles)' or 'cause to contain *salt*' (Beard 1995: 180-1). Deverbal nouns are said to undergo a similar process of acquiring nominal G-features and neutralising verbal ones (Beard 1995: 198-9). If functional derivation is parallel to affixal derivation both morphologically and semantically, and if affixation is separate from derivation, then transposition is understood to be simply a case of derivation like any other (Beard & Volpe 2005: 198-99).

This understanding of the data offers an advantage over a zero-derivation analysis. If we assume that derivation and affixation are separate, this eliminates the necessity of hypothesising an empty morpheme. This would avoid the issues associated with using analogy to determine which form bears the zero affix, although Beard nevertheless seems to be making analogical comparisons in example 1.53 above. Having fully separated derivation from its phonological realisation, the wide range of meaning patterns in conversion pairs is also less problematic, as each pattern need not be a manifestation of a single null morpheme.[67] Additionally, all of the advantages which accompany the positing of a directional morphological relationship as an explanation of the data in CONVERSION also apply to this model. Thus, it would be expected that the behaviour of conversion pairs would appear to mirror that of affixal derivation, as it seems to in some of the semantic relationships between the two forms, as well as in terms of the restrictions on the input (e.g., against affixed or Latinate bases).

Despite these advantages, however, it seems as though this model does not offer much in the way of explaining some of the other patterns in conversion pairs. For instance, can we consider pairs which show stress alternation in combination with meaning divergence to be cases of transposition? If we assume that stress alternation is simply another variant of the phonological realisations of derivation, why would this particular pattern seem to be associated with more divergent

[67] Cf., however, Bauer et al. 2013: 564.

semantics instead of an apparently directional relationship? Conversely, why do some forms in conversion pairs seem to be either mutually semantically dependent or related, without a clear direction? If all of these pairs are assumed to be cases of the same kind of transposition, we fail to capture these more fine-grained distinctions.

For these more symmetrical cases, Beard's model, despite being directional, does not provide tests to determine which member of a conversion pair is the base – in other words, which lexical features are inherent, and which have been acquired through transposition.[68] One might look to the semantics of the two forms to determine which contains the meaning of the other, but, as discussed above, such definitions are not entirely objective, and cannot help us in unclear cases like *guard* or *hammer*. Beard seems to appeal to analogy with the semantics of affixed forms, but as we have seen, this is not a reliable test either. In view of these objections, it is clear that further investigation is necessary if one is to assume a synchronically-directional morphological approach to CONVERSION.

1.4.1.3 A note on zero

Given that both zero-derivation and transposition assume such an approach, placing CONVERSION in the realm of morphological processes, it seems useful to briefly address the element which distinguishes between them: the zero morpheme. As noted in §1.4.1.1, neither Marchand nor Kiparsky provide a convincing reason why a zero morpheme is necessary to understand CONVERSION. Marchand's reasoning for the zero affix is based primarily on analogy, and on the assumption that one of the forms contains additional semantics. As discussed, both of these are problematic assumptions. Kiparsky, on the other hand, motivates the zero morpheme with the assumption of endocentricity. However, he does not need to refer

[68] Beard does not discuss whether his model presumes a separate lexical entry for the derived form. However, this assumption is implicit in his claim that conversion is equivalent to affixal derivation, and also in the notion that a lexical item that has not been transposed contains only its inherent lexical class features, while one which has undergone transposition contains the features of both its new class and the neutralised features of its base. The distinction between such theories and those that propose a single lexical entry will be further discussed in §1.4.2.

to such a morpheme to support the behaviour of CONVERSION in a level-ordered system. If this morpheme is not necessary, it is theoretically preferable not to assume it. As pointed out by Haas (1957), this zero suffix in English only seems to appear in instances where the context would otherwise indicate its presence – for example, a deverbal noun being employed in a nominal position. However, if the context alone may indicate that e.g., *walk* is a noun, the zero affix becomes redundant (Haas 1957: 40). Following this line of argument, further evaluation of the explanatory adequacy of the approaches presented in §1.4.1.1 will therefore not include the assumption of this empty morpheme.

1.4.2 A non-directional approach: category underspecification

The term category underspecification as used here refers to the hypothesis that conversion 'pairs' are actually cases of single lexemes which are semantically and syntactically underspecified for the categories Noun and Verb. Although variations on this hypothesis can be found in earlier work, my understanding of category underspecification as it relates to conversion pairs in English will be based primarily on Farrell (2001), with some additional reference to Evans & Osada (2005).[69]

Farrell (2001: 109) approaches CONVERSION from the perspective of cognitive construction grammar, and proposes that the items in question receive their category-related semantics from the syntactic context in which they occur. He argues that the semantic structure of such an underspecified lexeme may be represented in terms of a conceptual event schema, like the one illustrated for the item *kiss*. The underspecified representation at the top describes the event of the lips of the agent (the larger circle containing lips) making contact with the patient

[69] I will argue in §1.5 that category underspecification should be distinguished from the 'root-derivation' in approaches set within Distributed Morphology, as it seems to make different predictions regarding the relationships between uses in a pair. Some proponents (e.g., Acquaviva 2009) additionally argue for a root which is far more underspecified than Farrell (2001) suggests. Cf. §1.4.3.2.

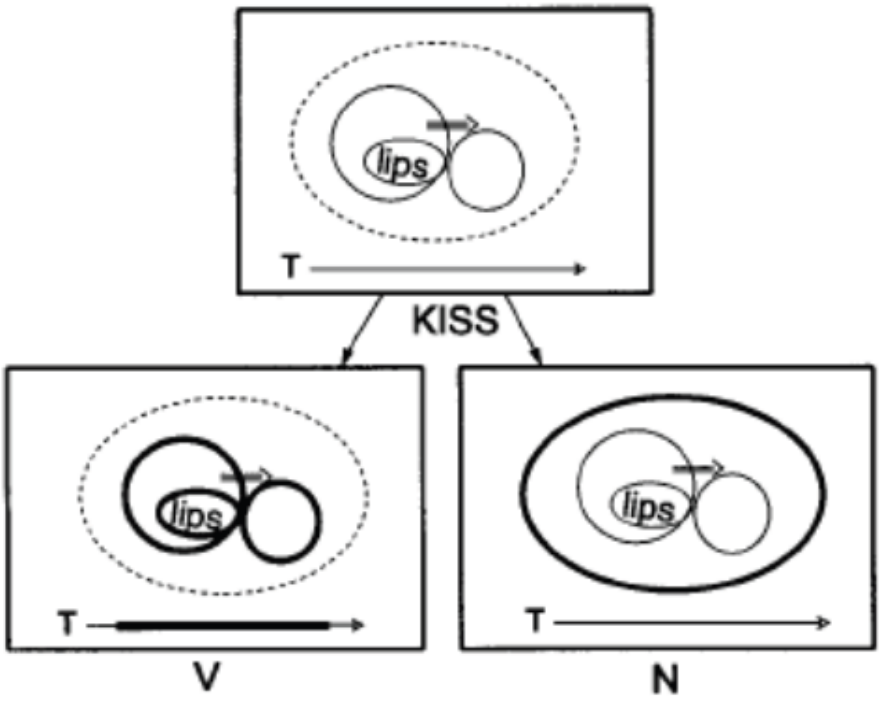


Figure 1.2: Conceptual structure of *kiss* (from Farrell 2001: 114)

(the smaller circle beside it). When this lexeme occurs in a verbal environment, the context will require the 'V' representation on the bottom left of the figure, which focuses on the processual/temporal aspect of *kiss*. On the other hand, when the lexeme occurs in a nominal context, the representation that focuses on the abstract notion of the event as a whole will be required (the 'N'; Farrell 2001: 113).[70]

Here Farrell makes a distinction between a 'process-centered alternation' like *kiss*, and a 'thing-centered alternation' like *bag*, the conceptual structure of which is given below. In this case, the event schema for the underspecified meaning describes the overall event of an agent (the left circle) acting on a patient (the right circle) in such a way that it comes to be within a thing that is considered a

[70]Figures 1.2 and 1.3 and Table 1.2 are from Figures 2 and 3, and Table 2 from Farrell, P. (2001). 'Functional shift as category underspecification.' *English Language and Linguistics* 5(1): 109-30, reproduced here with the kind permission of Cambridge University Press.

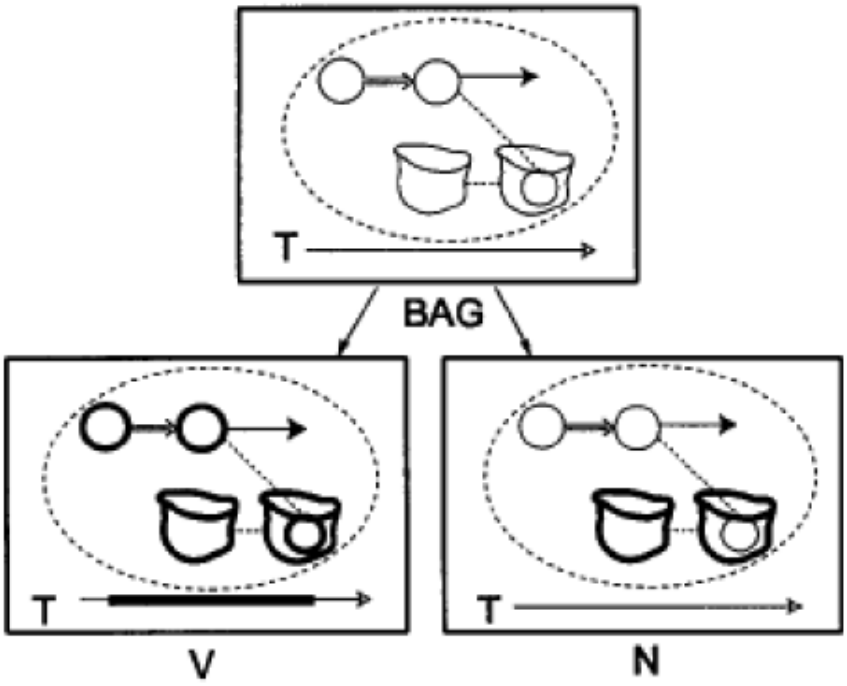


Figure 1.3: Conceptual structure of *bag* (from Farrell 2001: 115)

bag (Farrell 2001: 114).[71] The verbal environment produces a meaning focused on the causative process, while the nominal environment puts the focus on a salient participant in the event. Notice that this meaning alternation differs from that of process-centered alternations, which shift between the processual/temporal aspect and the event profiled as a whole (Farrell 2001: 113-14).

As evidence that this kind of category underspecification can occur in language, Farrell (2001: 116) notes the morphological patterns found in the Northern Californian language Wintu (shown in Table 1.2). In this language, all these forms share the same root, to which a verbal or nominal affix is added in order to create a verbal or nominal form respectively. It is clear here that it is the affixes that determine the word class of the form, while the root *c'a:w* is not specified for this feature. This alternation also fits the 'criterion of compositionality' proposed by Evans & Osada (2005: 367) as a requirement for ascertaining whether

[71] Note that a dotted line between participants signifies identity.

	Gloss	Morphological structure
c'a:wa	'sing'	root+indicative stem-formant
c'a:wada	'1st person singing/just sang'	indicative verb stem+1st person
c'a:wu	'sing!'	root+imperative stem-formant
c'a:wuwil	'sing with them'	imperative stem+comitative suffix
c'a:wi	'song/singer/singing'	nominal stem-formant

Table 1.2: Wintu stem formation with *c'a:w*, from Farrell (2001: 116)

a language lacks word class distinctions. In essence, this criterion states that the meaning of a form in a particular syntactic function must be only the result of the meaning of the root *plus* the features of the syntactic position. In other words, the meanings of the two uses of a root should differ only minimally in whether they are predicates or referring expressions, in order for the root itself to be argued to be underspecified for word class. As this is precisely the case in the Wintu examples, this supports the analysis of *c':aw* as an underspecified root – and likewise supports such an interpretation of those forms in English which fit this pattern.

Farrell further notes that because this model is non-directional and assumes no morphological derivation, a number of objections might be raised. Firstly, as mentioned in previous sections, if these meaning alternations are not the result of a morphological process, why are forms with Germanic affixes less likely to alternate in this way? Farrell (2001: 120) proposes that affixes somehow 'fix their bases as noun or verb.' This then also fixes the 'thing' or 'process' meaning of affixed words.[72] Because they are thus specified for these features, they cannot undergo the same shift in profiling.

Another objection concerns the difference between thing-centered and process-centered words, and the associated speaker intuitions of basicness. According to Farrell, the reason that items like *kiss* and *bag* differ in the kind of profiling shift available to them ultimately has to do with the concept that is most centrally

[72]Cf. the discussion of 'word-derivation' in §1.4.3.2.

associated with the lexeme. In the lexeme *bag*, for instance, the goal bag_{N} is a 'richly specified thing [that] plays a prominent role' in the event schema of the word (Farrell 2001: 123). The nominal meaning of *bag* thus focuses on the goal in the event schema. A word with such a thing-centered conceptual structure would, for the same reason, be intuitively felt to be basically a noun – though, as Farrell (2001: 123, fn. 23) notes, this may also be closely related to the lexeme's frequency of occurrence in the different syntactic contexts.

With this information in mind, the explanatory adequacy of the model of category underspecification may be more fully assessed. This general understanding of the data is in line with several aspects of the phenomenon under discussion. Under an underspecification account, it is not surprising to find such a wide range of meaning patterns in conversion pairs, as these patterns would emerge from the semantics of each individual underspecified lexeme. While it may seem that such a situation might lead to far more variation in meaning patterns than is actually found, the grouping of larger numbers of conversion pairs into certain patterns (cf. Table 1.1) would still not be unexpected, as the patterns would be limited to the types of meanings that nominal and verbal forms may potentially share when there is no further specification for things or processes. This shared, underspecified semantic representation is especially compatible with conversion pairs like *guard* and *coach*, which seem to share elements of meaning without the interpretation of one form being reliant on the full interpretation of the other. Along with Evans & Osada (2005), this model also provides a means for accounting for the predictable, compositional meanings of the two uses of such forms (§1.3.1.2), as the semantics of predication or referring need only be combined with the meaning of the shared root.

However, while Farrell's view is useful for a particular subset of the data, it still leaves several patterns unexplained. Despite the potential 'thing-centred' schema for pairs like *bag* in Figure 1.4.2, it seems to me that semantically-dependent meanings like bag_{V} would still require the entire, specified semantics of the pair

partner on which they depend. Furthermore, a pair like *bag* does not seem to meet the criterion of compositionality, since it refers to a specific type of object with certain features, rather than simply being 'a thing for *bagging*'. Thus, it does not appear that pairs like *bag* could consist of a shared root which is completely unspecified for thing or process features. These issues are also likely tied to speaker intuitions of basicness, for which Farrell's explanation is also not entirely satisfactory. If these intuitions indeed arise from the semantics of the lexeme being either thing- or process-centred, what determines what is the most central? For instance, why is *kiss* not instead thing-centred with regard to a salient participant in the event, such as the lips of the agent? It is plausible that this is simply another instance in which underspecified lexemes differ from each other, but this possibility is not articulated. If speaker intuitions are then instead connected to the relative frequencies of the nominal and verbal uses, what determines which frequency pattern emerges? Does process- or thing-centring determine the lexeme's frequency of occurrence in a particular position, or is it associated with a thing or process because of its frequency distribution? Farrell's discussion leaves such questions unanswered.

Another possible problem remarked upon in a footnote is the fact that unaffixed English words of Latin or French origin generally fail to alternate via CONVERSION (§1.3.3). Farrell (2001: 118, fn. 14) argues that this pattern is due to 'historical accidents.' This is a possible but somewhat unlikely explanation. Given that new conversion pairs are regularly coined (cf. *Googled*), we would expect Latinate pairs to have begun to appear at some point if there were no synchronic morphological constraint against them, as Farrell suggests. Furthermore, while the proposal that affixes 'fix' the category of their bases is not implausible, there is no immediately obvious reason why such 'fixing' should only apply to those forms with Germanic affixes, and not to Romance forms like *pressure*.

Also unaccounted for are the cases where patterns of meaning coincide with differences in form or syntactic features. Farrell does not consider cases like

'*combine*$_{\mathrm{N}}$/ *com*'*bine*$_{\mathrm{V}}$, where both the stress pattern and the meaning diverge to some extent. It also seems clear that any pairs, stress-shifting or otherwise, whose members have relatively independent meanings (e.g., *hammer*) are unlikely to be cases of a single lexeme of the type Farrell suggests, as the shared meaning would be relatively minimal and a great deal more would need to be specific to the particular syntactic position of the root.[73] The idiosyncratic meanings of the individual uses of such pairs therefore do not seem to exhibit the semantic compositionality we would expect. However, even those pairs where one form seems to be clearly related to the other may not fit neatly into this model. If there is only one lexeme in cases like *beat*, why should the nominal form only be related to the intransitive meaning of the verb? Furthermore, why should the verb *paper* be restricted to one sense of the noun, especially when that sense is clearly not the primary one?

Though this model alone clearly does not account for all the data, I will argue further in §1.5 that the theory of category underspecification is not entirely without merit. As will be suggested below, we may in fact be dealing with a number of different phenomena which do not neatly lend themselves to a single theoretical account.

1.4.3 Mixed models

The following approaches, rather than treating conversion pairs as manifestations of a single phenomenon, instead argue for a more fine-grained analysis. As we have seen in §1.3, there is significant degree of variation in the types of relationships and behaviour which obtain across different conversion pairs, which the models discussed thus far have been unable to completely explain. In contrast, the theories outlined below engage with this variation explicitly, noting in particular where it is systematic. Much like the general understanding which underlies the experimental work in the current study (cf. §1.5), these mixed approaches

[73] See §1.4.3.2 below for just such an interpretation.

attempt to account for this systematic variation in terms of differences in the lexical structure of the conversion pairs in question, and the possible kinds of relationships between pair members.

1.4.3.1 A lexicalist approach: Kiparsky (1983)

As noted in several of the examples presented thus far (e.g., example 1.19 in §1.3.1.3), Kiparsky proposes in another paper that conversion pairs do not fall into just two groups (i.e., Verb → Noun and Noun → Verb), but in fact may be divided into *three* categories based on their behaviour. Situating his argument within the Level-Ordering system described previously (§1.4.1.1B), Kiparsky (1983: 8) suggests that this third type consists of 'a class of nouns paired with verbs by virtue of merely sharing the same root.' He cites the examples of Hayes (1981) regarding different types of stress patterns, which I have referred to in §1.3.4 and sections following.

As noted previously in example 1.32, following Hayes (1981), Kiparsky suggests that the kinds of forms which share a stress pattern 'retain a predictable semantic relationship,' while forms like those in example 'are semantically more idiosyncratic.' However, we have also seen that this is not consistently the case – compare also *trans*ˈ*fer*$_{\text{V}}$ and ˈ*trans*ˌ*fer*$_{\text{N}}$ ('that which is/has been *transferred*'), which seem to have roughly the same semantic relationship as *re*ˈ*turn*$_{\text{V}}$ and *re*ˈ*turn*$_{\text{N}}$ ('that which is/has been *returned*'). Nevertheless, Kiparsky (1983: 9) suggests that the nominal and verbal forms with alternating stress are derived from a shared root on Level 1, where they each independently receive the stress assignment appropriate to their word class. The former set of cases, on the other hand, in which both forms have ostensibly verbal stress, are all cases of Verb → Noun derivation. However, rather than this derivation being assigned to Level 1, as in the previous discussion, Kiparsky (1983: 10) here assigns the process to Level 2, on the grounds that the retainment of the verbal stress pattern in the nouns suggests that they have already missed the opportunity for nominal stress

assignment on Level 1. Derivation in the opposite direction (Noun → Verb) is then also assigned to Level 2 for the same reasons (cf. '*pattern*$_{\text{N}}$ and '*pattern*$_{\text{V}}$).

In further support of this tripartite division, Kiparsky (1983: 11) also notes the patterns found among the class of instrumental verbs, which were initially discussed in §1.3.1.3. In that section, it was proposed that in some of these pairs (e.g., *chain*), the meaning of the verb requires the use of the noun, while in others (e.g., *anchor*), it does not (example 1.19). Kiparsky argues that nouns like *anchor*$_{\text{N}}$ (also *string*, *hammer*, *paddle*, *brush*, etc.) are not necessarily needed to perform the activities of their respective verbs; instead, they are 'merely the most *typical* instrument used for the activity' (emphasis in original). He therefore suggests that this is an indication that neither use is derived from the other, but that both are instead derived from a shared root on Level 1, with a meaning roughly representing the manner of the action performed (Kiparsky 1983: 11-12). In contrast, those verbal forms which refer specifically to the use of the noun are said to be derived from the noun on Level 2 – though, as previously mentioned, it is not always clear whether such verbs are truly dependent on their corresponding nouns (cf. example 1.20, and §1.4.3.2).

Nevertheless, Kiparsky (1983: 12) also provides further evidence in favour of the assignment of these processes to different levels. For instance, if we assume that compounding remains on Level 2 as in Kiparsky (1982), then a verb derived from a compound noun on this level should also be dependent on it:

(1.54) a. *You have to *padlock* the door with a latch.

b. *He *snowplowed* the sidewalk with a shovel.

c. *She *charcoaled* the drawing with ink.

(Kiparsky 1983: 12)

Furthermore, any verbs with irregular inflection (e.g., *string/strung*, *sting/stung*) should receive this inflection on Level 1, and thus should not be dependent on their nominal counterparts, as they could only be so if derived on Level 2. Conversely, Kiparsky suggests that verbs which have regular inflection in spite of their

phonological similarity to other groups of irregulars (e.g., *ink*/*inked*, *ring*/*ringed*) should have escaped irregular inflection due to their being derived from – and therefore dependent on – nouns at Level 2:

(1.55) a. to *string* up someone with a rope
to *sting* with a needle

b. *to *ink* a drawing with crayons
* to *ring* pigeons with dye marks

(Kiparsky 1983: 12)

As in Kiparsky's earlier model, an irregularly inflected verb cannot be derived from its corresponding noun. It must either be the base on which a derived noun is later formed on Level 2; or else it must be derived from a root on Level 1, where it may still receive the irregular marking. Denominal verbs, on the other hand, have no such opportunity, as they are not derived until the opportunity for irregular inflection has passed.

These kinds of distinctions which Kiparsky makes between directional and non-directional processes in CONVERSION provide a useful way of accounting for certain aspects of the phenomenon. As noted in §1.3.7, many of the characteristics found in CONVERSION show patterns of asymmetry as well as symmetry. Thus we find pairs in which one form seems to be semantically dependent or more complex; less frequent; more restricted in use; felt to be less basic, etc. Conversely, we also find pairs in which both members seem roughly equal to one another on these parameters. The logical step in this case would seem to be combining a directional model with one that allows for cases which do not indicate directionality, and thereby to capture a wider range of behaviour.

However, although Kiparsky's description possesses an advantage over some of the other models with regards to this consideration, we have already seen throughout §1.3 and above that there are a number of counterexamples to his claims. For instance, the 'semantic idiosyncrasies' attributed to pairs with stress alternation are said to be the result of each form being independently derived from

a shared root on Level 1.[74] However, there appear to be pairs which are either closely related in meaning, yet nevertheless alternate in stress; or else, they share a stress pattern (e.g., *hammer*), but arguably do not display semantic dependency. It is unclear from his proposal why a disyllabic form which is possibly root-derived might not alternate in stress, nor why an ostensibly dependent form might have a different pattern from its potential base. There also does not seem to be room within this model for those pairs like *guard* which seem more closely related, and yet do not appear to be related directionally; while they could arguably be derived from the same root on Level 1, Kiparsky seems to imply that this process is only indicated in cases of stress alternation and semantic idiosyncrasy. As noted in §1.4.1.1 above, however, while the phonological evidence among polysyllabic forms on its own may be well-suited to this account, it is not clear how one should understand the behaviour of monosyllabic pairs, especially given that the semantic patterns in disyllables do not always seem to correspond to the stress patterns.

A further issue concerns why Kiparsky has chosen to reassign Verb → Noun derivation to Level 2, rather than Level 1 as previously. It might be supposed that many of the examples presented in favour of the latter (such as the blocking of forms like **guider* in example 1.41) may be more accurately assessed as involving Level 1 root-derivation. Still, the assignment of nominalization to the same level as Noun → Verb means that it would be more difficult to distinguish instances of these two processes.

Altogether, despite the theory-particular questions raised by Kiparsky's arguments for both directional and root-derivation, the ability of his mixed model to begin disentangling some of the patterns found in CONVERSION still suggests that the intuition behind it may point in a promising direction.

[74] Cf. §1.4.3.2.

1.4.3.2 Root-derived vs. word-derived: a Distributed Morphology approach

Following on suggestions like those above, researchers working within the framework of Distributed Morphology (DM) have offered additional arguments which may explain some of the patterns found among conversion pairs.[75] According to the account of Arad (2003) discussed below, one may – just as in Kiparsky's approach – make a distinction between pairs of nominal and verbal forms in which both are directly derived from the same root (*root-derived*) and those pairs in which one form is derived from the other (*word-derived*), by conducting an examination of their phonological, syntactic, and semantic behaviour. While others (e.g., Harley & Haugen 2007) do not necessarily make this distinction, they still suggest that aspects of the behaviour of conversion pairs may be indicative of their underlying morphological structure.

In contrast to lexicalist theories, however, root-derivation is not considered in DM to be in any way an unusual or special situation. To briefly outline this framework, the grammar in DM does not contain a traditional 'lexicon.' Instead, there are abstract 'morphemes' (e.g., features such as [plural], [past], etc.) which may be combined together in certain ways according to rules of the syntax. These syntactic rules control the processes at all combinatorial levels, including what in lexicalist approaches is considered to take place in the lexicon (i.e., *word-formation*).[76] Because words are seen to be built by the same rules as phrases (cf. Marantz 1997), a DM approach does not involve a 'lexicon' which contains a list of words in the language, but rather a *Vocabulary*, which lists relations between abstract morphosyntactic information ('atomic roots...and atomic bundles of grammatical features,' possible insertion environments) and phonological realisations (Marantz 1997: 203).

[75] For the seminal paper outlining the theory of Distributed Morphology, see Halle & Marantz (1993). A concise summary is provided by Harley & Noyer (1999).

[76] Certain types of post-syntactic modification (e.g., Merger, Fusion, Fission, etc.) are also allowed (Harley & Noyer 1999: 5-7).

(1.56) *Example Vocabulary Items*:

a. /n/ ←→ [___ , +participant, +speaker, +plural] (A clitic in Barceloni Catalan; Harris1997a)

b. /y-/ ←→ elsewhere (An affix in the Ugaritic prefix conjugation; Noyer 1997)

c. ∅ ←→ 2 plural (A subpart of a clitic in Iberian Spanish; Harris 1994)

d. /kaet/ ←→ [$_{\text{DP}}$ D [$_{\text{LP}}$ ___]] (Root inserted in a nominal environment in English; Harley & Noyer 1998)[77]

(from Harley & Noyer 1999: 4; see references therein)

A crucial feature of the Vocabulary is that Vocabulary Items 'need not be fully specified' for all their possible insertion environments, nor indeed for all of the features which one might typically associate with a 'lexical item' (Harley & Noyer 1999: 3). For instance, the prefix in 1.56c is simply the default, and is only inserted when no more highly specified signal is required. Furthermore, a lexical root (or *l-morpheme* in the terminology of Harley & Noyer 1998) like *cat* is not itself specified for word class membership, but rather surfaces as a noun or a verb depending on its immediate syntactic environment (Harley & Noyer 1999: 4). Once appropriate phonological representations are associated with the abstract features within particular syntactic structures – and following any subsequent post-syntactic operations which manipulate phonological forms – these representations then interface with the Encyclopedia, which contains non-linguistic knowledge (e.g., for *cat*, is a furry animal, has four legs, etc.). From there a fuller semantic representation is realised (Harley & Noyer 2000: 352; Harley & Noyer 1999: 3).

In essence, DM distributes various elements of what is traditionally understood to be 'the lexicon' across the phonological, syntactic, and semantic components of the grammar (Harley & Noyer 1999: 3). More importantly for our

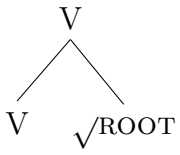
[77] I will return to the issue of the representation of nouns below.

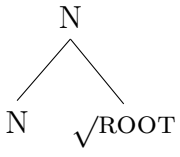
purposes, however, is the fact that lexical roots themselves do not have an inherent specification for word class. To reiterate, the atomic lexical roots in DM only become 'nouns,' 'verbs,' 'adjectives,' etc. when they appear in particular syntactic environments. However, proponents differ in some cases as to what this environment is assumed to be. For instance, most agree that roots become verbs when they appear (minimally) somewhere below a *little v* functional head (Marantz 1997; Harley & Noyer 1999; Alexiadou 2001; Arad 2003; Acquaviva 2009).[78] Nouns, on the other hand, are either assumed to be formed by placing a root below a *little n* head (Arad 2003; Embick & Marantz 2008; Lowenstamm 2008; Acquaviva 2009; Marantz 2013), or by placing a root (and its associated structure) into the environment of a Determiner Phrase, or DP (Harley 1999; Harley & Noyer 1999; Alexiadou 2001; cf. example 1.56d). A full discussion and evaluation of the theory of DM – as well as of the more particular issue of the presence or absence of little n – is outside the scope of the current study. Instead, I will consider the following DM account of conversion pairs on its own merits, and evaluate it simply with respect to its ability to account for the behaviour of the words in question. The question of whether or not nouns are formed via little n will be left open, and both options will be explored in turn in later discussions (cf. especially §4.3.1 and §5.3.2).

The account of conversion pairs which I will focus on is that of Arad (2003). In this paper, Arad primarily explores the patterns which obtain across Hebrew words, in particular the case of denominal verbs. In order to explain certain semantic, morphological, and phonological patterns in Hebrew, she proposes three groups of nominal and verbal surface forms: (1) those derived directly from an underspecified root (1.57); (2) verbs derived from a word specified as nominal (1.58); and (3) nouns derived from a word specified as verbal (1.59).

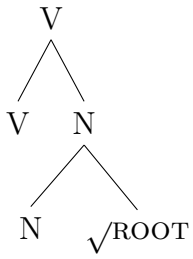
[78] Little v (or little vs) may be associated with a variety of different functions typically assumed to be verbal in nature – cf. references listed here, as well as Folli & Harley (2005) and Marantz (2013).

(1.57) *Verbs (a) and nouns (b) derived directly from roots:*

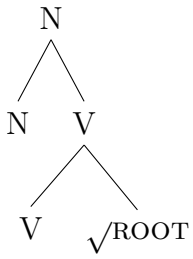
a.


b.


(1.58) *Verbs 'word-derived' from nouns:*



(1.59) *Nouns 'word-derived' from verbs:*



(Arad 2003: 757)

Revisiting the arguments and evidence of Kiparsky (1983) above, Arad suggests that the phonological and semantic patterns which he notes may also be accommodated by a DM framework recognising these three different categories. Like Kiparsky, Arad (2003: 758) claims that verbs like *tape* and *chain* (example 1.19) are semantically dependent on the meanings of their corresponding nouns. In contrast, again, are the *anchor*- or *hammer*-type verbs, which are argued to be semantically *independent* from their respective nominal forms, based on the fact that the noun itself is not a required component of the meaning of the verb. The

crucial point in Arad's model, however, is *why* these pairs should differ in the semantic relationships they have with the noun.

According to Arad, the differences we have repeatedly noted arise from the relationship between roots and specifications of word class in DM. Recall that DM argues for the existence of atomic lexical roots which do not have an inherent specification of word class. As such, if they are neither nominal or verbal, their semantic representations must also be underspecified regarding whether they refer to an entity or an event of some kind. Thus, when they do become specified through derivation, their meanings may diverge to an extent – so that, for *hammer*, for instance, neither the noun nor the verb 'entails the existence of the other' (Arad 2003: 757).

Returning to words like $tape_{V}$ and $chain_{V}$, then, the claim is that the entailment of the noun suggests that the input to these verbs is *not* an underspecified root, but a full word whose semantic and phonological properties have already been interpreted upon the merging of the root with a nominal head (Arad 2003: 758). Thus, the meaning which is specific to the nominal form must be incorporated into the meaning of the verb. Based on these patterns and those of Hebrew, Arad (2003: 747) proposes a *Locality Constraint*:

> *Locality constraint on the interpretation of roots*: roots are assigned an interpretation in the environment of the first category-assigning head with which they are merged. Once this interpretation is assigned, it is carried along throughout the derivation.

Furthermore, she argues that verbs and nouns derived directly from the root *cannot* entail one another in their meanings, 'because the interpretation of the noun is only available at the nominal projection,' and likewise the verb at the verbal projection (Arad 2003: 759).

The postulation of this locality constraint makes a further prediction regarding the surface phonological forms of pairs, depending on whether they are root-derived or word-derived. Thus, in line with Kiparsky, Arad also proposes root-derivation for disyllabic conversion pairs which alternate in their stress patterns.

Like their meanings, if the phonological forms of root-derived nouns and verbs are interpreted independently, we might expect that this may lead to phonological divergence in some cases. Conversely, if word-derived forms are dependent on the previously interpreted, fully specified word, they would be expected to retain the stress pattern of the word from which they were derived.

As for nouns word-derived from verbs, Arad (2003: 764) suggests that the locality constraint should apply and operate in the same way. She presents, without much discussion, a few potential cases of deverbal nouns, such as *wipe*, *roast*, and *walk*, noting that all seem dependent on the existence of the event referred to by their respective verbs and fall into a pattern which selects a specific 'piece' of the event (Arad 2003: 765). As for the root-derived counterparts to these sorts of meanings, she argues that 'a *run* does not require a *running* event in the same way a *walk* requires a *walking* event' (Arad 2003: 766; emphasis JD). It is not immediately clear to me what distinction is being made here between *walk* and *run*, unless the intention is to refer to more metaphorical meanings (e.g., the musical's *run*).

To summarise Arad's position, she agrees with Kiparsky (1983) regarding the division of conversion pairs into root-derived and word-derived, with the caveat that this derivation is carried out by the syntax rather than the lexicon. Additionally, the Locality Constraint which she proposes provides a useful account of why root-derived pairs might differ in their phonological or semantic specifications, and why word-derived pairs should have more in common. However, it will have been noted that, like many other accounts, the majority of her evidence is essentially based on semantic dependency. As I have argued in §1.3.1.3, it is not always easy to determine whether or not a form is semantically dependent; in fact, Harley & Haugen (2007: 9) specifically dispute her claim regarding *tape*, and suggest instead that all conversion pairs in the instrumental group are cases of derivation from a root specified only for manner (cf. example 1.20). Additionally, like Kiparsky (1983), Arad does not discuss how to model unclear cases

which appear to be neither directional nor divergent in meaning or form, and thus appear to share a single meaning which is not dependent on full nominal or verbal interpretation. Still, like Kiparsky's account above, Arad's approach provides us with some additional constraints regarding what we might find in the data, and how certain patterns could possibly be interpreted.

1.5 A working model of CONVERSION

In this chapter, I have attempted to provide an overview of the behaviour of the types of word forms under consideration, as well as an evaluation of some of the many theoretical analyses which it has inspired. However, the picture which has emerged from the preceding discussion is not entirely clear. To begin with, although I have presented evidence for and against particular theoretical formulations as though it were fairly unambiguous, the examples and discussion in §1.3 are of course far more variable. It should therefore be noted that references to particular patterns only point to *tendencies*, rather than categorical constraints. As with many phenomena which resemble processes of word-formation – whether morphological or not – there are idiosyncrasies, counterexamples, and gradient elements. Furthermore, the nature of the semantic relationships in conversion pairs (e.g., dependency, complexity), in combination with this gradience and a high degree of polysemy, means that it may be difficult to determine how or even whether certain pairs are related.

With these caveats in mind, I would nevertheless argue that a directional relationship must be acknowledged in those cases where certain characteristics most straightforwardly cluster. Thus, cases like that of *bottle* or *buy* – whose pair members seem to be asymmetrically related with respect to semantic dependency, frequency, (potentially) word class prototypicality, basicness intuitions, etc. – appear to be best analysed under a model which assumes that one member of the pair is an input to a process, and the other member of the pair is the output. The output then retains certain aspects of the input, e.g., elements of meaning, and of

course phonological form. However, it need not retain all features – the process may, for instance, operate upon only one sense of the input (compare *paper*$_{\text{N}}$ and *paper*$_{\text{V}}$ in example 1.22, or *beat*$_{\text{V}}$ and *beat*$_{\text{N}}$ in §1.3.2). Its inheritance of only a subset of the input's features may still suggest a directional relationship.

However, I would also like to propose that the assumption of directionality should be taken a step further, and therefore I also suggest that this relationship is *morphological*, and not just semantic. I have tentatively based this working hypothesis on the ability of the morphological models (zero affix aside) to account for apparently directional cases, and to explain the apparent existence of morphological constraints which seem to be in operation on this directional process, such as the relative rarity of pairs involving forms with Germanic suffixes, as well as the differences in inflectional regularity (cf. §1.3.3). Although I have used the term *morphological*, it should be noted that a relationship such as that described above may either be understood in terms of a lexicalist (1.60a) or a syntactic (DM; 1.60b) approach. The crucial hypothesis which these approaches share is that the output form has *additional underlying structure*. This structure may be represented roughly as below, where an input form *X* of word class *Y* is morphologically converted to word class *Z*. This process may apply in both directions, from Noun → Verb or Verb → Noun, and it results in a new lexeme with a related but distinct meaning.[79] I will refer to this process as *conversion*.

Although I am proposing that the process described offers a means of understanding those pairs which suggest directionality, it nevertheless seems clear that we cannot assume such a process for all conversion pairs. For one thing, there are more patterns of meaning relatedness than would be expected for a single morphological process (Bauer et al. 2013: 564). More importantly, there are also those cases where the forms in a pair suggest a kind of mutual dependency or relatedness (e.g., *guard*, *coach*), rather than a relationship of input and output.

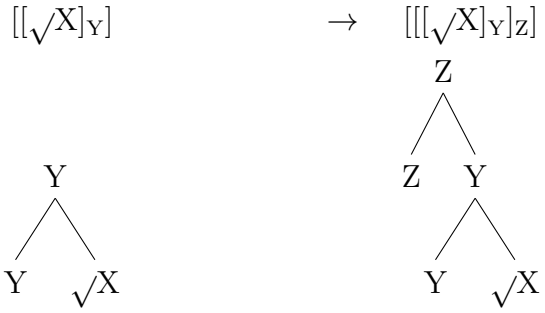
[79]It should be noted that, for the time being, the syntactic representation in b assumes the presence of a little *n*.

(1.60) *Morphological conversion*:[80]

a. Lexicalist representation:



b. Syntactic (DM) representation:



In addition to such pairs, however, we also find cases which instead appear to be relatively *independent* in certain ways (e.g., *hammer*, *'contest/con'test*). These, too, seem unlikely candidates for a directional process.

In light of such patterns, I would therefore like to propose a *non-directional* analysis for cases like these. Given that their behaviour differs in important ways, however, it is more appropriate to further subdivide these into two different phenomena: underspecification and root-derivation. Beginning with the latter, as it is hypothesised to function roughly as described in §1.4.3, I will assume that pairs which appear to share some element of meaning, and yet also have somewhat divergent semantics are in fact cases of root-derivation. As noted by both Kiparsky (1983) and Arad (2003), explaining such cases as pairs of individual forms, each independently derived from a common root, offers an explanation for why they seem to differ in certain ways – particularly their meanings, and sometimes their phonology. The key point for understanding these pairs – and how they differ from the underspecified ones discussed below – is summarised in

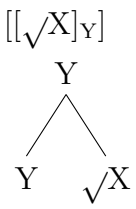
[80]The lexicalist tree is here represented as headless (i.e., without a *Z* head), as in Kim et al. (1991: 181); however, it might alternately be represented as involving a head which contains either a zero morpheme or some other type of phonologically null element.

the quote by Arad (2003: 758):

> Each specific interpretation of the root is only available in a specific (syntactic and phonological) environment.

In other words, the reason why the meanings and forms may differ between items derived from a common root is that neither derived form has access to the meaning or surface phonology of the other – these specifications are only present once the noun or the verb has been derived. Following Arad, I will represent cases of root-derivation as below.

(1.61) *Root-derivation*:



In these cases, a word *X* of word class *Y* has been derived from the acategorial root $\sqrt{X}$. *X*s of other word classes may also be derived from this same $\sqrt{X}$; however, they do not have access to the interpretation of $[[\sqrt{X}]_Y]$.

Given this constraint, root-derivation seems to be able to account for the kinds of patterns found in pairs like *hammer*. As products of derivation, the nominal and verbal uses of these pairs are prone to semantic and phonological idiosyncrasies.[81] However, it does not make the correct predictions for apparently mutually dependent, symmetrically-related pairs like *coach*. These pairs clearly do not diverge in meaning or form, but instead are closely tied, with neither of the uses seeming to be conceptually independent nor asymmetrically related. Their meanings seem to differ only in whether they function as a predicate or a referring expression. For these pairs, it appears that a kind of flexible underspecification is called for.

This underspecification, I propose, would still involve a common root for both forms in such pairs. As in root-derivation, this common root would be unmarked

[81] Cf. §1.5.1 below.

for word class, and its semantics would be underspecified for the distinction between entities and events/processes, much like the sort of schemas proposed by Farrell (2001; cf. §1.4.2). However, rather than the nominal or verbal uses being *derived* from this common root and receiving independent interpretations, these roots would simply be placed in a typically nominal or verbal environment, as indicated by the context (e.g., inflectional suffixes, determiners). It is not entirely clear from the present data whether such forms with disambiguating inflection or particles (e.g., *to* in *to guard*) would themselves be fully categorised as nouns or verbs in a similar way to the root-derived forms. However, given the relatively minor meaning alterations between e.g., *to coach* and *a coach*, I would propose that such forms do not become categorically 'specified' before they appear in a sentential context.[82] Outside of this sentential context, the different nominal and verbal markers on these forms would function as a kind of inflection, with all of them belonging to the paradigm of a single root. These inflectional markers would indicate morphosyntactically relevant information (e.g., entity or process) without significantly altering the meaning of the root or 'creating a new word.' In this way, each use in the context of these markers would still have access to the interpretation of the other forms, as this interpretation is shared.

The three-way distinction roughly sketched above is the one under which this study will operate. However, before the claims made here can be articulated more fully, it is necessary to briefly address two closely related issues as regards the contrast between conversion and underspecification, and the type of distinctions which must be assumed. The first concerns the difference between inflection and derivation; the second will then return to the relationship between the analysis of conversion pairs and the overall organisation of word classes in English.[83]

[82] Cf. Don & van Lier (2013).
[83] Cf. §1.2.2.

1.5.1 Inflection vs. derivation

To greater or lesser degrees, traditional linguistic theory has generally assumed that there is a useful distinction to be made between an inflectional process and a derivational one (Perlmutter 1988; Scalise 1988; Plank 1994; Booij 1996 – though cf. Halle 1973). It has been argued that the major difference between the two processes is the particular relationship between the complex (output) form and its stem/base (input) – in essence, is the complex word simply another form of the same lexical item (inflection), or is it a separate lexeme created by the application of a morphological process (derivation)? As noted by Bauer et al. (2013: 533; *inter alia*), the answer to this question is not always unequivocal, and is sometimes at risk of circularity when the distinction between being a separate lexical item or being a *form* of a lexical item 'is defined in terms of the distinction between inflection and derivation.' In order to cope with this difficulty, a number of researchers have chosen to approach the distinction in terms of a feature-based continuum, ranging from prototypical inflection at one end, passing through less clear intermediate cases, and then to prototypical derivation at the other end. A few of these features (quoted from Bauer et al.'s summary of Plank 1994) are listed below:

> - Inflection is typically formally regular; derivation may not be.
> - Inflection is typically semantically regular; derivation may not be.
> - Inflection is typically fully productive; derivation typically shows (unmotivated) gaps in productivity.
> - Inflection does not add significantly to the meaning of the base, but contextualizes that meaning; derivation adds to the meaning of the base.
> - Inflection does not change the major category (noun, verb, etc.), but derivation may.
>
> (Bauer et al. 2013: 534, on Plank 1994)

The basic argument is that the distinction is not categorical, but rather more to do with the interaction of different aspects of the relationship between a complex form and its stem/base on the one hand, and between the complex form and other bases and complex forms in the language on the other.

With this in mind, the difference between directional conversion and root-derivation on the one hand, and underspecification on the other might be roughly restated in terms of a difference between a derivational process and an inflectional one. As regards conversion, I have posited that this is a process which creates a new lexeme with a different internal structure, i.e., a derivational process. Similarly, root-derivation involves the formation of two independent lexemes which happen to be related to the same root. In contrast to these processes, however, the placing of an underspecified root into an environment with particular markers – whether nominal or verbal – is not argued to create a new lexeme, but rather to simply 'contextualize' the root, in the same way that an inflectional affix might also be argued to do. This understanding of underspecification would seem to align well with the sorts of patterns we find among symmetrical, closely related forms: they should be formally regular; semantically regular; and their use as either a noun or a verb should not add significantly to the meaning of the root. Following e.g., Kiparsky (1983), we would further predict that any additional nominal or verbal inflectional marking such roots received would simply be the default for the specific environment – after all, the verb cannot have an irregularity specification on its lexical entry if such an independent verb entry does not exist.

Although this proposal is somewhat tentative, the possible differences resulting from such a distinction will be revisited throughout this investigation, as they may prove crucial for an understanding of the behaviour of different groups of conversion pairs.

1.5.2 Word class and the analysis of conversion pairs

In §1.2.2, I briefly discussed some evidence in favour of distinct major word classes in English – at least for nouns and verbs – while leaving open the possibility that these classes may overlap to some extent. In fact, the proposal for morphological conversion which is illustrated in example 1.60 rests upon the presupposition that the classes of noun and verb may be distinguished in a non-superficial way.

Intuitively, if there is no difference between nouns and verbs, then it cannot be said that a form has been moved from one class to another; at most, there may be an alternation in syntactic function (i.e., reference vs. predication). However, in a language without a class distinction, lexical forms in general would not be limited to one or the other of these functions, as there would be no distinct group of forms associated with them.[84] Instead, every form would be eligible for use as both a referring expression and a predicate (Evans & Osada 2005: 366). In such a situation, with a form having no inherent class membership, there would in turn be no grounds for arguing that the form had been 'shifted' from one of its uses to another. With no restriction on where an item can appear, how would one discern when such a shift had taken place? Which function would be the 'basic' one? One might suggest looking to the semantics of each use, in order to determine if those of the other, more basic use might have persisted. However, under the criterion of compositionality noted by Evans & Osada (2005: 368; cf. §1.4.2), a language can only truly be said to have no word class distinction if the semantics of a particular use of a root are simply the result of combining that root's meaning with its syntactic function; such a criterion must then apply to all roots in the language (Evans & Osada 2005: 378).[85] If a particular use has more specific, idiosyncratic semantics, then there is evidence that this form may be a separate word, with its own form, meaning, and function. In other words, this separate form/meaning combination is specified for word class.

[84]There is still debate regarding whether or not such a language actually exists; see e.g., Evans & Osada (2005) and discussion in that same volume of *Linguistic Typology*, as well as Luuk (2010) and Rijkhoff & van Lier (2013).

[85]Cf. Croft (2001) and Don & van Lier (2013).

Given that the majority of English word forms behave in this latter fashion (Evans & Osada 2005: 375) and many fail to alternate at all, there is ample support for the idea that an otherwise unmarked word form in this language may have an inherent specification of word class, or else a 'fixed interpretation' in the terminology of Arad (2003) – essentially, a bundle of particular semantic and morphological features with an expected syntactic function. Thus, it may be possible for this inherent marking/fixed interpretation to be carried over into a different word class, where the features associated with this new class are then added to those of the old (e.g., in morphological conversion). This is obviously not to say that all forms which alternate between unmarked predicative and referring uses must necessarily be analysed this way; rather, it is the case that the organisation of English word classes, with its reasonably clear distinction between (referring) nouns and (predicating) verbs, allows conversion as a possibility. In contrast, the potential areas of overlap between the two classes may suggest a location for putative underspecified pairs – an area where the distinction between 'nominal' and 'verbal' is minimal.[86] Thus, in conjunction with the likely effects on conversion pairs which may arise from the inventory of word formation processes in a language (Kiparsky 1982; Vonen 1994), the close connection between word class organisation and possible analyses of these pairs again further suggests that an understanding of CONVERSION phenomena must be, to some degree, language-specific (Ježek & Ramat 2009; Don & van Lier 2013).

1.6 Conclusion

Following on the discussion above, the primary working hypotheses (and sub-hypotheses) for this investigation into English conversion pairs may now be summarised as follows.

[86] As will be discussed in §6.4, it is possible that the presence of these word class distinctions may drive certain changes in underspecified forms, thereby pushing them towards being specified. Cf. Clark & Clark (1979).

(1.62) **Pairs of forms whose relationship is asymmetrical are related by the process of *conversion***. This process is (a) directional; (b) morphological; and (c) derivational, and it creates a new lexeme of a different word class, building on the basis of an existing one by adding *further morphological structure*.

(1.63) **Pairs of forms whose meanings are relatively independent of one another are separate lexemes formed via *root-derivation***. The two forms are not directionally related, but are separately derived from a shared root which is not itself specified for word class.

(1.64) **Pairs of forms which are mutually and symmetrically related are inflected forms of a single *underspecified* root**. This root is not inherently marked as either a noun or a verb, but receives an 'entity' or 'process' interpretation when it appears in a relevant context. These interpretations are not new or separate lexical items, but simply contextualised forms of the root.

Although I have devoted several portions of this chapter to discussing root-derivation, the experimental work to follow will primarily only deal with this pattern insofar as it may be distinguished from cases of conversion or underspecification. As noted in §1.2.3, the dearth of experimental work on these issues means that the scope of the investigation into CONVERSION is limited by the need to establish the baseline behaviour of the forms in question under experimental conditions. I will therefore be focussing on presumed cases of conversion and underspecification, due to the closer semantic relationships within such pairs – though, as will be noted throughout, there may be some difficulties in disentangling these types of pairs from one another, as well as from root-derivation.

In fact, it is these same difficulties which raise interesting questions with respect to where one draws the boundaries between these three types, as well as how the semantic representations of each might function, and to what degree these representations are specified or underspecified, etc. Although arguments for particular distinctions have been presented here and in the earlier literature, the linguistic evidence under consideration is not completely unequivocal, and there is no clear consensus regarding the nature of CONVERSION. It is here that an experimental investigation may therefore offer a useful contribution: are there

any differences in the processing of (apparently) different types of conversion pairs which may provide us with an indication as to how they might (or might not) be represented? What information does this processing depend upon?

Based on these questions, and the above descriptions of this diverse phenomenon, I will begin the experimental investigation of conversion pairs with a discussion of the extensive body of research on morphological processing in word recognition, with a view to begin suggesting how one might approach an experimental inquiry into the underlying structure of conversion pairs (Chapter 2). This will be followed by a review of the methods, results, and analysis of two experiments on morphological conversion (Chapters 3 and 4). Based on the results of these experiments, Chapter 5 will then explore the experimental behaviour of pairs which are hypothesised to be cases of underspecification, comparing and contrasting this behaviour with that of apparent directional pairs. Finally, Chapter 6 will revisit the various patterns of behaviour noted in the data of §1.3 and explore their relationships to the results obtained in the experimental tasks. These relationships will be used to further inform our understanding of the nature of conversion pairs.

Chapter 2

Experimental background: morphological structure in word recognition

2.1 Introduction

As laid out in the preceding chapter, the theoretical evidence on conversion pairs suggests that some of them may be involved in a directional process which derives a new word from an existing word, without any change in surface form. I have argued above that this process is a morphological one which adds another layer of structure in the process of derivation (example 1.62). In contrast, it was hypothesised that other conversion pairs may actually be surface realisations of a single item without a word class specification, with neither form in a 'pair' necessarily having more or less underlying structure than the other (examples 1.63 and 1.64). If this is indeed the case, how might we expect such pairs to be represented and organised in the grammar? And how might this organisation differ between apparent cases of conversion and those of underspecification (or root-derivation)? If differences in the behaviour of conversion pairs can be explained in terms of their underlying morphological structure, then we must first have some understanding

of how morphological structure in general is argued to be mentally represented and organised, in order to fully understand what we might expect with regard to the phenomena under investigation.

To that end, this chapter presents an overview of previous experimental research on the influence of morphological factors in word recognition. The literature on word recognition is extensive, and the studies specifically concerned with the role of morphology in word recognition span more than four decades. Crucially, however, as will be revealed below, much of this literature strongly supports the idea that the morphological structure of a complex word affects how such a word is recognised. The field of word recognition thus provides us with a fertile testing ground for an investigation of the morphological status of conversion pairs. Although this chapter is by no means an exhaustive discussion of this complex area, the works cited here are the most directly relevant for our understanding of the processing and storage of conversion pairs, and are the groundwork upon which the design and hypotheses of the experiments in the following chapters will be built.[1]

The central concern of this considerable body of research is the mental representation of speakers' knowledge of morphological structure and relationships, and how this representation might affect their comprehension of language. For instance, if speakers of English are asked to characterise a word like *darkness*, they will, upon reflection, most likely say something along the lines of, 'It is a noun, and it is made up of the adjective *dark* and the ending *-ness*.' But is this analysis of sublexical structure simply based on metalinguistic knowledge, and thus only available upon reflection – or in some cases, only relevant to linguists? Or does this knowledge play a role in speakers' grammar – more specifically, in their *mental lexicon*, the mental list of the words they know in the language? Does it have an effect on their comprehension?

The answers to such questions have generally taken the form of two primary

[1]For recent reviews on the role of morphology in word recognition, see Amenta & Crepaldi (2012) and Marslen-Wilson (2007).

proposals. The first, which is in line with many of the studies to be presented below, is that speakers' knowledge of sublexical structure is not merely metalinguistic; rather, morphologically-complex words like *darkness* are, on some level, *decomposed*. This *decomposition* is understood as either a process in which complex words are broken down into their component parts (generally morphemes), such as *dark* and *-ness*, or are else represented in such a way that the componential nature of this structure is preserved.[2] From a theoretical perspective, the usefulness of this decomposition would be twofold. Firstly, it would make it possible to store only the pieces of multi-morphemic words, and thereby provide a means of reducing the number of words with individual entries in the lexicon. Secondly, it would offer a way of 'captur[ing] speakers' knowledge about the relations among items listed,' however far this might extend (Butterworth 1983: 258).

However, as Butterworth (1983) notes, the theoretical usefulness of decomposition does not necessarily imply its psychological reality (cf. §2.2.1.2). Opponents of decomposition have thus argued for some variant of the *Full Listing Hypothesis* (hereafter FLH), in which it is proposed that 'every word-form the speaker knows is explicitly listed' in the speaker's mental lexicon, even those which are completely regular, such as the plural form *cats* (Butterworth 1983: 260). These researchers argue that not only is lexical access via these listed full forms more efficient in terms of confirming the lexical status of morpheme combinations, but also that the experimental evidence reveals it to be the default strategy used during word recognition.

As we shall see in the following discussion (particularly §2.3), however, the situation may be more complex than the strongest versions of either of these approaches would suggest. Thus, the relevant question may not be 'Are all complex words decomposed or fully listed?,' but rather questions like 'What determines

[2]While the term *decomposition* is usually used to refer to some process or state of multi-morphemic words, it has also occasionally been applied to the processing of complex items which are not necessarily described as containing multiple morphemes in the traditional sense (Morris & Stockall 2012; cf. §3.3.4).

whether decomposition occurs, or is manifested? Can there be "degrees" of decomposition? If decomposition occurs, is it applied automatically, or only in certain circumstances? How might the total number of morphemes in a word, and their relationships to one another, affect the recognition of the word as a whole?'

Although I do not claim to have answered these questions definitively, I will argue on the basis of the research reviewed here that the effects of speakers' (conscious and unconscious knowledge) of morphological structure can indeed be observed during word recognition. However, the extent to which this applies in particular cases depends on the relative influence of a number of closely interrelated factors – from various types of information about the words in question, to the design and implementation of the experiment itself.

With these themes in mind, this chapter is structured as follows: §2.2 provides the general context in which the study of CONVERSION is situated, presenting evidence for the importance of morphological structure in word recognition (§2.2.1) as well as evidence supporting its separability from other types of processing (§2.2.2). §2.3 then offers a more detailed examination of the primary factors which interact with and affect morphological processing, paying particular attention to the issues which must be taken into account when designing experiments into morphological structure. Finally, §2.4 briefly summarises these various threads of research, and suggests some possible directions for an investigation of conversion pairs which takes into consideration this complex background.

2.2 General background

What happens when we see or hear a morphologically-complex word? How might such words be represented mentally? As noted above, numerous studies have sought to provide some insight into whether and how the morphological structure of a word might affect the way in which it is recognised. One of the primary approaches to investigating the processing and storage of complex words in En-

glish has been through exploring whether or not speakers use information about each word's *stem* (or *base*, or *root*) during recognition of the word as a whole – and if so, which information is important. For example, does perception and comprehension of the word *darkness* involve the use of some of the characteristics of *dark*? One might intuitively suppose so, given the semantic closeness and phonological/orthographic similarity between the two forms. But which characteristics are relevant? And would we find that the same characteristics are relevant for forms like *elusive* and its base *elude*, or for *apartment* and its etymological relative *apart*? These are the kinds of questions which the research summarised in this section has attempted to address.

Before proceeding to the discussion of this research, some remarks on the terminology of *root*, *stem*, and *base* are in order. As alluded to above, these terms are often used somewhat interchangeably in psycholinguistic literature which focusses on English. This is not entirely surprising, given both the tendency in the language to avoid long concatenations of morphemes, and the prevailing trend in studies of morphological processing toward investigating, at most, bimorphemic words – for which one often need only distinguish between the affix and the 'non-affix' morpheme. However, the context of the current study requires a more detailed distinction between these three types of 'non-affix.'

Such a distinction is succinctly summarised by Bauer (1983), who defines these terms as follows:

(2.1) *Root, stem, and base*:

a. A **root** is a form which is not further analysable, either in terms of derivational or inflectional morphology.

b. A **stem** is...the part of a word-form which remains when all inflectional affixes have been removed.

c. A **base** is any form to which affixes of any kind can be added.

(from Bauer 1983: 20-21, emphasis in original)

Thus, in the word *untouchables*, the ultimate root would be *touch*. Ignoring, for the moment, its membership in a conversion pair, the root *touch* is not further decomposable, either inflectionally or derivationally. The stem of *untouchables* would then be the form *untouchable*, which takes the plural suffix -*s*. Although *touch* may also function as a stem to which inflectional affixes may be added, it does not play this role in *untouchables*. Finally, both *touch* and *touchable* – as well as the stem *untouchable* – are considered to be bases, as all of them may have affixes attached. While *untouchable* is both a stem and a base, the former two cannot also be considered stems, as they only take the derivational affixes -*able* and -*un*.

Although the differences between these three forms are pertinent to the current study on CONVERSION, any discussion of earlier experimental work will simply follow the terminology used in the particular paper under consideration, in order to avoid making any claims with regards to the status of forms outside of the experiments conducted herein. However, the theoretical model outlined in §1.5 in fact necessitates a further distinction between the above terms. Thus, while the noun $bottle_{\mathrm{N}}$ – assuming it is not derived from the verb – may under example 2.1 be considered to be a root 'which is not further analysable,' I will reserve the term *root* for those pairs which are hypothesised to be underspecified (e.g., $\sqrt{\text{GUARD}}$). Thus, $bottle_{\mathrm{N}}$ would be argued to be either a *base* from which the verb is derived, or a *stem* to which nominal inflection may attach; proposed derived forms like $bottle_{\mathrm{V}}$, on the other hand, will only be referred to as *stems*, as they will not be considered in the context of any further affixation apart from inflection. That said, this more precise usage will not be employed until Chapter 3, until which point the use of these terms will not be intended as a comment on the details of the morphological structure of the words investigated in the literature (unless otherwise indicated).

2.2.1 Morphological effects in word recognition: the importance of the stem

We turn now to a discussion of some of the seminal papers in the field of morphological structure and word recognition, with a particular focus on whether or not morphological decomposition takes place during the course of normal processing. First, however, it will be helpful to introduce the basic concept behind the experimental task employed by many of the studies reviewed here: lexical decision. In a standard lexical decision task, participants respond to individual linguistic stimuli by indicating whether the item presented is an existing word in a particular language. Items may be presented visually or auditorily, and the participants are typically (though not always) native speakers of the language to which the items belong.[3] For each item presented, participants make a decision: is this a word or a 'nonword'? The goal of such a task is to encourage the participants to process the items presented to them, while ideally minimising their awareness of the ways in which the stimulus items have been systematically varied according to the aims of the research (Harley 2008: 170-71).

Along with the accuracy of participants' responses to each lexical decision, such experiments generally also measure response/reaction time (RT) or 'latency' – that is, how long it took the participant to make a decision. Depending on the particular construction of the stimuli and the experiment, systematic variations in response latency (or lack thereof) have been argued to reflect how the linguistic system processes, accesses, and stores different types of information. Although some objections have been raised regarding possible biases in lexical decision tasks (Ratcliff & McKoon 2008; Wagenmakers 2009), in general the task (and its variations – cf. §2.2.2) has repeatedly proven useful in psycholinguistic research. Because lexical decision has been used to explore such a wide range of issues, this task will also later be applied to the experiments on CONVERSION, in order

[3]Lexical decision tasks have also been used for investigations into bilingual language processing – see, e.g., references in Altarriba & Basnight-Brown (2009).

to allow us to more easily compare and contrast the results with those of earlier investigations of other phenomena.[4]

2.2.1.1 Taft & Forster (1975) and the Affix-Stripping Hypothesis

One of the earliest studies to use lexical decision to investigate the psychological reality of morphological decomposition is that of Taft & Forster (1975). In this paper, the authors suggest that words with multiple morphemes are decomposed prior to lexical access, with any prefixes or suffixes being removed before the stem is searched for in the lexicon (Taft & Forster 1975: 638). They propose this hypothesis based on the results of a series of lexical decision tasks which focus not on words, but on different types of nonwords. In these tasks, participants were presented with nonwords consisting of either a bound stem on its own (e.g., **juvenate* from *rejuvenate*) or a similar non-stem word fragment (*pseudostem*) on its own (e.g., **pertoire* from *repertoire*); or a bound stem combined with an incompatible prefix (e.g., **dejuvenate*) vs. a fragment combined with a prefix (e.g., **depertoire*).

Words were categorised as containing either stems or pseudostems based on (a) their etymology and (b) whether the 'prefix contributed to the meaning of the word' (Taft & Forster 1975: 640). Stems were the non-prefixed portions of those words in which the meaning of the prefix played a role, e.g., *re-* in *rejuvenate* means *again*. Pseudostems, on the other hand, were portions of words like *-pertoire* in *repertoire*, which appears to contain the prefix *re-*, but whose initial letters in fact do not play any independent role in determining the meaning of the word. In separate experiments, Taft & Forster found that which type of stem a nonword contained affected how long it took participants to classify the item as a nonword. Nonwords containing real stems showed longer response latencies as compared to pseudostems. Thus **juvenate* was more difficult to reject than **pertoire*, and **dejuvenate* was more difficult to reject than **depertoire*.

[4]See Forster 1976 for a review of some early research on lexical decision.

These results fall out, they argue, from the fact that words like *rejuvenate* are actually composed of a prefix and a bound stem – a stem which has its own entry in the lexicon. Words like *repertoire*, on the other hand, are not truly composed of multiple morphemes, and thus there is no listing for the pseudostem **pertoire*. Under this theory, it is the discovery in the lexicon of the real (bound) stems – which cannot occur as words on their own – which causes participants to be slower at rejecting them. As for the prefixed nonwords, a similar situation is said to obtain once the prefix has been identified and removed, or 'stripped.' However, upon finding the lexical entry of a real stem for **dejuvenate* nonwords, the processor would then proceed to determine whether the prefix was compatible with this stem, and, failing that, would then search for and fail to find an entry for the full undecomposed form.[5] Meanwhile, prefixed pseudostems, lacking a lexical entry for the 'stem,' would not be subject to a check for prefix-stem compatibility, and thus would be more quickly rejected (Taft & Forster 1975: 643-44).

However, Taft & Forster argue further that there are several other interpretations which may be in line with the results they obtain. One of these is the possibility that, in addition to the prefixed nonwords being decomposed and searched for via the stem, the lexicon is also simultaneously scanned for the existence of the whole word form. Although Taft & Forster (1975: 644) write that '[n]o judgment can be made' as to whether or not this is the case, this alternative does not seem to be consistent with their results. If decomposition and full-form lexical search take place in parallel, searching for **dejuvenate* nonwords as a whole would be more efficient than decomposing them – it would become immediately apparent that there was no lexical entry for **dejuvenate*. Under this model, it should therefore be just as easy to reject a real-stem nonword as it is to reject forms like **depertoire*.[6]

In addition to this proposal, Taft & Forster (1975: 644) suggest another alternative which may be able to account for their results. As they point out, it is

[5] I will return to the issue of the checking of stem-affix compatibility in §2.2.1.2 below.
[6] Cf. Butterworth (1983: 277), quoted in §2.2.1.2 below.

also possible that complex words with bound stems, rather than being listed in the lexicon by those stems alone, are in fact stored as whole forms which include details of their morphological structure – e.g., *rejuvenate* would be represented as *re*(*juvenate*), while *repertoire* would only be listed as *repertoire*. As a consequence, the **juvenate* and **dejuvenate*-type nonwords would be harder to reject because they 'share a structural element with a lexical entry' (Taft & Forster 1975: 644). Crucially, this model would still require an initial stripping of the prefix from **dejuvenate* and **depertoire* nonwords before the lexicon is searched, in order for the processor to recognise this shared structural element. Extending this model to existing words containing bound stems, it would follow that items which share such a structural element (e.g., -*mit* in *submit, admit, emit*, etc.) all nevertheless have their own lexical entries, in contrast to the initial explanation which suggests that there is only one entry: the stem itself. The authors note that their findings alone do not offer a means of determining which of these two proposals is more likely. Nevertheless, under either interpretation, the results overall suggest that the analysis of morphological structure does indeed play a role in recognition.

However, in conjunction with this insight, Taft & Forster's work also raises a number of questions. Although the longer response times of morphologically-structured nonwords like **dejuvenate* seem to indicate that their prefixes are stripped prior to a search for the stem, such nonwords by definition do not have lexical entries. Thus, we cannot be sure from these experiments whether the same order of events will necessarily apply during the recognition of real words. One might suggest that real words, having been previously encountered, will have entries that can be easily found when searching the lexicon. Any further analysis of their morphological structure, if it occurs, might follow rather than precede this search (cf. e.g., Butterworth 1983 below).

Even if real words are indeed processed in the same way as Taft & Forster's nonwords, it is important to note that these nonwords were constructed with

reference to a specific type of real word – derived, prefixed words with bound stems. As such, it is possible that these characteristics may have affected their results. For instance, as described above, Taft & Forster (1975: 640) distinguished words consisting of a prefix and a bound stem (e.g., *rejuvenate*) from similar monomorphemic words (e.g., *repertoire*) based on whether the apparent prefix 'contributed to the meaning of the word.' Given the difference in the processing of the nonwords containing these stems, it is possible that more subtle variations in the degree to which the components of an apparently complex word contribute to the whole may also have consequences for how these words are recognised. Extrapolating further, how similar or different would we expect word recognition to be when it involves items with inflectional affixes, which tend to be more semantically regular? Would we also predict the same amount of influence from semantic transparency for those complex items which contain free rather than bound stems?

These are just some of the questions raised by Taft & Forster's influential paper which subsequent research has endeavoured to answer, using arguments based both on theory and on experimental findings.

2.2.1.2 The Full Listing Hypothesis (FLH)

In an article titled 'Lexical Representation,' Butterworth (1983) rejects the Affix-Stripping Hypothesis of Taft & Forster (1975), and instead offers his own proposal for how complex words are processed and stored: the *Full Listing Hypothesis* (cf. §2.1). As noted above, under the FLH it is argued that there is in fact no need for morphological decomposition during normal recognition, as a speaker's mental lexicon will contain every word-form the speaker knows, regardless of its morphological structure (Butterworth 1983: 263).

However, as we have seen above, there is some evidence that speakers may track regularities across words – such as form and meaning pairings in prefixed words – and use this information in their processing of nonwords, breaking them

down into their component parts before searching the lexicon. Butterworth (1983: 262) agrees that it is clear that speakers do have some knowledge of regularities. He cites further evidence from language acquisition as found in the famous '*wug*-test,' where children who were asked to refer to more than one **wug* produced the regular plural **wugs* (Berko 1958). As he points out, however, this does not necessarily mean that this knowledge is applied in the case of familiar, known forms. Instead, he suggests that 'the rules may serve as a fall-back procedure' when encountering unfamiliar forms – for example, nonsense words like **wug*, or the kinds of nonwords used in Taft & Forster (1975). Furthermore, he suggests that this knowledge of regularities may not even take the form of a rule, but may instead function more like an analogy based on existing forms. For known forms, however, it would not be necessary to either apply a rule to a base in order to produce a complex form, nor would it be necessary during recognition to decompose a complex form in order to locate a relevant lexical entry.

In fact, Butterworth contends that, although decomposition can be induced by the kinds of items used by Taft & Forster (1975), it is not a useful word recognition strategy, and may actually slow down the process of recognition for certain types of known words in reading. In support of this idea, he cites a study by Rubin et al. (1979) which further investigated prefixed and pseudoprefixed words along lines similar to Taft & Forster (1975). In two versions of a lexical decision task, Rubin et al. found that participants took longer to respond to words which only appeared to be prefixed (e.g., *infant*) than to truly prefixed words (e.g., *disappear*), suggesting that the pseudoprefixed words were also being (incorrectly) decomposed prior to a futile search of the lexicon for the non-existent 'stem.' However, this effect was strongest when the overall proportion of prefixed items in the task was higher. Rubin et al. (1979: 765), and likewise Butterworth (1983: 278), suggest therefore that while decomposition is indeed an available strategy, and it can be induced by the addition of highly decomposable forms, it is not the default during normal recognition and may actually delay responses in

some cases.[7]

Further work on the recognition of spoken prefixed words also argues against the occurrence of decomposition in normal word recognition. Using three different types of experimental task, Tyler et al. (1988) compared the recognition of prefixed words to their free, unaffixed stems. They suggest that, if affix-stripping is the default, that the sequential left-to-right nature of speech means that hearers would have to wait until they had heard enough of the speech signal to recognise the *stem* of a prefixed word, before they would be able to recognise the whole word. However, they argue that this is not what actually happens during auditory word recognition. Instead, they propose that hearers simply process spoken words in a continuous, left-to-right fashion, and are able to recognise both morphologically-simple and -complex words as soon as they have heard enough information to reach each word's 'uniqueness point,' or UP. This UP is the point at which a word is uniquely distinguishable from all other words in the language: e.g., *remind* becomes distinguishable from e.g., *remark* at the second vowel (Tyler et al. 1988: 370). Thus, recognition of a prefixed word without decomposition depends on the UP of the prefixed word as whole, while recognition with prefix-stripping depends on the UP of the stem.[8]

As mentioned, the primary comparison in Tyler et al.'s study is between prefixed words like *miscount* and their free stems, e.g., *count*. They began by calculating theoretical UPs for each of these words and comparing them to their recordings of the words. For their stimuli, which they used for all three tasks, the theoretical UPs for prefixed words as a whole were around 90 milliseconds (ms) earlier than for the free stems. These stimuli were then used in a gating task, in which participants heard the first 50 ms of the word (the first 'gate'), and then indicated what word they thought they were hearing. At each subsequent gate,

[7]It is worth noting, however, that Rubin et al.'s first experiment produced longer response times and higher error rates for pseudoprefixed words even when the task as a whole had a lower proportion of prefixed fillers, though this difference (35 milliseconds) was not statistically significant.

[8]As Tyler et al. (1988: 369) note, for auditory recognition of suffixed words, both models predict that access will begin with the stem, as it will necessarily be heard first.

they heard an initial fragment of the word which was 50 ms longer (i.e., 100 ms, 150 ms, etc.), and again indicated what word they thought they were hearing, until the whole word had been heard. The goal of this task was to determine an experimental 'recognition point' parallel to the theoretical UP.

The authors found no difference in the recognition points of the prefixed words as compared to the free stems (Tyler et al. 1988: 373). This, they argue, runs counter to the predictions of a prefix-stripping model, under which one would expect that the recognition point for prefixed words should be roughly the same as that of the stems plus the duration of the prefix – i.e., later than the stems overall. Initially, however, the results also do not seem to be in line with the predictions of Tyler et al.'s 'continuous' account, which indicates earlier theoretical UPs for the whole forms of the prefixed words. As Schriefers et al. (1991: 29) point out in another paper, however, the prefixed words were always greater in length – an issue which can delay recognition in gating, as well as in the other two tasks used by Tyler et al.. If the results are corrected for this issue (by subtracting the mean duration of the prefixes), recognition points for the stems of prefixed words are almost 200 ms earlier than for those same stems presented on their own (Tyler et al. 1988: 374).

Similar results were obtained when the same words from the gating task were used in a lexical decision task and in a naming task, where participants were asked to say the word they were hearing as soon as they recognised it (Tyler et al. 1988: 378). In both of these tasks, responses were around 140 ms earlier for prefixed stems, after correcting for the length of the prefix (Tyler et al. 1988: 376; 378). Based on this robust series of results, the authors conclude that auditory word recognition does not proceed via prefix-stripping. Instead, they argue that it proceeds from left-to-right, until a word is uniquely identifiable. Crucially, as they note, this implies a level at which full forms of these words are stored, in order for the processor to be able to determine the point at which a word becomes unique.

In addition to the above experimental results which seem to be in favour of the FLH, Butterworth (1983) makes a further logical point concerning a particular step of the recognition process according to Taft & Forster (1975) – 'recombination,' or the checking of stem-affix compatibility (cf. §2.3.2.2 and §2.3.4). Taft & Forster (1975: 644) suggest that this is one of the steps which slows rejection of **dejuvenate* nonwords, since after locating the stem *-juvenate*, the processor would need to check whether this stem attaches to the prefix to form a word. However, as Butterworth (1983: 277) points out:

> How is the reader to test whether a base and ending are valid in combination except by reference to a full listing of forms, and if there is a full listing of forms, why then bother with decomposing the letter string? [...] Notice that it is not sufficient for both base and ending to be recognized as valid, since there will be many combinations of real base and real affix which will not be a word...

In essence, Butterworth (1983: 290) argues that full listing of all morphologically-complex word forms is more efficient in terms of lexical access than is decomposition, which he claims is primarily used as a 'fall-back procedure'. However, as we shall see in numerous studies to be discussed, whatever its level of efficiency or lack thereof, there is a great deal of evidence in support of the idea that decomposition is routinely used in normal word recognition – and, as will be detailed in the next section, convincing evidence that it may in fact be more efficient than supposed by Butterworth.

2.2.1.3 The importance of the stem

Following on the experiments by Tyler et al. (1988), Schriefers et al. (1991) investigate the processing of prefixed, unprefixed, and pseudoprefixed spoken words in Dutch. They begin by noting a number of problems with Tyler et al.'s work. The primary issue pertains to the particular stimulus recordings used in the earlier tasks: as the authors themselves note, the tokens of the stems in isolation were, on average, 28 ms longer than the equivalent stem portions of the prefixed tokens (Tyler et al. 1988: 374). As the gating task they employed presented all

stimuli, regardless of type, in increments which increased by 50 ms, the crucial segments will not have been distributed in the same way across each of the gates. The second issue, as noted above, is the possible influence of overall word length, which makes it somewhat difficult to accurately compare the recognition of the stems to the recognition of the longer prefixed words (Schriefers et al. 1991: 29).

With these issues in mind, Schriefers et al. (1991) conducted a series of experiments aimed at correcting for these problems and further exploring how spoken prefixed words are recognised. They used both gating tasks (constructed similarly to Tyler et al. 1988), and phoneme monitoring, in which participants were shown a letter representing a certain phoneme, and were asked to respond as soon as they heard this phoneme in a spoken list of words which followed. The first experiment compared free stem words with two prefixed words containing this same stem. Unlike Tyler et al. (1988), Schriefers et al. (1991: 31) used the same stem token for all three word types (cross-spliced with the prefixes), and gated the prefix and the stem separately so that the stem was distributed across the gates in the same way for each condition. For one of the prefixed words, the UP of the whole word (measured from stem onset) was the same as that of the stem (=STEM condition). For the other prefixed word, the UP was earlier (<STEM). They suggest that, on a purely left-to-right account, these words should be recognised on the basis of their individual UPs. For the gating task, this means that the stem and =STEM words should be recognised around the same time, while the <STEM words should be identified earlier (Schriefers et al. 1991: 30). As for the phoneme monitoring task, participants were instructed to respond to the same phoneme in all three conditions: the UP phoneme of the stem and =STEM conditions. For the <STEM words, however, this same phoneme fell after the UP. Citing the fact that responses in phoneme monitoring are quicker when the crucial phoneme falls after the UP, they predict a similar pattern of results for left-to-right processing in this task as well, with quicker responses to the <STEM words (Schriefers et al. 1991: 33). In contrast, they argue that a strict prefix-

stripping account would predict equivalent responses across all word types in both tasks, as recognition should only be based on the UP of the stem (Schriefers et al. 1991: 30; 33).

Instead of either of these patterns, both tasks revealed that the prefixed =STEM condition produced similar response times to those of the <STEM condition. Furthermore, the items in these two conditions were actually identified significantly more quickly than the stems on their own. Noting that Tyler et al. (1988) also found that their prefixed stimuli produced quicker responses, the authors suggest that this pattern is more complex than simple left-to-right processing, as the latencies to their prefixed words were similar despite differences in UP (Schriefers et al. 1991: 34). However, as they point out, because the words in each condition had different initial phonemes, they may also have been different with respect to numbers of phonologically-similar competitors (i.e., their *cohort*) – a difference which may have affected the results.[9]

In light of this possibility, Schriefers et al. (1991: 35) conduct an additional experiment which attempts to control for this factor, which they term *lexical environment*. Again using the gating and phoneme monitoring tasks, they compare two sets of free stems and prefixed words, as illustrated in the table below.[10]

	Stem	Prefixed
EARLY	leRen (‘to learn’)	afleRen (‘to unlearn’)
LATE	leveRen (‘to supply’)	afleVeren (‘to deliver’)

Table 2.1: Experiment 2 example stimuli, adapted from Schriefers et al. (1991: 35)

The two most crucial comparisons here are between the prefixed forms and their stems; and between the ‘EARLY’ and ‘LATE’ prefixed forms. As the condition names will suggest, the ‘EARLY’ stems (e.g., *leren*), although they had the same onsets as the ‘LATE’ stems (e.g., *leveren*), had earlier UPs. Their

[9]For the seminal paper on the effect of a word’s cohort on its recognition, see Marslen-Wilson (1987).

[10]I have here adopted the notation of Schriefers et al. (1991), and use uppercase letters to indicate theoretical UPs.

corresponding prefixed forms, however, were more similar to one another, using the same prefixes, and with identical UPs and similar surface frequencies of occurrence across the language – the frequency of the particular form *afleren* was similar to that of *afleveren* (Schriefers et al. 1991: 36).[11] However, the addition of the prefix to the 'LATE' stems shifted the UP of the prefixed forms to an earlier segment than that of their stems.

For the 'EARLY' words, both left-to-right processing and prefix-stripping predict similar identification times (measured from stem onset) for the isolated stem and prefixed forms, as both types of words have the same UP. For the 'LATE' words, however, the prefixed forms, if accessed left-to-right, should elicit quicker responses than their bare stems; meanwhile, prefix-stripping again predicts no difference between prefixed and unprefixed forms. Furthermore, assuming prefix-stripping also predicts that the two types of prefixed forms should differ according to the UPs of their stems, while continuous processing predicts no difference between them, due to their identical full form UPs (Schriefers et al. 1991: 36-7).

As with the previous experiments, the results do not correspond precisely to either of these opposing views. Stems in both 'EARLY' and 'LATE' prefixed words were identified significantly more quickly than these stems on their own. Furthermore, 'EARLY' words were also identified significantly earlier than 'LATE' words. This pattern held across isolated stems, where it might be expected due to different UPs; more importantly, however, it also applied to the prefixed forms, which were extensively matched on a number of parameters.[12]

The common thread across these two sets of experiments, as well as those of Tyler et al. (1988), is that the stems of prefixed words are identified more quickly than the same stems without prefixes, regardless of the location of the

[11] As will be extensively noted and discussed throughout the current chapter and those following, how frequently a particular form (or its parts) generally occurs in a language often has a strong effect on response latencies and accuracy in many different experimental tasks (cf. Bradley 1980 below and references in §2.3.2).

[12] I will not discuss the results of the phoneme monitoring task here, as they are somewhat more complex. Crucially, however, they also show shorter latencies for prefixed forms as compared to their stems.

UP. Schriefers et al. (1991: 42) refer to this pattern as the 'prefixation effect.' Note that this effect is counter to both a strict prefix-stripping model, which proposes that lexical access only depends on the stem, as well as a strict left-to-right model, in which access should only depend on a word's UP. Instead, Schriefers et al. (1991: 44) propose that while auditory word recognition proceeds essentially left-to-right – noting the difference between 'EARLY' and 'LATE' stems, in line with their UPs – this system is also sensitive to the morphological structure of words, and in particular, to characteristics of the stem.

In further support of this interpretation, they conduct a *post-hoc* analysis of the data from their second experiment. Recall that the 'EARLY' and 'LATE' prefixed words in this task were matched to one another in overall length, prefix, UP, and surface frequency. However, due to the different sets of words, the 'EARLY' stems were in fact much more frequent than the 'LATE' stems (Schriefers et al. 1991: 36). As higher frequency of a form has been known to speed responses in a number of tasks (see, e.g., Monsell 1991 and §2.3.2), Schriefers et al. separated their 'EARLY'/'LATE' data into two groups. In the first group, they included 'EARLY' and 'LATE' words with more similar stem frequencies and matched prefixed word frequencies. The second group contained 'EARLY' stems which were far more frequent than the corresponding 'LATE' stems, with an even greater difference between these groups than across the stimuli as a whole. The prefixed words in this second group were also matched in surface frequency. When the stimulus response latencies from the gating task were divided according to these two groups, a clear pattern emerged. For both groups, prefixed stems were again identified more quickly than their unprefixed counterparts, regardless of the UP. However, in the first group, where stem frequencies were similar, there was no significant difference in the response times to the 'EARLY' and 'LATE' prefixed words. In contrast, the 'EARLY' prefixed words in the second group, in line with their much higher stem frequency, have far shorter latencies than the 'LATE' prefixed forms (Schriefers et al. 1991: 43).

In combination with the repeated advantage from the presence of a prefix, this analysis suggests that the processing of prefixed forms is not only dependent on the morphological structure of such words, but it is also dependent on information about the stem itself – such as its frequency. As such, the lexicon cannot be limited to only full forms 'completely blind to word-internal structure' – as might be suggested under the FLH – but it must also take into account the characteristics of the component parts of complex forms (Schriefers et al. 1991: 44). That said, Schriefers et al. do not suggest an explicit explanation for the general prefixation advantage.

For a recognition model which may provide a means of accounting for this robust effect, and which may also offer a solution to the issue raised by Butterworth (1983) above (cf. §2.2.1.2), we turn to a discussion of morphological parsing in Hankamer (1989). This paper primarily concerns the implausibility of the FLH for Turkish, as well as for other agglutinating languages that have a large number of words with a high degree of morphological complexity. However, Hankamer's descriptions of how a morphologically-driven recognition system might function in these languages also seem to be applicable to a language like English.

One possibility that Hankamer (1989: 399) describes is an affix-stripping mechanism similar to that outlined by Taft & Forster (1975). However, as noted, the affix-stripping model as initially proposed runs into the issue of how a particular stem/root-affix combination is determined to be acceptable if the combined full form is not already listed in the lexicon (Butterworth 1983: 277).[13] One solution which might be suggested is that, upon recognition of a particular affix, the set of acceptable stems which may be attached is then restricted, based on information about the stem category to which the affix may attach, the semantics of the affix, etc. Since the properties of the affix will determine possible stems, there will be no need to access a list of full forms in order to verify whether the

[13] As this discussion references Turkish, I here make a distinction between a stem which allows further affixation but which may itself contain affixes (e.g., *sanity*) and a root (e.g., *sane*) which appears not to be further analysable, though I make no claims regarding whether this is the underlying 'root' in a Distributed Morphology sense.

stem and affix can be combined. After stripping the affix, the parsing mechanism would then proceed to check whether the remainder of the word was an allowable stem.

Hankamer describes this type of parsing in terms of suffixed words. It might be supposed to work better still for prefixed items, as the prefixes will be encountered prior to their stems. As he points out, however, '...the set of stems determined by a suffix is always very large, and not necessarily even finite' (Hankamer 1989: 402); the same may also be said for prefixes. As a result, Hankamer rejects this model for Turkish – since most suffixes in this language can attach directly to a root, a lexical search to determine whether the remaining portion is, in fact, an unalaysable root, would need to take place every time a suffix was removed. Due to the high average number of morphemes in Turkish words (Hankamer 1989: 398), such a remaining portion is not very likely to be an unanalysable root. By way of example, Hankamer notes the particular case of words containing iterative suffixes like *-ki*, which has a roughly pronominal meaning in words like *evlerimizdeki*:

(2.2)

ev	'house'
evler	'houses'
evlerimiz	'our houses'
evlerimizde	'in our houses'
evlerimizdeki	'the one in our houses'

(Hankamer 1989: 397)

Such polymorphemic words are not at all uncommon in Turkish – in fact, because a suffix like *ki* can begin a new cycle of suffixation (e.g., *evlerimizdekiler*, 'the ones in our houses,' etc.), individual words can often be even longer. Thus, given the ubiquity of such highly complex words in this language, a suffix-stripping approach would seem to entail several failed searches of the lexicon for every word of sufficient complexity, as what remains after stripping a suffix from a complex

form will usually itself be a complex form, rather than a root (Hankamer 1989: 402).

Despite this, Hankamer (1989: 404) is careful to note that the same considerations may not necessarily apply to the same extent in non-agglutinative languages. Although it is still true for English that the number of different stems to which a particular affix may attach is quite large, long strings of affixes attached to a single root are much less common, and chances are therefore comparatively greater that the fragment which remains after an affix is stripped is a root (Bauer et al. 2013: 507). Hankamer's objection therefore does not seem to have quite the same weight in English.

Nevertheless, the alternative parsing mechanism which he proposes also holds explanatory value. In what he labels *root-driven analysis* (Hankamer 1989: 399), morphological parsing proceeds from left to right, with recognition of the root restricting the set of suffixes which may follow. In contrast to an affix-stripping approach, the set of items which can attach to a given root/stem is usually much smaller. For Turkish, this removes the need for multiple searches of the lexicon to determine whether what is left is a root, as roots in the language always appear first. Additionally, in a similar way to parsing via affix-stripping, this root-driven analysis also avoids the issue raised by Butterworth (1983: 277).[14]

As before, this type of parsing is only described in terms of suffixation. How then might morphological parsing function for prefixed words? Given the results of Schriefers et al. (1991) for Dutch, and their reinterpretation of Tyler et al.'s results for English, the best model would seem to be a hybrid of the two mechanisms described above. If we assume, following the conclusions of these experimental studies, that spoken word recognition does indeed proceed essentially from left-to-right (as in a root-driven analysis), the affix in a prefixed word will necessarily be encountered – and likely recognised – first. Having recognised the prefix, the number of allowable stems which might possibly follow would be

[14] A similar model is proposed in Segui & Zubizarreta (1985: 770).

reduced to a subset of the lexicon. The processor could then conduct a search for the remaining fragment of the word; however, rather than searching the entire lexicon, it would only be necessary to search this particular subset. We might therefore expect a reduction in the time it takes to locate a match for the stem in this subset, relative to the usual unrestricted search for this stem when it does not follow a prefix. This reduction might then manifest itself as a relative advantage for the prefixed form of a stem, i.e., a 'prefixation effect.'

Of course, as it stands, such a model is not necessarily without limitations. For example, it is not immediately clear how words with both prefixes and suffixes, such as *unhelpful*, would be parsed – although the form *un-* may also attach to verbs (e.g., *untie*), it does not attach to $help_{\mathrm{V}}$, but rather to the adjective *helpful*. As such, the restrictions on the types of forms to which the prefix may be attached must allow for forms with which the prefix combines *hierarchically*, rather than simply those which can follow it linearly. Indeed, there is experimental evidence which suggests that the processing of ambiguous trimorphemic words (e.g., *unlockable*, with either the structure [[*unlock*]-*able*] or [*un*-[*lockable*]]) is sensitive to factors like the frequency of subconstituents (e.g., *unlock* is more frequent than *lockable*), and that recognition of such trimorphemic words is influenced by these factors even in incompatible sentential contexts (de Almeida & Libben 2005; Pollatsek et al. 2010). Thus, while the higher frequency of *unlock* would lead to a default parse of [[*unlock*]-*able*], the high frequency of *helpful* (and non-existence of **unhelp*) would lead to a default parse of [*un*-[*helpful*]] (Pollatsek et al. 2010: 93). This kind of frequency-sensitivity therefore suggests that the set of forms predicted to follow a specific prefix could also include complex items – particularly those which are highly frequent.

However, despite this possible extension to the left-to-right model, it still fails to alleviate the problem that Hankamer notes with respect to how far a prefix might restrict the set of possible stems – when compared to how far a stem/root may restrict the set of possible affixes, the former seems significantly

less efficient. In that regard, it may be helpful to note that in English, prefixation is also far less common than suffixation. In fact, there is also cross-linguistic evidence which suggests that suffixation is highly preferred over other types of affixation. As discussed extensively by Cutler et al. (1985), this may in fact be due to processing advantages for encountering the root first, such as what might follow from the parsing mechanism described above.

Given this cross-linguistic preference, and the fact that affixation in English is largely suffix-based, it may seem strange that much of the early research on morphological processing has been focused on prefixed forms. As noted by Tyler et al. (1988: 369), however, recognition of suffixed forms is likely to proceed from left-to-right regardless of whether or not decomposition is assumed. Still, as we shall see, there is extensive evidence that the morphological characteristics of suffixed words are equally important in how these words are recognised.

For instance, in a series of lexical decision tasks, Bradley (1980) investigates the influence of two different frequency measures on the response times to visually-presented suffixed words, in a comparison not dissimilar from the *post-hoc* analysis of Schriefers et al. (1991). For each set words ending in four different English suffixes (*-ness*, *-er*, *-ment*, and *-ion*), she tests two groups of items. In one group, pairs of words are matched in the total frequency of the suffixed form and its plural, which Bradley (1980: 42) calls the *particular-form frequency count*, but which I will refer to as *lemma frequency*.[15] However, the pairs differ in their *morphological family frequency* (Bradley's *cluster frequency*), which includes the combined lemma frequencies of the suffixed word, its base, and any other related derived forms.[16] In a second group, pairs of words with the same suffix are matched in morphological family frequency, but differ in lemma frequency. For example, *sharpness* and *briskness* have roughly the same lemma frequency, but *sharp* and its morphological relatives are far more frequent than *brisk* and its

[15] Cf. Ford et al. 2010: 118 and §2.3.2.

[16] Also sometimes referred to as *cumulative root frequency* – cf. Giraudo & Grainger (2000; §2.3.2.1) and Pylkkänen et al. (2004).

relatives. Likewise, *happy* and *heavy* have roughly similar morphological family frequencies, but *happiness* occurs more frequently than *heaviness* (Bradley 1980: 43). If response times to each member of a pair differ, and if this difference is consistent across the group, it suggests that the frequency measure on which the pairs are *not* matched has an influence on the recognition of these words.

For the *-ness*, *-er*, and *-ment* groups, Bradley finds that those pairs which differ in family frequency also consistently differ in response latencies. This effect seems to appear regardless of variations in the regularity of the meaning of the combined suffixed word, such as how 'lexicalised' or seemingly independent the suffixed word is from the meaning of the base (e.g., *consumer*, *allotment*).[17] In contrast, a difference in lemma frequency does not seem to induce a reliable difference in response times when family frequencies of words ending in these three suffixes are matched. For words ending in *-ion*, on the other hand, Bradley (1980: 52) finds no consistent influence of either frequency measure.

Based on this pattern of results, and the apparently different treatment of *-ion* words as compared to *-ness*, *-er*, and *-ment* words, Bradley suggests that the crucial distinction to be drawn is one of consistency in form. As *-ion* is a '+boundary' (Chomsky & Halle 1968: 66-67) or 'Level 1' (Kiparsky 1982) suffix, the bases of words which contain *-ion* often differ phonologically (and sometimes orthographically) when these same bases are in isolation, e.g., *divide* vs. *division*. The stems of words ending with the other three suffixes, on the other hand, do not vary.

From this, in combination with the fact that the semantic transparency of the suffixed form does not seem to change the effects of family frequency which do appear, Bradley (1980: 53) concludes that suffixed words in English are processed on the basis of morphophonological regularities across related items. She further argues that the effect of family frequency on the words ending in *-ness*, *-er*, and

[17]However, cf. Bradley (1980: 47-9) regarding the potential confound with familiarity in the case of 'pure agentives' suffixed with *-er*, e.g., *briber*. I will return to a more detailed discussion of the patterns in Bradley (1980) and their implications in §2.3.3 below.

-ment results from the fact that these derived forms and their bases share a lexical entry (Bradley 1980: 37). However, as will be discussed further below (cf. §2.3.1), evidence from other studies suggests that derived words in English may have separate lexical entries from their bases, and the results summarised here do not necessitate such a strong claim regarding the representation of these words. Nevertheless, in line with the experiments in Schriefers et al. (1991), Bradley's data supports the theory that the processing of morphologically-complex words is strongly influenced by information about the stem/base of these words. As such, it is clear that the morphological structure of these words must be available during processing, in order for the system to discern the presence of the stem, and thereby access its lexical information. This indicates, contrary to the predictions of the FLH, that morphological analysis of some sort must play a role during normal word recognition. The following sections will therefore be devoted to further exploring the extent of this role, and the patterns which may condition how it is manifested.

2.2.1.4 Morphology and meaning: Marslen-Wilson et al. (1994)

Although there is some evidence that the morphological structure of words is relevant to how they are recognised, given the variety of approaches taken in the different studies summarised above, it is somewhat difficult to draw any more detailed conclusions from these studies alone with respect to how this information is organised and stored, as well as when it comes into play. To that end, Marslen-Wilson et al. (1994) undertake an extensive and systematic investigation of derived prefixed and suffixed words in English. The goal of this investigation, which used six lexical decision tasks, was to determine whether the lexical entries of such words are morphologically structured, and what characteristics of a word might affect the presence or absence of this structure. While the previous research described above was conducted within one modality at a time (i.e., auditory *or* visual), Marslen-Wilson et al. (1994: 4) note that in exploring the lexical

entry, they are primarily concerned with an abstract representation of a word in a speaker's brain – a representation which should be modality-independent. They argue that this representation links both the auditory form and the orthographic form of a word to its semantic and syntactic information, so that a literate speaker conceives of these two forms as one word.

In an effort to tap into this abstract entry, the authors employed a cross-modal priming paradigm within their lexical decision tasks. In a priming task, participants are exposed to a stimulus (the prime) which bears some relation to a stimulus presented at a later point in the task (the target).[18] Responses to the target when it follows a prime – such as latencies and error rates in the case of lexical decision – are compared with baseline responses to the target when it follows a different, usually unrelated, prime stimulus.[19] The size of the priming effect is thus measured by subtracting response latencies to the target following the related prime from these baseline responses. Responses to a target may be facilitated (i.e., quicker) when following a related prime, or they may be inhibited (i.e., slower), depending on the type of relationship between the two stimuli. Facilitation of responses to the target is thought to reflect repeated activation of some information which the prime and target have in common (Marslen-Wilson 2007: 184; cf. Morton 1969 and Henderson 1985). Thus, any differences in the size or direction of the priming effect may offer insight into the nature of the relationship between the prime and the target.

However, as Marslen-Wilson et al. (1994: 6) suggest, if the prime and the target are presented in the same modality, this priming effect may be influenced by *any* level of the relationship between the prime and target, including any similarities in the speech signal or in orthographic form which may be at a level lower than that of the lexical entry. In order to avoid this, their tasks use a cross-

[18]The time delay between the prime and its target – sometimes referred to as the interstimulus interval (ISI) – may vary depending on the goals of the research. Cf. §2.2.2.

[19]Although both Marslen-Wilson et al. (1994) and the experiments in this thesis use an unrelated baseline, other studies have also used different types of baseline measures, such as the first presentation of a target (e.g., Stanners et al. 1979; §2.3.1) or responses following an orthographically-related prime (e.g., Grainger et al. 1991; §2.3.2.1).

modal design, with an auditory prime and a visual target, under the assumption that any observed effects of the prime's relationship to the target will be the result of a relationship on an abstract, modality-independent level. Thus, on each trial in these tasks, participants first heard a prime, and then immediately saw a target, about which they made a lexical decision.

As in previous studies, the stimuli in these experiments included derived words and stems. The types of words tested and the relationships between them varied on a number of dimensions. The three primary variables, however, concerned the morphological, semantic, and phonological relationships between the primes and their targets. For their stimuli, Marslen-Wilson et al. (1994: 7) defined morphological relatedness according to (1) whether the derived word had a listed affix; (2) whether the stem of the derived word after removal of this affix corresponded to the free stem (or its underlying form); and (3) whether the free stem and the derived form were related historically. Note that, unlike the study in Taft & Forster (1975), these criteria treat morphological relatedness separately from the semantics of the stem or the affix. Instead, sets of words were assigned ratings of semantic relatedness or unrelatedness via a survey of native speakers. This allowed the authors to distinguish between morphologically-related pairs which are synchronically semantically transparent (e.g., *insincere* – SINCERE) and pairs in which the derived word has an identifiable prefix, but is nonetheless considered to be semantically unrelated to the stem (e.g., *restrain* – STRAIN).[20] Finally, though all of the pairs which were classed as morphologically related were, by definition, also phonologically related, the extent to which this relationship was transparent on the surface varied. Phonologically-transparent pairs were those in which the derived member was simply composed of the free stem and the affix, without any changes in the stem (e.g., *friendly* – FRIEND). The free stems in phonologically-'opaque' pairs, on the other hand, differed from their realisations within the derived forms (e.g., *elusive* – ELUDE), showing phonological variation

[20]Throughout this study, I will distinguish primes from targets by the use of italics for the former and small caps for the latter.

similar to that in the words ending in -*ion* which were tested by Bradley (1980).

The first three tasks investigated suffixed words. In the first of these tasks, phonologically-transparent, morphologically-related pairs were compared to two types of phonologically-opaque pairs of morphological relatives. In one of these groups, the stem of the derived form simply differed slightly from the free stem, as in *elusive* – ELUDE. Pairs in the second group also differed in the phonological realisations of the stem, but the surface form of the free stem additionally differed from its theorised underlying representation (e.g., *vanity* – VAIN, underlying form /vÆn/ – cf. Marslen-Wilson et al. 1994: 8). These three sets of morphologically-related prime-target pairs were further compared to a condition in which the prime and target had their first syllables in common, but were otherwise unrelated (e.g., *tinsel* – TIN). When compared to an unrelated baseline, all of the groups of derived word primes significantly facilitated correct responses to their morphologically-related stems, regardless of phonological transparency. In contrast, primes which only had a phonological relationship to their targets, such as *tinsel*, did not have a reliable influence on target responses (Marslen-Wilson et al. 1994: 10).

The second task compared groups which varied in semantic relatedness. Pairs of words which had both a morphological and a semantic relationship (+Morph, +Sem) were contrasted with those which had only one or the other of these relationships. Furthermore, for those prime-target pairs which were related morphologically, the authors also compared the priming effect of derived word primes on stem targets to that of derived word primes on other derived word targets. These derived targets were composed of the same stem as their primes, but were combined with a different suffix (e.g., *confession* – CONFESSOR). The general pattern of results which emerged from this experiment was one based on semantic relatedness: derived words facilitated responses to their stems if they were also related in meaning (e.g., *friendly* – FRIEND), and primes which only had a semantic relationship to their targets (e.g., *idea* – NOTION) also induced facilita-

tion. Any primes which lacked this relationship to their targets, even if they were connected morphologically (e.g., *casualty* – CASUAL, *successful* – SUCCESSOR), nevertheless failed to prime their relatives. However, contrary to this pattern, *confession* – CONFESSOR pairs, where primes and targets were semantically- and morphologically-related suffixed forms of the same stem, also did not produce a priming effect.

In view of the results thus far, this lack of an effect for suffixed 'derived/derived' pairs is surprising. Marslen-Wilson et al. (1994: 15) initially suggest that this may be due to the inclusion in this condition of pairs with bound stems (e.g., *fragile* – FRAGMENT), or may be due to an issue with the use of a derived form as a target. To address these possible factors, the stimuli in the subsequent task only contained free stems, again varied with the goal of investigating the contribution of semantic relatedness. Prime-target pairs were thus all morphologically-related according to the criteria described above, but differed in whether or not they shared elements of meaning. In four of the five pair groups, suffixed forms served as primes, with either their stems, or other suffixed forms sharing those stems, as their targets. In light of the previous experiment, the authors also included a condition in which suffixed targets were preceded by their stems as primes (e.g., *friend* – FRIENDLY).

The results of this follow-up task confirm those of the earlier experiment. Prime-target pairs which were semantically related led to facilitation of target responses. This included both pairs where the derived form primed the stem, and those where the stem primed the derived form. However, as before, suffixed words did not prime other morphologically-related suffixed words, even when the words were judged by native speakers to be highly related in meaning. Based on these results, in combination with those of the previous two experiments (summarised in Appendix A, Table A.1), the authors propose a preliminary model of the lexical organisation and access of suffixed words.

In essence – aside from those pairs where both prime and target were de-

rived words – all and only those primes with a semantic relationship to their targets reliably led to priming of those targets. This was the case even when the phonological relationship between the words was not completely transparent. Marslen-Wilson et al. (1994: 17) argue that this pattern indicates that these pairs are related to one another on a level which abstracts away from surface phonological alternations, and which groups together morphologically-related words only if they are synchronically related in meaning.

However, they contend that these priming effects are due to more than just the presence of a relationship. In fact, they claim, the morphologically-related pairs which showed priming did so because of repeated activation of the morpheme shared between the stem and the derived form – namely, the stem itself. This suggests that the morphological structure of these suffixed, derived forms is somehow represented at the level of the lexical entry. The authors model this representation in terms of a shared lexical entry headed by the stem morpheme, with links to the various suffixes which may be attached to it (Marslen-Wilson et al. 1994: 18). However, as suggested by Clahsen et al. (2003), one might alternately propose that a derived word has a separate entry from its stem, with an internal structure which contains the shared stem morpheme.[21] Regardless, both interpretations reinforce the identity of the stem morpheme in both the free and the suffixed forms. Furthermore, as mentioned, this shared morpheme on the level of the lexical entry appears to only apply to semantically-related words. As Marslen-Wilson et al. (1994) note, without a synchronic semantic relationship, there is no motivation for a speaker to assume a shared morpheme between words that simply sound or appear similar. Such a strategy would not offer any advantage, as the meaning of a '-Sem' suffixed word like *department* cannot be computed on the basis of the meaning of *depart*.

The remaining issue is the consistent lack of priming between two semantically-related suffixed words with the same stem. The authors suggest that this null

[21] Cf. §2.3.1.

effect is in fact due to competition between the suffixes for attachment to this shared stem, which cancels out any previous stem activation. Because two words derived from the same stem (such as *governor* and *government*) will nevertheless have different semantic and syntactic characteristics from one another, they are therefore distinct items, and the identification of one of them during word recognition entails that the word being identified cannot be the other form. However, as Marslen-Wilson et al. (1994: 19) point out, this raises the question of why the free stem itself, which is equally distinct, is not also considered a competitor. They argue that because recognition of the stem does not require any of its links to possible affixes, there is no subsequent effect of the competition between these affixes; therefore, the activation of the stem morpheme is not cancelled out.

Given this reasonably straightforward account, what might one expect for the behaviour of prefixed forms? In general, the pattern of results for the remaining three cross-modal priming tasks (summarised in Appendix A, Table A.2) is similar. Looking first at the results for semantically-related pairs, it seems that this meaning relationship again correlated with facilitation, and did not depend on whether the derived word preceded its stem, or vice versa. Additionally, Marslen-Wilson et al. (1994) also investigated whether derived prefixed and suffixed forms sharing a stem would prime each other, and found significant facilitation for both prime-target orders (e.g., *distrust* – TRUSTFUL and *judgment* – MISJUDGE). Interestingly, these experiments also revealed significant priming between pairs of prefixed words sharing a stem. All three of the derived/derived conditions tested here thus showed an effect, contrary to the findings above for suffixed prime-target pairs. I will return to the authors' interpretation of this difference shortly.

As for conditions in which primes and targets were *not* related in meaning, it is clear that any other variations in their relationship did not change the lack of facilitation.[22] The authors tested both prime-target orders, as well as pairs of derived words sharing both free and bound stems. An additional '-Sem' stem/derived

[22] Although *strain* – RESTRAIN pairs also showed a marginally significant inhibition, for reasons of space I will not address this here. Cf. Marslen-Wilson et al. (1994: 24).

suffixed condition was also added, as this combination had not previously been included. In all cases, these semantically-unrelated pairs seemed to be treated similarly to those words which had no historical morphological connection, and shared only phonological/orthographic features. To rule out other possible factors, these '+Phon' only words were further subdivided according to whether the longer form appeared to be transparently composed of a prefix and the (unrelated) 'stem' (i.e., pseudoprefixed pairs like *dispatch* – PATCH), or, if not, according to whether or not the 'stem' was contained in a stressed syllable. None of these factors appeared to influence priming in these words.

Thus, across these six experiments, it seems that the semantic relationship between the prime and the target had a strong influence on whether or not prior presentation of this prime induced facilitation. As before, aside from the suffixed derived/derived pairs, all conditions that included pairs of words with a semantic relationship showed priming. However, if we assume that these suffixed pairs did not prime one another due to competition between the suffixes for attachment to the stem, it initially seems puzzling that the same considerations do not apply between two prefixed words, or between a prefixed word and a suffixed one. Marslen-Wilson et al. (1994: 3) propose that this pattern is due to a 'cohort-based interference effect' (Marslen-Wilson 1987; cf. Tyler et al. 1988). As discussed in §2.2.1.3 above, there is some evidence that spoken words are basically processed from left-to-right. This means that suffixed words with the same stem will also have the same initial sequence of phonemes, and therefore will compete with each other until a uniqueness point is reached. Pairs of prefixed words, or prefixed and suffixed words, on the other hand, will have different initial phonemes, and will thus be distinguishable from one another from the very first segment. Without the competition effect to counteract it, the facilitation from the activation of the shared stem will then be visible (Marslen-Wilson et al. 1994: 27).

This explanation seems to be roughly in line with the model of morphological parsing outlined earlier, based on the description by Hankamer (1989). It should

be noted, however, that if this interpretation is correct, then it seems that cross-modal priming may also be subject to effects originating from lower, access-based levels, at least to some extent. According to the proposal sketched by Marslen-Wilson et al. (1994), such effects may even mask the effects of structural information contained in the lexical entry.

There is one final issue which this study only mentions in passing (Marslen-Wilson et al. 1994: 18). Although it is true that the only '+Morph' pairs which produced priming were those which were also '+Sem,' significant facilitation was also found when a word was primed by a '+Sem' only relative (e.g., *idea* – NOTION). This raises the question of whether morphological relatedness – at least on the level of the lexical entry – can be distinguished from semantic relatedness. While the authors note that there is other experimental evidence (to be discussed below) that suggests different time-courses for semantic and morphological effects, their experiments alone cannot fully disentangle the relative degree to which semantic relatedness independently contributes to their priming effects. Still, in line with the research discussed thus far, it is unmistakably clear from this study that in accessing a semantically-transparent, morphologically-complex word, listeners and readers are also accessing information about the morphemes of which it is composed.

2.2.2 The independence of morphology: dissociations from meaning and form

The discussion in §2.2.1 supports the theory that morphological structure has a prominent role in word recognition. But what is the source of these apparently morphological effects? The work by Marslen-Wilson et al. (1994) indicates that the semantic relationships between words have an influence on the way that morphologically-complex words are recognised. Additionally, aside from suppletive forms, words which are considered to be morphologically related are generally also similar phonologically – and, by extension, orthographically. This has

led some to claim that morphological effects do not reflect a separate level of structure in the grammar, but instead only arise from sets of regularities in the relationships between the forms of words and their semantic characteristics (e.g., McClelland & Patterson 2002; cf. Marslen-Wilson 2007). Under this view, there is therefore no processing that is distinctly morphological – instead, any apparent morphological effects are due to the combined influence of meaning and form.

The question of whether or not these morphological effects are in any way independent is particularly relevant to an understanding of how conversion pairs are mentally represented. As discussed in Chapter 1, the most central cases of conversion pairs (as understood through the working definition based on Valera 2006) are phonologically identical and closely related in meaning. Thus, in order to determine whether the relationship between two members of a pair may be said to be morphological – as opposed to being, in particular, purely semantic – it is necessary to explore whether morphological relatedness might be usefully distinguished from 'the overlap of form and meaning' (Marslen-Wilson 2007: 186). As will become apparent below, there is ample evidence to support such a distinction during the process of word recognition. The most robust effects have emerged from the use of two primed lexical decision paradigms in particular: delayed (or long-lag) priming, and masked priming. I will discuss earlier research associated with each of these paradigms in turn, as well as some of the advantages and disadvantages of using such tasks to investigate morphological processing.

2.2.2.1 Delayed (long-lag) priming

Like the experiments conducted by Marslen-Wilson et al. (1994), a lexical decision task with delayed priming also tests the impact of prior exposure to a prime on responses to a target, with the goal of understanding how information about the relationship between the two forms is used during the process of recognition. However, while the particular cross-modal design described in §2.2.1.4 presented targets immediately after the end of their auditory primes, the ISI in a delayed

priming task is more extended. Targets are either presented after a certain time delay (e.g., Henderson et al. 1984), or presented after a number of intervening words or nonwords (e.g., Marslen-Wilson & Tyler 1998). Additionally, rather than using both auditory and visual stimuli, delayed priming tends to be intramodal.[23] The idea behind this design is that the effects of different types of prime-target relationships may have different time courses, so that effects which are found using *shorter* lags between prime and target may disappear when this lag is extended, or vice versa. Thus, by using delayed priming, one may be able to disentangle these different effects, and thereby determine their relative influence on the processing of particular kinds of words.

One of the earliest studies to apply this paradigm to a comparison of morphological and semantic effects is Henderson et al. (1984). In this paper, the authors compared lexical decisions in four different types of prime-target conditions: (1) a 'morphemic' condition, in which primes and targets were morphologically-related suffixed forms which had the same stem; (2) a semantic condition, in which primes and targets were semantic associates but not morphological relatives; (3) an orthographic condition, in which primes and targets began with the same letters but were otherwise unrelated; and (4) a condition in which primes were completely unrelated to their targets. All of these conditions were tested with both a 1 second (1000 ms) interval and a 4 second (4000 ms) interval between the prime and the target, and were entirely visually presented. There were no additional stimuli presented during these intervals.

When primes and targets were only 1 second apart, Henderson et al. (1984: 217) found that correct responses were significantly quicker for those targets which followed morphologically- or semantically-related primes, as compared to those in the unrelated condition. In contrast, responses to targets in the orthographic condition took far longer. When the ISI was extended to 4 seconds, the morphemic

[23] As participants usually respond to every stimulus item in a delayed priming task (including primes), restricting presentation to a single modality helps to avoid the possibility of participants' noticing the pattern of primes and targets.

condition still showed significant priming; in the semantic condition, on the other hand, the effect was greatly diminished. Finally, orthographically-related primes still induced longer target responses at the longer ISI.

Henderson et al. (1984) argue that these results indicate that semantic priming effects decay more quickly than effects of morphological relatedness. This suggests that priming between morphological relatives is not merely due to semantic similarity, but that instead it is possible to distinguish between these two types of relationship.[24] Although they do not discuss the results of the orthographic condition in detail, the fact that target responses here were slower rather than faster suggests that orthographic overlap is also not responsible for morphological priming at either ISI length.

In a similar vein but using spoken stimuli, Marslen-Wilson & Tyler (1998: 433) found that primes with a morphological relationship to their targets – whether regular (e.g., *called* – CALL) or irregular e.g., (*gave* – GIVE) – led to significant and equivalent facilitation of target responses, even with 12 items intervening between a target and its prime. However, pairs of words in which the prime only bore a semantic relationship to the target did not display a significant priming effect. Recent studies in the auditory domain in German (Scharinger et al. 2009; Lahiri & Reetz 2010) have produced a similar pattern of results, with semantic priming absent when only 5-8 items intervene, in contrast to persistent morphological priming.

As for the influence of phonological and orthographic relatedness, the lack of priming between words like *tinsel* and TIN in Marslen-Wilson et al. (1994), as well as the inhibition found in orthographic pairs in Henderson et al. (1984), suggests that effects of this relationship are distinct from those of morphological relatedness. However, other studies also weigh in on this issue. For instance, in a delayed priming task conducted by Stolz & Feldman (1995: 115), facilitation was found over an average lag of 10 items if primes were morphologically-related to

[24]It is also worth noting that the priming found in the suffixed-suffixed morphemic condition here is in contrast to the lack of priming for such pairs in Marslen-Wilson et al. (1994).

targets, while primes that only bore an orthographic relationship to the targets (e.g., *market* – MARK) did not affect responses. Likewise, Napps & Fowler (1987: 268) found no effect of prior presentation of an orthographically-related prime word regardless of the length of the ISI, which ranged from 10 intervening items to 0 (with an ISI of 2600 ms).[25] In addition to the results on English, the same pattern was also obtained in a visual delayed priming task conducted in German (Drews & Zwitserlood 1995: 1101), where robust priming effects were found with morphologically-related words, but not with those which were only orthographically related.[26] While the results for the orthographic pairs in Henderson et al. (1984) are not consistent with the null effects found in these other studies, it nevertheless seems that the influence of orthographic overlap in delayed priming is distinct from that of morphological relatedness, and does not contribute to the facilitation between pairs sharing a stem.

The effects found in the above delayed priming tasks seem to confirm that morphological priming cannot solely be attributed to the semantic relationship between primes and targets, as facilitation from meaning relatedness does not persist as long as morphological effects. Likewise, it seems as though morphological priming in these tasks is not simply based on overlap in form. Based on these considerations, it has been argued that the effects of morphological structure are not reducible to either purely semantic or phonological/orthographic characteristics (Stolz & Feldman 1995).

However, some researchers have argued that these effects do not reflect linguistic factors at all, but rather arise from the trace of a previously experienced event (i.e., having seen/heard a stimulus) being stored in a participant's episodic

[25]Napps & Fowler (1987) refer to the primes in this condition as 'pseudoinflected,' as they fully contained the target 'stem' word, followed by additional letters (e.g., *ribbon* – RIB). However, as will be explained in §2.2.2.2, it is important to distinguish such pairs (which I will refer to as *form* or *orthographic* pairs) from those in which the longer word contains a pseudosuffix in addition to the pseudostem (*morpho-orthographic* words, e.g., the false analysis *halt+er* in *halter*). Note that Napps & Fowler included both types in their pseudoinflected condition.

[26]Strictly speaking, the orthographic pairs in Drews & Zwitserlood (1995) were also morpho-orthographically related.

memory.[27] Once this trace is stored, the participant would then be quicker at responding to a stimulus which resembled the trace in their episodic memory. It is not clear, however, why such a mechanism should differentially apply to words sharing the same stem as opposed to words which only happen to resemble one another orthographically – assuming, of course, a similar degree of phonological/orthographic overlap.[28] More troubling, perhaps, for an interpretation of delayed priming as lexical is the possibility of conscious strategic effects (Frost et al. 1997; Napps & Fowler 1987). If participants are fully aware of the prime stimulus, they are more likely to consider the possible relationships between primes and targets, and thus may develop response strategies based on what they perceive to be the most useful for the task. This may lead to effects which are not truly representative of the lexical relationships under investigation. Despite these possible issues, it is worth noting that the different studies discussed above – using various types of designs, ISIs, modalities, and languages – have nevertheless produced a fairly consistent pattern of results which differentiates morphological relatedness from semantic or phonological relatedness. This therefore suggests that the distinction between these factors is fairly robust, and that delayed priming may, in spite of its issues, provide us with a means for further exploring how these factors may relate to one another.

2.2.2.2 Masked priming

In attempts to reduce the possible contributions of the strategic and episodic effects noted above, other priming paradigms have also been employed. One of the most well-studied of these is visual masked priming, in which processing of the prime stimulus is constrained.[29] In this paradigm, the prime is obscured by

[27] Cf. Monsell (1985) for an in-depth examination of some evidence for and against this theory.

[28] See also some further discussion of episodic effects in §2.3.1.

[29] Although there has been work on developing and refining an auditory masked priming paradigm (Kouider & Dupoux 2005; Kouider et al. 2010; Davis et al. 2010), this discussion will be restricted to visual presentation, as the majority of the work on masked priming in lexical decision has been done in the visual domain and it is therefore easier to compare results across studies.

a 'mask,' which may be composed of a series of hash marks (Rastle et al. 2000), an unpronounceable string of letters (Diependale et al. 2013), or an unrelated word (Forster & Davis 1984). The mask may be presented either immediately before the prime (forward masking), immediately after (backward masking), or both before and after. To further restrict conscious awareness of the prime, the mask is often (though not always – cf. Rastle et al. 2000 below) combined with a short prime presentation (30-65 ms). Unlike delayed priming, the target in a masked priming task is presented immediately after either the prime or the backward mask. These particular factors – a mask, a short prime presentation or *stimulus onset asynchrony*, and immediate presentation of the target – combine to 'interrupt' the processing of the prime, so as to ensure that it is 'never encoded into episodic memory...hence the participants are unable to subsequently report its identity' (Frost et al. 1997: 832).[30] Additionally, this paradigm serves to avoid strategic effects, since participants are often not even aware of the presence of the prime – particularly at shorter SOAs – and thus cannot be consciously changing their responses based on the perceived relationships between previously presented primes and targets (Forster & Davis 1984; Frost et al. 2000).

As the recognition of the prime is restricted in masked priming, priming effects in this paradigm are thought to reflect the processes which happen during the earlier stages of visual word recognition. Given that priming based on morphological relatedness seems to have a different time course from that of semantic or purely phonological/orthographic relatedness, it has been argued that the time restrictions of masked priming may offer further insight into the relative influences of these factors. In a masked priming study which varied the duration of prime presentation, Rastle et al. (2000) explored *when* during processing these different types of effects emerged. The experiments involved lexical decisions tasks, in which a series of hash marks first appeared on a screen, followed by a

[30]Stimulus onset asynchrony (SOA) is measured from the start (*onset*) of one stimulus to the start of the next. Unless otherwise noted, I will follow the masked priming literature in using *SOA* to essentially refer to the duration of prime presentation, since the onset of the target in these studies usually corresponds to the point at which the prime ends (the *offset*).

prime presented for 43, 72, or 230 ms. The prime was then immediately replaced by the target, to which participants made a YES-NO response. Participants who received the two shortest prime durations were not informed of the prime, while participants in the 230 ms condition were told they would see a word briefly presented after the hash marks.

The first experiment compared priming across five conditions: (1) a transparent morphological condition, in which the prime was a suffixed form of the target and had a synchronic semantic relationship (e.g., *departure* – DEPART); (2) an *opaque* morphological condition, in which primes were historically morphologically related to targets, and were orthographically composed of the target and a suffix, but were no longer semantically related to the target (e.g., *apartment* – APART; cf. Marslen-Wilson et al. 1994); (3) a purely semantically-related condition (e.g., *cello* – VIOLIN); (4) an orthographic condition, in which the targets fully overlapped with the initial segments of the primes but were otherwise unrelated (e.g., *electrode* – ELECT[31]); and (5) an identity condition (e.g., *church* – CHURCH). Responses following related primes in each of these conditions were compared to responses to the same targets preceded by an unrelated prime.

The size of the resulting priming effect varied across the five conditions and the three prime durations (Rastle et al. 2000: 515). A transparent morphological relationship between the prime and the target produced significant facilitation at all SOAs, as did identity primes. In the opaque morphological condition, significant priming was only found when the prime was presented for 43 ms; there was no effect at longer SOAs. Semantic priming, on the other hand, was only present at the two longer duration times (72 and 230 ms). Finally, in contrast to the other four conditions, there was no facilitatory effect of orthographically-related primes, although they did marginally inhibit target responses when presented for 230 ms. This pattern of results is summarised below, with 'Yes' indicating

[31]Like Napps & Fowler (1987), Rastle et al. do not distinguish between orthographic pairs like *electrode* – ELECT, and morpho-orthographic pairs like *corner* – CORN, in which the prime appears to be composed of the stem and a suffix. As a result, they include both types of pairs in their orthographic condition. Cf. Rastle et al. (2004) below.

facilitation at a particular prime duration, and 'No' indicating either no effect or inhibition.[32]

Relatedness	Example	43 ms	72 ms	230 ms
[+Morph, +Sem, +Orth]	*departure*/DEPART	**Yes**	**Yes**	**Yes**
[+Morph, -Sem, +Orth]	*apartment*/APART	**Yes**	No	No
[-Morph, +Sem, -Orth]	*cello*/VIOLIN	No	**Yes**	**Yes**
[-Morph, -Sem, +Orth]	*electrode*/ELECT	No	No	No
ID	*church*/CHURCH	**Yes**	**Yes**	**Yes**

Table 2.2: Summary of results from Rastle et al. (2000), Experiment 1

This pattern, in which morphological structure seems to play a role in the early stages of the processing of prime words, with semantic and purely orthographic effects arising later – and, in the case of the orthographic primes, *slowing* rather than speeding responses – suggests that it is possible to distinguish between the influences of these factors. However, Rastle et al. (2000: 519) note that the robust facilitation found in the transparent morphological condition may in fact be 'due to to *summed* effects of similarity in meaning and form' (emphasis in original). To investigate this possibility, they run a follow-up experiment using the same paradigm.

In this task, they included a condition in which primes were related to targets orthographically and semantically, but not morphologically (e.g., *screech* – SCREAM). Also tested were identity, semantic, and purely orthographic conditions similar to those described above, as well as a transparent morphological condition in which the prime and target shared a stem (e.g., *adaptable* – ADAPTER). The results of this second experiment are illustrated in Table 2.3.

As in their first experiment, identical primes and [+Morph, +Sem] primes induced faster reaction times than corresponding unrelated primes. The orthographic and semantic conditions also produced results similar to those in the first

[32]As in Marslen-Wilson et al. (1994), Rastle et al. indicate the relationships between primes and targets in each condition in binary terms, using the variables 'Morph' and 'Sem,' and replacing 'Phon' with 'Orth' (e.g., orthographically-related) due to the visual stimulus presentation. Tables 2.2 and 2.3 are adapted from *Language and Cognitive Processes*, 15(4/5), Rastle, K., Davis, M., & W. Marslen-Wilson, 'Morphological and semantic effects in visual word recognition: A time-course study', Pages 507-37, Copyright (2000), with permission from Taylor & Francis.

Relatedness	Example	43 ms	72 ms	230 ms
[+Morph, +Sem, +Orth]	*adaptable*/ADAPTER	**Yes**	**Yes**	**Yes**
[-Morph, +Sem, +Orth]	*screech*/SCREAM	No	No	**Yes**
[-Morph, +Sem, -Orth]	*cello*/VIOLIN	No	No	**Yes**
[-Morph, -Sem, +Orth]	*typhoid*/TYPHOON	No	No	No
ID	*church*/CHURCH	**Yes**	**Yes**	**Yes**

Table 2.3: Summary of results from Rastle et al. (2000), Experiment 2

experiment, with no facilitation for orthographically-related primes, and with priming effects from semantic relatedness only emerging at the longest SOA. Likewise, the *screech* – SCREAM pairs, despite their relationship in both form and meaning, still only showed a significant degree of priming at the longest prime duration. This lack of semantic and orthographic priming at earlier points in the recognition process seems to suggest that effects found at shorter prime durations are indeed morphological in nature, and are not simply caused by either semantic or orthographic relatedness, or some combination of the two (Rastle et al. 2000: 529).[33]

However, a later experiment conducted by Rastle and her colleagues (Rastle et al. 2004) indicates that the situation is more complex. This experiment was limited to masked priming with a 42 ms prime presentation – a duration at which purely semantic and orthographic effects would not be expected. The authors compared a transparent morphological condition, a orthographic or *form* condition, in which the letters of the prime matched those of the target plus 'a nonmorphological ending' (e.g., *brothel* – BROTH; Rastle et al. 2004: 1092); and a *morpho-orthographic* condition, in which primes *appeared* to be composed of the target and an existing suffix, but were not semantically related to the target, and generally not etymologically related either (e.g., *corner* – CORN). As before,

[33]In the transparent morphological condition, a slightly lesser degree of priming was found at the longest prime duration (Rastle et al. 2000: 524). It is possible that this is due to the same kind of competition between suffixed forms as that reported by Marslen-Wilson et al. (1994); cf. §2.2.1.4. However, because Rastle et al. use both suffixed-suffixed pairs and prefixed-prefixed pairs (e.g., *unset* – RESET), it is difficult to tell whether this might be the case.

responses in these conditions were compared to baseline target responses following an unrelated prime.

With this short prime presentation, Rastle et al. (2004: 1093) found significant facilitatory effects of prior exposure to primes which were related either morphologically, or only morpho-orthographically, with no effect in the purely orthographic condition. Moreover, the facilitation in the 'transparent' and 'opaque' conditions was statistically equivalent (27 and 22 ms, respectively). Combined with the lack of semantic priming at this short SOA in Rastle et al. (2000), these results suggest that during the early stages of visual word recognition, there is a level of automatic processing which decomposes any word which appears to be morphologically-complex – regardless of whether or not there is any other evidence to support this analysis. A word like *corner*, for instance, cannot be argued on semantic or etymological grounds to be composed of *corn* + *er*. The priming effects described in Rastle et al. (2004) for both morphologically- and morpho-orthographically-related pairs have been widely replicated in a number of other studies, both in English and other languages (cf. Rastle & Davis 2008 and Bertram et al. 2011 for reviews). These morphologically-conditioned facilitatory effects even persist in the face of regular spelling differences between some complex words in English and their stems, such as a missing 'e' (e.g., *adore/adorable*) or a duplicated consonant (e.g., *drop/dropper*).[34]

The unifying thread of these and other similar investigations of short SOA masked priming is one of a distinct stage of visual word recognition, which automatically applies a morphological segmentation process to any words whose orthography matches the orthographic patterns of the truly morphologically-complex words in the language. Orthographic similarity to another word is on its own not sufficient to trigger this process, and thus there is no facilitation for targets which simply overlap. Instead, when orthographic primes are compared to an unrelated baseline, we find either a null effect or inhibition (Grainger et al.

[34]This also applies to pairs which are not semantically related. See McCormick et al. (2008) and McCormick et al. (2009).

1991; Giraudo & Grainger 2000; Rastle et al. 2000; Longtin et al. 2003; Rastle et al. 2004).[35] As for the processing of meaning, the time-course study of Rastle et al. (2000) supports the idea that semantic information is not accessed until somewhat later in the recognition process.[36] Whenever this may be, the presence of equivalent priming of morpho-orthographically- as well as morphologically-related pairs indicates that priming effects at this earlier stage are not wholly conditioned by the semantics of the words involved. On the whole, the visual masked priming paradigm, when combined with a short prime duration, appears to produce a reliable pattern of priming effects. It may therefore allow us to identify morphological processing independently of semantic and purely orthographic processing – although the fact that *corner* primes *corn* suggests that it may not necessarily reveal evidence regarding deeper morphological structure.[37]

2.2.3 General background: summary

The research presented thus far argues that the morphological structure of a complex word affects how it is recognised. The studies reviewed in §2.2.1 show that information about the stem of a prefixed or suffixed word is used when identifying the word as a whole. This information is not only utilised when normal lexical access fails, as proposed by Butterworth (1983), but it is also employed during normal word recognition (Schriefers et al. 1991; Bradley 1980). Furthermore, those complex words which also have a transparent semantic relationship to their stems appear to somehow encode this relationship at the level of the lexical entry (Marslen-Wilson et al. 1994). Across these studies, we find that the evidence supports the existence of *decomposition* in some form – whether as part of lexical access or as part of the structure of a word's lexical entry, or both.

However, as described in §2.2.2, effects arising from access to a complex word's stem are not solely dependent on the semantic relationship between the stem

[35]This may be dependent to some extent on the relative frequencies of the prime and the target. Cf. Segui & Grainger (1990).

[36]Though cf. §3.3.1.2B.

[37]However, see Crepaldi et al. (2010), discussed in §2.3.1.

and the full form, nor do they merely seem to arise from the coincidence of this semantic relationship with phonological/orthographic similarity. Instead, the results of lexical decision studies using both delayed and masked priming lend support to an interpretation of apparent morphological effects in terms of an independent level of processing. This independent level attempts to determine the morphological structure of words during the recognition process. In the case of masked priming in particular, it is clear that part of this process for visually-presented words involves a procedure whereby any letter string that fits certain criteria will be decomposed into its potential component morphemes, prior to lexical access.[38] Under such conditions, effects based on similarity in meaning, or pure similarity in orthography, do not appear. Similarly, in delayed priming, when the participant is fully aware of a complex prime, the effects of access to the stem morpheme persist over a period of time, and outlast the effects of either semantic or phonological/orthographic similarity.

Thus, previous experimental work suggests that it is possible to find evidence of morphological structure in investigations of word recognition. In particular, masked priming and delayed priming paradigms may offer a means of differentiating morphological relatedness from semantic and phonological similarity – an issue of particular significance to the present study (cf. §1.5). Nevertheless, as suggested in §2.1, discerning whether or not morphological structure plays a role is not simply a matter of 'testing for effects of the stem'. The following section therefore offers a further look at some of the factors which may influence the extent to which morphological effects are apparent, with a primary focus on those issues which may be important to an understanding of the processing of conversion pairs.

[38]This decomposition must take place before lexical access in order for words like *corner* to be incorrectly parsed; however, as will be noted in §2.3.4 below, masked priming effects are also found with certain types of nonwords, which by definition cannot be accessed in the lexicon. This therefore serves to further confirm the pre-lexical nature of automatic decomposition.

2.3 Factors in the processing of morphological structure

Thus far I have primarily referred to the kinds of words examined in these studies as '(morphologically-)complex words.' As suggested in Chapter 1, however, determining which forms may be designated as complex is not entirely straightforward. Furthermore, the words which *are* generally considered by linguists to be morphologically-complex are nevertheless a diverse group, with a variety of different types of surface morpho-phonological realisations and underlying morphological structures, and different types of relationships to their apparent stem (or base, or root) forms. Previous research into how these differences interact with processing suggests that such characteristics may also affect the degree to which morphological effects (in terms of reference to the stem/base/root) are visible – or, in some cases, may even seem to reduce the relative importance of morphological analysis during recognition. For reasons of space, it is not possible to discuss all of these characteristics in detail; I have thus chosen those which seem the most relevant to the experiments on CONVERSION. It should also be stressed that although these factors are discussed separately, they are all closely interrelated. Any effects based on one of these characteristics will also most likely have implications for another.

2.3.1 Inflected vs. derived

As suggested in §1.5, it is possible that the difference between inflection and derivation is an important one for an understanding of CONVERSION. Additionally, however, determining whether a complex form is 'a different word' from its base is also a relevant consideration for understanding morphological processing. It has been argued, for instance, that if a complex word is not its own separate lexeme, then the full form of the word may not be stored in the lexicon at all, instead being created by adding an affix, or applying a rule to the base form (Pinker

& Prince 1994). When such a word is compared to a complex word which *does* have its own lexical entry – as is often supposed for derived forms – this difference in the status of their entries may have consequences for how the words are processed relative to one another. Additionally, experiments which are aimed at uncovering nature of the relationship between a complex form and its base could, in theory, reveal effects of the extent to which the two forms are independent.

Despite the relevance of this issue, much of the experimental work mentioned up to this point does not make an explicit distinction between those affixed words which are inflected forms of their stems, and those which are derived. Some studies, such as Taft & Forster (1975) and Marslen-Wilson et al. (1994), have for various reasons only considered one type (i.e., derived forms), but have not directly compared or contrasted them. This section briefly reviews several studies which venture into this area of inquiry, beginning first with earlier work using delayed priming tasks (Stanners et al. 1979; Fowler et al. 1985; Raveh & Rueckl 2000), and then proceeding to a more detailed consideration of the masked priming study of Crepaldi et al. (2010).

One of the earliest attempts to explore the distinction between inflection and derivation as it applies to word recognition is found in Stanners et al. (1979). The authors of this paper used a series of visual delayed priming tasks to investigate how effective derived forms were at priming their bases as compared to inflected forms.[39] Rather than using responses following an unrelated prime as a baseline, they calculated priming effects by comparing target responses following the 'critical' (inflected or derived) prime to those in an identity condition, where the target was preceded by itself. These responses were then compared to those of the first presentation of the base form in the identity condition, which was essentially unprimed. Inflected primes (verbs, e.g., *pours*) and different types of derived primes (adjectives, e.g., *selective*; nouns, e.g., *appearance*) with various

[39]Stanners et al. use the term *base* to refer to the citation form of a lexical item (e.g., *walk* rather than *walked*, *walker*, etc.), regardless of whether the complex form related to this base is inflected or derived.

suffixes were tested in separate experiments. Inflected primes significantly facilitated target responses (e.g., POUR), speeding recognition to the same degree as did the identity primes. Derived primes were further subdivided according to the number of orthographic variations between the complex forms and their bases; however, this variation did not have a significant effect, and all derived primes elicited faster responses to their targets as compared to first presentations of the isolated bases (e.g., SELECT, APPEAR). Unlike the inflected forms, however, the derived forms *did not* induce a priming effect equivalent to that of the identity primes. Instead, prior presentation of derived relatives produced a significantly smaller degree of facilitation than priming by the bases themselves.

Stanners et al. (1979: 407) argue that this difference between priming a base with a derived form and priming with the base itself is due to the fact that words related through derivation have separate lexical entries from their bases, while inflected forms do not. Although this is counter to the model later advanced by Marslen-Wilson et al. (1994; §2.2.1.4), it should be noted that Marslen-Wilson et al. only investigated the priming effects of derived words, and only as compared to an unrelated baseline. Furthermore, Stanners et al.'s subsequent claim is in fact aligned with the results found in the later paper, as they argue that the separated entries of derived words and their bases must nevertheless be interconnected in some way, in order for the derived words to produce significant priming effects. They suggest that this connection may be similar to an alternative proposed by Taft & Forster (1975), in which a complex derived word like *rejuvenate* is represented in the lexicon as *re*(*juvenate*), a full form with its morphological structure represented. Furthermore, they contend, part of the processing of derived words involves access to the base form, which they suggest accounts for both the priming effect and the fact that derived words in their experiments had longer response times overall (Stanners et al. 1979: 411).[40] In contrast, the priming found when inflectional forms were used as primes, which was similar

[40]Cf. §2.3.5 for a more detailed discussion of this latter point.

to pure repetition of the base, is said to reflect a shared lexical representation. Processing for these complex words is thus suggested to proceed along lines similar to the affix-stripping approach, with the suffix being removed and the base representation accessed directly (Taft & Forster 1975).

Although Stanners et al. (1979) find a difference between priming by inflectional relatives and priming by derivatives, other research seems to argue against interpreting this difference in terms of a difference in lexical representations. For instance, Fowler et al. (1985) suggest that the results in Stanners et al. (1979) might actually stem from the encoding of these forms in episodic memory (cf. §2.2.2.1). They argue that because the inflected forms used by Stanners et al. had an overall greater amount of orthographic overlap with their bases than the derived forms, the bases therefore had a higher degree of similarity to the stored memory of the inflected primes. To test this assumption, they first use a delayed priming task similar to that of Stanners et al., but with a stronger within-items design, in order to directly compare the relative priming effects of inflected and derived forms on the same base targets. To further investigate whether the priming effects were lexical in origin, nonword prime-target pairs were constructed with similar orthographic relationships to one another as in the inflected and derived pairs. The task produced a pattern which somewhat resembled that observed by Stanners et al., with inflected primes inducing facilitation equivalent to that of identity primes, and derived primes inducing less. Interestingly, however, although response times following inflected and identity primes were significantly different from the unprimed first presentation of the target, those following derived primes, while numerically faster than the unprimed responses, were not faster to a statistically significant degree. Nonword pairs displayed a similar pattern, though the effects tended to be more marginal, and the overall priming effect was largely due to facilitation in the identity condition (Fowler et al. 1985: 244).

Concluding that Stanners et al.'s results were due to episodic effects, Fowler

et al. attempt to minimise these effects by increasing the number of intervening items between related primes and targets to 48, from the 6-12 used in the first experiment. Unlike the first task, this experiment was more similar to the design of Stanners et al. in that base targets were either primed by an inflected form *or* a derived form, rather than one of each. This second task found that both inflected and derived primes produced facilitation equivalent to that of identity primes, while no effect was observed between related nonwords (Fowler et al. 1985: 245).

The combined results of Fowler et al.'s experiments suggest that inflected and derived complex words are not treated differently from one another in delayed priming, and that differences which may be observed are not due to differences in lexical representation, but rather to the level of orthographic similarity between episodic memory events. Nevertheless, it is possible that even if a portion of the differential priming effect is caused by episodic factors, the facilitation may still involve some influence from lexical processing and structure. Firstly, while the facilitation of nonwords in Fowler et al.'s shorter experiment does seem to point towards effects of orthographic overlap, these effects were not as strong as for the word pairs, and seemed to mostly be due to pure repetition priming from the identity condition. Secondly, as the authors note (Fowler et al. 1985: 253, n. 2), if the results of the first experiment were entirely based on the influence of episodic factors, the fact that inflected primes are not orthographically identical to their stem targets would seem to predict a smaller priming effect for these words, as compared to identity primes. However, responses to targets did not significantly differ between these two prime conditions (Fowler et al. 1985: 244). Furthermore, as mentioned above, Stanners et al. (1979: 407; 409) also investigated the effect of different degrees of orthographic overlap during their investigation of derived primes. However, they did not find a significant difference between the level of facilitation from primes with greater overlap (e.g., *selective* – SELECT) and those with more orthographic differences (e.g., *descriptive* – DESCRIBE).

Noting these conflicts between the results of Stanners et al. (1979) and Fowler

et al. (1985), Raveh & Rueckl (2000) conducted a further investigation of inflected and derived forms in delayed priming. Despite the fact that Stanners et al. (1979) found no difference among derived forms with different degrees of overlap, Raveh & Rueckl (2000) nevertheless argue that the lesser amount of facilitation for these primes in Stanners et al.'s experiments was an effect of the lesser orthographic similarity. They also criticise the lack of a within-items design in both Stanners et al. (1979) and the second experiment of Fowler et al. (1985). In view of these points, they tested a set of base targets (e.g., BAKE) in three different related prime conditions: with an identity prime (e.g., *bake*); with an inflected form ending in *-s*, *-ed*, or *-ing* (e.g., *baked*); and a with derived form ending with a suffix with the same number of letters as the inflectional suffix (e.g., *baker*). A third condition, which presented the target without a preceding related prime, was used as a baseline. The lag between prime and target was similar to that of Stanners et al. (1979), with 8-13 items intervening between members of a prime-target pair.

The results revealed a pattern of effects that was not entirely straightforward (Raveh & Rueckl 2000: 110). As Raveh & Rueckl predicted, target responses in all three related conditions were significantly faster than when the target was unprimed. Furthermore, the difference in responses following inflected primes and those following derived ones was not statistically significant. Nevertheless, they also found that, in the derived condition, the amount of facilitation produced by these complex primes was significantly less than that of identity primes, whereas prior presentation of inflected forms had a similar effect to having previously seen the base itself.

However, the authors suggest a possible confound which many studies of morphological processing in English word recognition do not address: word class ambiguity, like that of conversion pairs (Raveh & Rueckl 2000: 111). Noting that it is not always possible to identify the word class of some targets presented in isolation (e.g., *pack* presented alone can be read as either a noun or a verb),

they propose that prime-target pairs which they had assumed to be inflectionally related (e.g., *packed* – PACK) may not have been so if the target was understood by participants as belonging to a different word class (e.g., *pack*$_{\text{N}}$).

To account for this, their follow-up task used only unambiguous verbs or words with a strong verb bias as targets, presented in the same design as described above. The results of this additional task were somewhat clearer. As before, all three conditions with related primes showed significant facilitation of target responses when compared to the unprimed condition. While the identity primes led to significantly faster times than either the inflected or derived forms, no difference was found between the latter two conditions (Raveh & Rueckl 2000: 114).

Based on these results, they conclude that morphologically-complex derived words are likely processed in the same way as inflected words, at least as far as can be revealed by a lexical decision task with delayed priming.[41] However, given that their argument is based to some extent on a null effect, they note that the results should be interpreted with caution (Raveh & Rueckl 2000: 115). Furthermore, as suggested by the criteria noted in §1.5 for distinguishing inflection from derivation, inflected and derived words may have different syntactic and semantic properties, and may therefore vary in the particular relationship they have to their stems/bases. Raveh & Rueckl (2000: 116) point out that while these characteristics and how they interact might indeed affect recognition of these complex words, their 'results indicate that the syntactic and semantic differences between inflections and derivations are not *sufficient* to produce a difference in the manner in which these classes of words are processed' [emphasis in original].

Raveh & Rueckl's results, in conjunction with those of Fowler et al. (1985) and Stanners et al. (1979), suggest that whether (and how) the distinction between inflection and derivation affects the recognition of words involved in these pro-

[41] Although not discussed for reasons of space, it should be noted that Raveh & Rueckl (2000) also conducted two fragment completion tasks with the same stimuli, and found similar patterns of results.

cesses may be a complex issue, and one which is likely more nuanced than simply categorising words as 'inflected' or 'derived.' For instance, Clahsen et al. (2003: 129) note that Raveh & Rueckl's results may also have been affected by their use of a large variety of different suffixes in their derived conditions (*-er*, *-y*, *-or*, *-age*, *-ive*, *-ful*, *-ure*, *-ery*, and *-ist*), since different suffixes may be treated differently in processing.[42] Although this raises a possible theoretical and methodological issue with interpreting Raveh & Rueckl's results, the studies of Fowler et al. (1985) and Stanners et al. (1979) are also subject to methodological caveats, as neither of these studies controlled for the relative frequencies of the words in the inflected and derived conditions, which also may have affected the results.[43]

Despite these difficulties in interpreting the delayed priming data presented above, there is still reason to believe that there may be some kinds of processing differences which may indicate (either directly or indirectly) whether or not two forms are related by derivation or inflection – though perhaps these differences may be quite subtle, and may be more likely to appear under more sensitive experimental conditions. Bozic & Marslen-Wilson (2010), for instance, suggest that the processing of derived forms may be handled by a different neural system than that of inflected forms, a suggestion which seems to be confirmed in the different patterns of brain activity found in recent fMRI investigations (Bozic et al. 2013a,b).

More pertinent to the present study, however, is the indirect evidence provided by the masked priming tasks in Crepaldi et al. (2010). In this paper, the authors investigate the existence of masked priming effects between irregularly-inflected forms in English and their bases, and find that the pattern of effects for these pairs is different than for the derivationally-related pairs tested in Rastle et al. (2004).[44] Targets consisted of the base forms of irregularly-inflected words (e.g., FALL and MOUSE), each of which was presented in three different prime

[42] Cf. Bradley (1980, discussed above), Bertram et al. (2000b), and §2.3.3 below.
[43] Cf. §2.3.2.
[44] Cf. §2.2.2.2.

conditions. One of these was the irregularly-inflected relative of the target (e.g., *fell* and *mice*). A second prime condition consisted of forms which only bore an orthographic relationship to the target (e.g., *full* and *maze*), while a third condition used unrelated monomorphemic prime words in order to establish a baseline (e.g., *hope* and *warn*). Primes in the first two conditions (the 'Morphological' and the 'Orthographic' condition) were matched in their degree of orthographic overlap with the target, as well as in their length, frequency, and the size of their orthographic neighbourhood (analogous to a phonological cohort; cf. §2.2.1.3). As in Rastle et al. (2004), primes were forward-masked (i.e., preceded by hash marks) and presented for 42 ms (Crepaldi et al. 2010: 85-6).

Responses to the targets showed a significant effect of the type of prime which preceded them. Inflectional relatives produced significant facilitation, with faster responses in the Morphological condition than in either the Orthographic or the unrelated condition. The latter two conditions, meanwhile, did not differ (Crepaldi et al. 2010: 87). In light of the previous work by Rastle and colleagues, which only found facilitation from primes which were morpho-orthographically segmentable, Crepaldi et al. find this result puzzling, as irregularly-inflected forms are not segmentable in the same way. Additionally, as supported by both Rastle et al. (2000) and Rastle et al. (2004), the priming effect cannot be argued to reflect the semantic relationship between the inflected form and its base, as meaning relatedness alone does not seem to have an effect on priming at such a short SOA. They first propose, therefore, that the results may reflect 'islands of sub-regularity' in the orthographic relationships between many irregularly inflected forms and their bases: for example, *feed*, *meet*, and *breed* follow the same pattern in the past tense, to become *fed*, *met*, and *bred* (Crepaldi et al. 2010: 87-8).

In order to investigate this possibility, they therefore designed a further experiment which included the same type of stimuli as the previous task, but also included three additional conditions: (1) a set of 'pseudo-irregular' pairs matched

with islands of sub-regularity (e.g., *tell* – TALL, which patterns like the truly related pair *fell* – FALL); (2) an Orthographic prime condition matched to the pseudo-irregular pairs (e.g., *toll* – TALL); and (3) an unrelated condition. The task was then conducted using the same procedure. For the stimulus set which included genuine inflectional relatives, the results replicated the pattern found in the previous experiment, with inflected forms producing significantly faster responses to their bases than either an orthographic relative or an unrelated form. However, unlike the truly morphologically-related pairs, the pseudo-inflected pairs did not facilitate reaction times, and target responses in the three prime conditions (pseudo-irregular, orthographic, unrelated) did not significantly differ from one another (Crepaldi et al. 2010: 91).

In summary, priming effects in this study only emerged between those forms which were truly morphologically related, while relationships based on orthographic similarity – whether semi-regular or not – did not affect reaction times. However, this contrasts with the pattern found in Rastle et al. (2004), which found priming effects for 'pseudo-derived' morpho-orthographic pairs like *corner* – CORN. Thus, a question arises: why is the effect for *corner* – CORN equivalent to *dealer* – DEAL, while *tell* – TALL is not equivalent to *fell* – FALL?

Crepaldi et al. propose that the locus of priming is different in these two cases, and that this difference stems from the contrast between inflection and derivation. They suggest the model of processing illustrated in Figure 2.1.[45]

Under this model, items that appear to be morphologically complex are first decomposed into an apparent stem and affix. These 'morphemes' then activate representations in the orthographic lexicon, where only existing words are represented.[46] The orthographic representations then activate lemmas, which are individual lexical entries composed of a 'specific meaning' and 'lexical-syntactic

[45]Figure 2.1 reprinted from *Journal of Memory and Language*, 63(1), Crepaldi, D., Rastle, K., Coltheart, M. & L. Nickels, '"Fell" primes "fall", but does "bell" prime "ball"? Masked priming with irregularly-inflected primes', Pages 83-99, Copyright (2010), with permission from Elsevier.

[46]The dotted lines between the segmentation level and the orthographic lexicon indicate possible feedback between these levels (Crepaldi et al. 2010: 93).

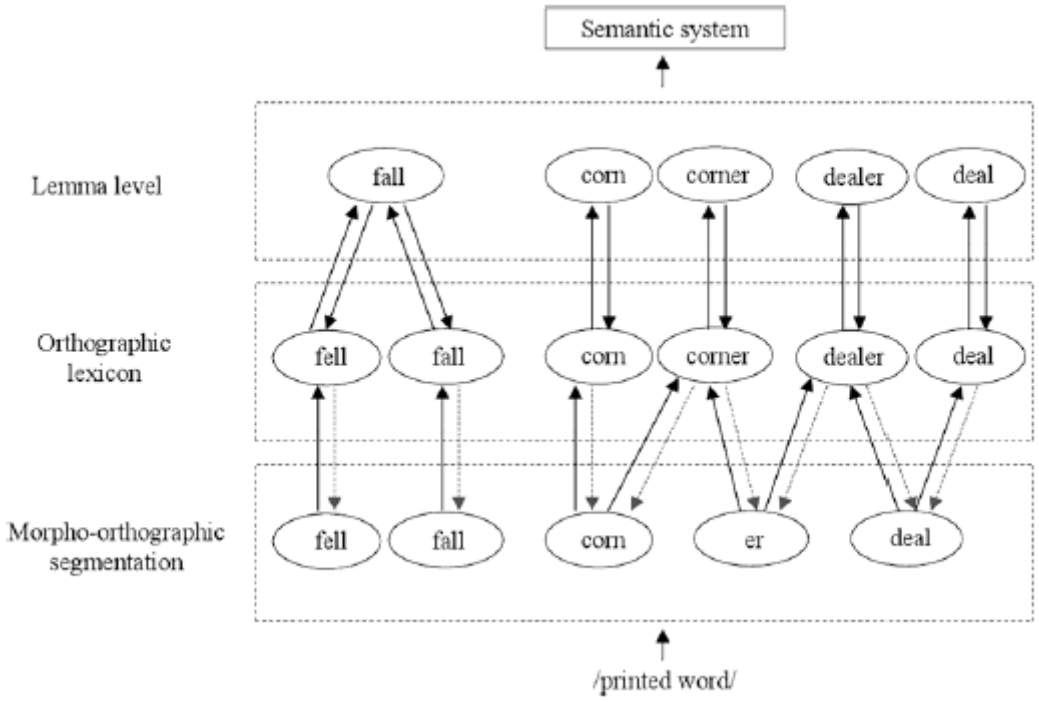


Figure 2.1: Extended morpho-orthographic segmentation model (from Crepaldi et al. 2010: 93)

properties' (Crepaldi et al. 2010: 92; cf. Levelt et al. 1999). The crucial proposition the authors make is that while inflectionally-related forms share a node on the lemma level, derivationally-related forms do not. Because *fell* is an inflected form of *fall*, it directly activates FALL's lemma node, thus speeding responses to the base form when it is subsequently presented. This produces a priming effect, despite the fact that *fell* cannot be automatically segmented on the basis of its orthographic characteristics.

In the case of *dealer* – DEAL, the activation is of a different sort. When *dealer* is segmented into a stem and affix, the stem itself activates the 'deal' node in the orthographic lexicon. This further activates the lemma node for DEAL. However, because this activation is not due to *dealer* and *deal* sharing a lemma, a similar process may operate for *corner* – CORN. This similarity then gives rise to the equivalent priming effects observed for both truly derivationally-related pairs and apparently derivationally-related pairs (Crepaldi et al. 2010: 92-3).

This model has an added benefit in that it makes clear predictions regarding priming effects in visual masked priming, particularly as regards regularly-inflected forms such as *cats*. Crepaldi et al. (2010: 95) suggest that larger priming effects should be found when *cats* precedes CAT than for any of the cases in Figure 2.1. This is due to the fact that the lemma node for CAT should receive priming from two sources: from 'cats' in the orthographic lexicon, as it is an inflected form of CAT; and, after decomposition, from the orthographic node for 'cat' as well.[47] Should this prediction be borne out, such an effect would lend support to the idea that there is an underlying difference between inflection and derivation.[48]

Though Crepaldi et al.'s experiments do not directly compare inflected and derived words, they do seem to demonstrate that these two types of words may behave differently under the same experimental conditions. If we assume, as they suggest, that inflected and derived words differ in their representation on the lemma level, then it seems reasonable to suppose that this difference may also affect processing when such morphologically-complex words are consciously perceptible, i.e., during delayed priming. However, it is also possible that those characteristics on which the distinction between inflection and derivation is based – such as those noted in §1.5 (cf. Plank 1994) – or those which co-vary with this distinction to an extent (e.g., orthographic similarity) may individually have stronger or more visible effects, particularly during the later stages of recognition which follow those targeted by short SOA masked priming. Based on the particular studies reviewed above, it is not completely obvious whether any such distinction would actually manifest in terms of the sharing or not sharing of a lexical entry, or whether it might be better understood as the confluence of the mental realisations of several interacting factors like the ones noted above, as well as those discussed further below.[49]

Regardless of whether and how the apparent distinction between inflection

[47]The possible effect of two sources of priming will be explored further in §3.3.2.1, where the above model is applied to the first experiment on conversion pairs.

[48]However, cf. §3.3.4.

[49]Cf. Bertram et al. (2000b) and the discussion in Raveh & Rueckl (2000).

and derivation might influence morphological processing, its relevance to an investigation of CONVERSION is clear. If members of directional conversion pairs are in a relationship of base vs. derived – as suggested in §1.6, example 1.62 – it is possible that this relationship might be treated differently than the relationships between each of these pair members and their respective inflectional forms. Furthermore, this derivational relationship might also give rise to effects which differ from those of apparently underspecified pairs, assuming that the latter are indeed inflected forms of the same root (example 1.64). Such possibilities will thus figure prominently in the design, predictions, and interpretation of the experiments conducted in the following chapters.

2.3.2 Frequency

As alluded to above, the overall frequency of occurrence of a word across a language is one of the most robust predictors of word recognition time, and has a very strong influence in tasks like lexical decision (Forster & Chambers 1973; Whaley 1978; Yap & Balota 2009; cf. Monsell 1991 and Murray & Forster 2004 for reviews). High frequency items, *ceteris paribus*, generally facilitate faster responses than low frequency items – though, as suggested by certain studies above (Schriefers et al. 1991; Bradley 1980), and as we shall explore further below, its effects are far more complex than a simple inverse correlation with reaction time.

To thoroughly discuss and evaluate the previous research on the influence of frequency in word recognition, and what it can reveal about the processing and storage of morphologically-complex forms, would on its own be a monumental task. Instead, I have here attempted to review a small – and somewhat disparate – selection of the literature, focussing primarily on the specific papers which have informed my own predictions and analyses. However, before beginning this discussion, it is first necessary to clarify what is meant by various terms which will be used to refer to different types of frequency measurement, as they are not always used consistently across the literature. There are, of course, other

types frequency-based information (cf. §2.3.4 regarding transition probability), but these are the primary measurements used in this discussion, as well as in the current study in general.

> **1. Surface frequency:** This will be used to refer to the frequency of the surface form of a word, e.g., for *running* or *farmer*, this is the frequency only of the forms *running* or *farmer* themselves, and not any related variations.[50]
>
> **2. Lemma frequency:** This will be used to refer to the frequency of a particular 'lemma' as a whole – that is, the surface frequencies of a word and all its inflected variants, e.g., the lemma frequency of *bleat* is the sum of the surface frequencies of *bleat, bleats, bleated, bleating*, the lemma frequency of *farmer* includes the frequencies of *farmer* and *farmers*, etc.[51]
>
> **3. (Morphological) family frequency:** This will be used to refer to the summed frequencies of all inflected, derived, or compound variants of a particular base, e.g., the family frequency of *earn* includes the frequencies of *earn, earns, earned, earning, earnings, earner, earners, unearned*, etc.[52]
>
> **4. Orthographic word form frequency:** This is a measure specific to the present study, and refers particularly to the combined surface frequencies of both the nominal and verbal forms of the unaffixed stems in a conversion pair, e.g., the orthographic word form frequency of *run* includes the surface frequencies of both run_{V} and run_{N}. Although not used in the current section, it will become more relevant when developing experimental predictions in the following chapter (cf. §3.3.2.1).

Every attempt will be made to use the above terms to describe the relevant frequencies in my own work and that of others; however, should the discussion require reference to other measurements specific to a particular work, this difference will be indicated. We now turn to a review of the specific studies of frequency and recognition that have provided the most pertinent information for the experiments on CONVERSION.

[50] For the special case of the unaffixed forms of conversion pairs, the surface frequency of e.g., $cloak_{\mathrm{N}}$ will only encompass the surface frequency of the nominal use of this form. This should be distinguished from what I will call the *orthographic word form frequency* – see 4.

[51] This measurement has also been referred to as *stem* (Baayen et al. 1997) or *base* frequency (Bertram et al. 2000a).

[52] Cf. however, Solomyak & Marantz (2010), who do not include compound frequencies in their count (§2.3.4).

2.3.2.1 Prime-target frequency

We begin with some general considerations regarding the effects of frequency on priming. For instance, in a 1977 paper by Scarborough et al., a *post-hoc* analysis of the results of a delayed priming task reveals an interesting pattern. In this identity priming task, visually-presented words and nonwords were repeated following lags ranging from 0-15 intervening items. Responses to these repeated items were significantly facilitated as compared to their first presentations; however, for real words, this effect did not vary according to the number of items intervening, and priming remained strong across 15 trials (Scarborough et al. 1977: 3).[53]

In an effort to further clarify the *locus* of this repetition effect, the authors later separated the stimuli into two sets based on their frequencies, using the median stimulus frequency to determine a high-frequency and a low-frequency group.[54] When the responses to these words from their first and second presentations were also divided into the frequency groups of their corresponding words, a significant interaction emerged (Scarborough et al. 1977: 5). This interaction revealed a larger priming effect for low-frequency words than for high-frequency words, although responses in both groups were speeded by repetition. According to Scarborough et al., this pattern suggests a partial explanation for the general advantage for higher-frequency words in recognition tasks (Monsell 1991; Murray & Forster 2004), as it seems that greater repetition speeds responses, especially when the word has had fewer 'lifetime repetitions' (i.e., is of lower frequency).

Forster & Davis (1984) argue against this interpretation, instead proposing that the pattern of frequency effects found by Scarborough et al. is episodic in nature. To test this hypothesis, they conduct a series of experiments, one of which roughly mirrors that of Scarborough et al. (1977). In this visual lexical decision task, participants responded to two blocks of trials. In the first block were 60 trials, consisting of high- or low-surface frequency identity primes, along with fillers which only appeared once. After an unreported period of time, participants com-

[53] Priming of nonwords, on the other hand, decreased as lag increased.

[54] Scarborough et al. (1977) do not specify what type of frequency measure they use.

pleted the second block of 120 trials, which contained both repetitions of (high- and low-frequency) words from the first block (i.e., targets) and a new set of fillers. As in Scarborough et al.'s experiment, the results of this 'delayed repetition' task showed a much larger degree of facilitation for words with lower surface frequencies. Although high-frequency words were also significantly primed, the difference in response times for first and second presentations of these words was about half the size of the difference for low-frequency items (Forster & Davis 1984: 687).

In contrast to these results, however, are those of the subsequent masked priming experiment on the same stimuli (Forster & Davis 1984: 682). In this task, the identity prime was presented for 60 ms, and followed immediately by the target. The prime was preceded by a forward mask composed of an unrelated word. Responses to targets following a related prime (i.e., itself) were then compared to responses following an unrelated prime word. Reaction times to both high- and low-frequency words showed a significant facilitatory effect of repetition, although the high-frequency words elicited faster responses overall. In this task, however, there was no difference between the two frequency groups in the amount of facilitation they received (Forster & Davis 1984: 683-84).

The authors argue that, taken together, the results of these experiments support the idea that the pattern of frequency effects found in delayed priming is caused by episodic factors. They point out that the masked priming task was designed to minimise these factors by preventing conscious perception of the prime (cf. §2.2.2.2), and argue that the lack of a frequency effect in this task indicates that the influence of episodic memory was successfully reduced. While it is indeed likely that masked priming minimises the encoding of primes in episodic memory, it is not entirely clear how this encoding would necessarily lead to a greater benefit for low-frequency words than for high-frequency words. Furthermore, as Forster & Davis (1984: 681) themselves note, episodic factors would also be expected to lead to a decrease in priming for *all words* over longer lags – a prediction which is

in contrast to their results and those of Scarborough et al. (1977, among others; cf. §2.2.2.1). Regardless of the source, it is clear that the frequency of the target may have an influence on the level of priming revealed by a delayed priming task, at least as far as identity priming is concerned.

As for *masked priming*, although the results in Forster & Davis (1984) suggest that frequency has little effect under such conditions, later research indicates that the issue may actually be somewhat more complicated, particularly when prime and target frequency are considered independently. The two primary studies which have directly tested for effects of prime and target frequency on masked morphological priming are the studies of Giraudo & Grainger (2000) and Grainger et al. (1991). The first of these was conducted in French, with a forward mask and a prime duration of 57 ms. Targets were tested in six different prime conditions: (1) following a high-surface frequency prime with the same root as the target (e.g., *amitié* – AMI; 'friendship – friend'); (2) a low-surface frequency prime with the same root as the target (e.g., *amiable* – AMI; 'friendly – friend'); two conditions involving an orthographically related prime (e.g., *amidon*–AMI; 'starch – friend'), which was similarly varied in frequency; and a condition each of high and low frequency unrelated primes (Giraudo & Grainger 2000: 429-30).

The authors found a significant facilitatory effect from high-frequency primes that were morphologically-related (e.g., *amitié*), which speeded responses to related targets by 33 ms relative to an unrelated prime of a similar frequency. Meanwhile, the response times in the low-frequency prime conditions did not significantly differ according to the type of prime (i.e., related vs. unrelated; Giraudo & Grainger 2000: 430-31). This pattern indicates that priming with higher frequency morphologically-related primes may be more effective.

Meanwhile, in another masked priming study, Grainger et al. (1991) investigated the possible effects of *relative* prime-target frequency – that is, whether the prime is more or less frequent than the target. This study used forward masking and a 64 ms SOA. The experiment relevant to this discussion con-

tained six separate conditions (Grainger et al. 1991: 376).[55] In one group, suffixed targets were preceded by higher surface frequency items that were either morphologically-related (e.g., *mural* – MURET; 'wall – dike/embankment'); orthographically-related (e.g., *murir* – MURET; 'ripen – dike/embankment'); or unrelated (e.g., *nanti* – MURET; 'wealthy – dike/embankment'). In the second group, the higher frequency morphological primes from the first set became the targets, and were preceded by either their lower frequency morphological relative (e.g., *muret* – MURAL), a lower frequency orthographic relative (e.g., *murir* – MURAL), or a lower frequency unrelated item (e.g., *nanti* – MURAL). The mean surface frequencies for the morphologically-related pairs were 3.2 occurrences per million for the lower frequency items, and 43 per million for the higher frequency items.

When compared to the orthographically-related conditions, responses to targets preceded by morphological relatives were significantly faster (45 ms faster for the higher frequency primes, 26 ms for the lower frequency primes).[56] However, the level of facilitation for the two prime-target orders did not significantly differ (Grainger et al. 1991: 377).

Grainger et al.'s results seem to indicate that the size of morphological priming effects in masked priming does not necessarily depend on whether the prime is more or less frequent than the target. Nevertheless, having noted the smaller 26 ms effect for targets with lower frequency primes, one might postulate that a significant difference in the size of the priming effect may have been observable if the prime and target had a larger frequency difference. Referring back to the experiment in Giraudo & Grainger (2000), however, we do not entirely find this

[55]The experiment also included prefixed-prefixed pairs, but as these may behave differently from the suffixed items used in the current study (cf. §2.2.1.3 and 2.2.1.4), these conditions will not be discussed.

[56]When the morphologically-related condition was compared to the unrelated condition, Grainger et al. obtained very similar results to those of Marslen-Wilson et al. (1994), i.e., no priming when both prime and target were suffixed. However, in line with Marslen-Wilson et al., they argue that this is due to inhibition caused by the sharing of initial letters. They thus compare response times in the morphologically-related condition to the orthographically-related one, in an effort to filter out these effects.

line of reasoning confirmed. While it is true that the low frequency primes (9 occurrences per million) did not prime the targets (549 occurrences per million), the high frequency primes (109 occurrences per million) produced a significant 33 ms effect, despite the fact that they were still much less frequent than these same targets.

Given that these latter targets had quite high surface frequencies, Giraudo & Grainger (2000: 432) propose that the facilitation they received from (high frequency) morphological relatives might actually be due to an artificial increase in the use of morphological parsing, which they suggest may have been induced by the masked priming paradigm. If this is the case, they reason, then the overall frequency of a word's morphological family (i.e., the summed frequencies of all words containing the same 'root') should be also correlated with differences in priming. They design a task with two groups of free root targets, one of which had a high mean family frequency, and one lower. The targets across these two groups were matched in surface frequency and length, as were the primes. Each group had three different prime conditions: (1) a suffixed morphological relative; (2) an orthographic relative; and (3) an unrelated word. The results showed that morphologically-related primes elicited significant facilitation, as compared to the unrelated condition. However, the level of this facilitation was not affected by the family frequency of the targets (Giraudo & Grainger 2000: 433).

The above studies suggest that, while the surface frequency of a prime may affect the degree to which it primes its morphological relatives in masked priming, neither the surface frequency nor the overall family frequency of the target have an effect on this task. Notably, the effect of prime frequency under these conditions further suggests that frequency effects are not solely episodic. In delayed priming, however, it seems as though effects of target frequency (and possibly prime frequency) may indeed arise, although it is not clear how these factors will interact with morphological rather than identity priming. Despite the fact that these experiments only concern particular types of frequency under particular

conditions, they nevertheless give important insight into the possible effects of prime and target frequency in a lexical decision task. The potential implications of these effects for understanding the results of the experiments in the present study will be considered in more detail in the following chapters.

2.3.2.2 Taft (2004): The Reverse Base Frequency Effect

A number of investigations using unprimed lexical decision tasks have reported that, when surface frequencies of complex words are matched, those with higher 'base frequencies' are recognised faster. This so-called 'base frequency' may refer to morphological family frequency (e.g., Taft 1979; Bradley 1980; Burani et al. 1984); lemma frequency (e.g., Alegre & Gordon 1999); the lemma frequency of the isolated base (e.g., for *allowance*, the lemma frequency of *allow*; Bertram et al. 2000b); or the surface frequency of the isolated base (e.g., Ford et al. 2010). Regardless of the measurement, the 'base frequency effect' is often used to support the idea that morphologically-complex words are obligatorily decomposed into their constituent morphemes during word recognition, with access to the base/stem then dependent on the relative frequency of that base/stem.[57] However, some experiments have also produced effects of the surface frequency of the complex form, either alone or in addition to 'base frequency' effects (Taft 1979; Sereno & Jongman 1997; Burani et al. 1984). Taft (2004) contends that these results do not conclusively disprove a decompositional account, but instead suggest a more complicated picture.

For the cases in which both 'base' as well as surface frequency modulate lexical decision times (Taft 1979; Burani et al. 1984), Taft argues that morphologically-complex words are first broken down into the base and affix(es), and that lexical access takes place via the base. This produces the 'base frequency effects.' Once the base has been accessed, it is then recombined with its affix(es), and it is here, Taft reasons, that surface frequency effects may arise. The more frequently the

[57] Other arguments have been advanced to account for 'base frequency' effects (e.g., Caramazza et al. 1988).

base combines with a particular affix to form this whole word (cf. 'transition probability,' §2.3.4), the easier this recombination will be. If two words are therefore matched on lemma or family frequency, but they differ in the frequency with which their bases combine with their affixes (i.e., their surface frequency), then their processing times may also differ (Taft 2004: 746-47).

As noted, however, some studies seem to indicate that only surface frequency affects response times in some cases (Sereno & Jongman 1997; Bertram et al. 2000b). However, Taft suggests that further complicating factors related to the recombination stage may be obscuring possible effects of lemma/family frequency. The first of these issues concerns whether or not the stem to which an affix is attached happens to be phonologically and orthographically identical to another stem which belongs to a different word class. This includes conversion pairs, such as Taft's examples *timed* and *raged*, and presumably also semantically-unrelated homonyms like *stalk*$_{\text{N}}$ ('part of a plant') and *stalk*$_{\text{V}}$ ('follow someone or something'), although they are not mentioned explicitly. If, as Taft suggests, a complex word like *timed* is first decomposed into a stem and suffix, and these pieces then recombined at some later stage, there may indeed be reason to believe that this latter step is affected by whether or not the stem could potentially belong to more than one word class. While it is clear that this consideration may have consequences for how conversion pairs are recognised, Taft (2004: 750) does not include such words in his own experiments due to the possible problems during recombination; however, I will consider this point in more detail in §2.3.4.[58]

The other two issues which Taft (2004: 750) suggests may affect the recombination stage are essentially variations of one primary concern: the functional compatibility of a stem and an affix. For example, the noun *moon* is much more common in the singular than in the plural (*moons*), due to the relative rarity of needing to refer to more than one moon. This could then cause difficulty for *moons* at the recombination stage, as there will be some hesitation in deciding

[58] See also §3.3.2.1 and §4.2.2.2.

whether or not *moon* can be plural. Similarly, as compared to a more dynamic verb, it would not be as easy to decide that the stative verb *seem* would be able to attach to progressive -*ing*, to form *seeming*. In contrast to such cases, however, an affixed form may also be more common than its base for functional reasons (e.g., *fangs*). A lexical decision to this kind of affixed form may therefore be faster than otherwise expected from its lemma/family frequency, as it will be much easier to determine that the stem and affix may be combined. Words like these may therefore appear to pattern according to their surface frequencies rather than to their lemma/family frequencies. Additionally, as Taft (2004: 758) notes, items whose affixed form is more common are more likely to have lemma frequencies which are not much larger than their surface frequencies.

In order to further investigate the hypothesised stage of recombination, and how issues like those noted above might interact with recombination to affect lexical decision times, Taft (2004) conducted two lexical decision tasks which varied the kind of nonwords included. One version of the task contained nonwords composed of a nonsense stem and a real suffix (e.g., **juxing*), while another contained nonwords which combined a real stem with a real suffix (e.g., **joying*). Taft suggests that the recombination stage will be more important when the nonwords in the task are like **joying*, as the non-combinability of the two morphemes is the information that will be most necessary for triggering the 'nonword' response. If affixed words with alternating stems like *timed* are avoided, then items like *moons* – which, for functional reasons, have high lemma frequency and low surface frequency – should show the usual effects of lemma frequency when they occur with nonsense stem nonwords like **juxing*.[59] On the other hand, when the same words occur with nonwords like **joying*, response data should lack such a pattern of effects, or even pattern in the opposite direction (Taft 2004: 753-54).

In the first such task, three word conditions were used: (1) low surface fre-

[59]Taft (2004) does not explicity state whether he uses family or lemma frequency as his measure of 'base' frequency; however, as he describes the base frequency of *grow* as the summed frequencies of *grow, grown, grew, grows* and *growing* – without including derived forms like *grower* – it seems more likely that his experiments employed lemma frequency.

quency/medium lemma frequency (LS/ML, e.g., *mending*); (2) low surface frequency/high lemma frequency (LS/HL, e.g., *seeming*); and (3) high surface frequency/high lemma frequency (HS/HL, e.g., *growing*). The first group was compared to the second for lemma frequency effects, and the second to the third for surface frequency (Taft 2004: 754). The results showed that both reaction times and error rates were significantly affected by what kind of nonwords were used, and responses were faster and more accurate with **milphs*-type nonwords. This nonword effect did not significantly interact with differences in frequency for the reaction time analysis; however, a distinct pattern still emerged in the error rates. When the nonwords had nonsense stems, there were significantly fewer errors for LS/HL (*seeming*) items than LS/ML (*mending*) items; however, when the nonwords had real stems, responses to HL items were significantly less accurate. As for surface frequency, HS (*growing*) items had significantly fewer errors when the nonwords had real stems. The pattern of response times matched that of the error rates. Furthermore, as Taft (2004: 755-56) notes, the high error rate for LS/HL (*seeming*) words when **joying* nonwords were included (20.9%) may have skewed the mean response times, as times for incorrect responses were not included in the analysis. Nevertheless, based on this pattern, Taft argues that because the **joying* nonwords increased the importance of the recombination stage, the LS/HL words like *seeming* were more difficult to correctly identify, due to the fact that conflicts between the functional information of the stem and that of the affix hindered the recombining of the two morphemes.

The second task investigated whether words like *fangs* may also be affected by a change in the importance of recombination. Taft (2004: 759) compared two groups of words: (1) low surface frequency/low lemma frequency words (LS/LL, e.g., *fangs*) and (2) low surface frequency/medium lemma frequency words (LS/ML, e.g., *slots*). The type of nonwords included in the task was varied in the same way as in the previous experiment. When the nonwords had nonsense stems, a straightforward lemma frequency effect emerged, with LL (*fangs*) words

eliciting slower responses. However, when real stem nonwords were used, this effect disappeared. This pattern is in line with Taft's prediction that the use of words like *fangs* – whose rare occurrence in unaffixed form leads to a low overall lemma frequency – may actually obscure expected lemma frequency effects, due to the affixed forms having an advantage during the recombination stage.

The results of these two experiments are interpreted in support of such a recombination stage. Following the decomposition of a morphologically-complex word, (Taft 2004: 761) argues, affixes are reattached to their stems/bases, and are possibly checked for syntactic or functional compatibility (cf. §2.3.4). However, the ease with which this is done may not only depend on characteristics of the stem, such as its functional information or word class ambiguity, but may also be related to the relative lemma and surface frequencies of the word. Although other explanations for this pattern have been proposed (e.g., Crepaldi et al. 2010 in §2.3.4), these results should be taken into account when outlining the possible outcomes of experiments investigating morphological processing, especially as the factors which affect recombination may also affect the processing of the stimulus items used here.[60]

Finally, it is worth noting an important conclusion which may be drawn from results such as those of Taft (2004). Although there is a wide range of literature which exploits variations in surface and lemma/family frequency in order to support arguments for whole-word vs. decomposed storage and access (e.g., Bradley 1980; see also Vannest & Boland 1999; Bertram et al. 2000b below), it must also be remembered, as succinctly summarised by Marslen-Wilson (2007: 183), that 'variations in lexical decision reaction time between sets of stimuli can rarely be unambiguously attributed just to the frequency differences between these sets.' Therefore, it is necessary to use caution in the interpretation of results based on frequency manipulations.

[60] Cf. §4.2.2.2.

2.3.2.3 Frequency, word class, and lexical search

As noted in §1.3.5, the nominal and verbal uses in a conversion pair often differ to some extent in their relative frequencies. Given the effects of frequency on recognition which have been discussed thus far, a question naturally arises: will these frequency differences lead to differences in recognition for nominal as compared to verbal conversion items?

A recent study which explicitly addresses the issue of frequency and its interaction with forms which may function as both nouns and verbs is that of Teddiman (2012).[61] This paper is one of the few which explicitly investigates conversion pairs, by asking participants to quickly categorise isolated printed words as either a noun or a verb. This task included four groups of words: (1) unambiguous nouns (e.g., *bird*); (2) unambiguous verbs (e.g., *earn*); (3) ambiguous words with a higher noun frequency (e.g., *work*); (4) ambiguous words with a higher verb frequency (e.g., *walk*; Teddiman 2012: 239). Frequencies were drawn from CELEX (Baayen et al. 1993), though it is not clear which type of frequency was used. Participants were asked to respond as quickly and as accurately as possible.

For the unambiguous words, accuracy was high (93%), suggesting that participants were able to classify the words without much reflection. Responses to the ambiguous words were more variable, though not significantly slower (Teddiman 2012: 240-41). More importantly, however, the category chosen by participants for ambiguous words was significantly correlated with the words' relative nominal or verbal frequency, with a higher frequency in a particular use leading to more participants placing the word in that category. A follow up questionnaire, which allowed participants to rate the 'nominalness' of the same words on a 7-point scale, replicated this pattern. Responses in both tasks also correlated with frequencies drawn from a separate corpus (COCA; cf. Teddiman 2012: 246).

The results of these investigations suggest that speakers are (a) sensitive to how frequently a conversion item occurs as a noun relative to how often it occurs

[61] Cf. Forster & Bednall (1976).

as a verb; and (b) this frequency measure is connected to their assignment of a word class to the item when there is no surrounding syntactic context. Teddiman (2012: 249) further suggests that the speed of the online task, in combination with the lack of a response time difference for ambiguous as compared to unambiguous words, points to a process of lexical access in which the more frequent meaning is located first. However, she also notes that the situation is somewhat less clear-cut when the relative nominal and verbal frequencies are closer to one another, and participants appear in such cases to give more variable responses.[62] Furthermore, it is not clear from these tasks what sorts of processes take place once the dominant meaning is located. Still, the strong patterns found in Teddiman's study serve to highlight the influence that relative frequency of occurrence may have on the categorisation and recognition of conversion pairs.[63]

2.3.3 Affix type and productivity

Despite the complexity of the issues relating to frequency and its effects on word recognition, a number of studies have employed frequency manipulations in recognition tasks in order to explore whether or not the particular affix used in a complex word, and how productive that affix is across the language, might have an effect on how the word is processed or stored. Although, as noted above (cf. Marslen-Wilson 2007), it is not clear how much variation in frequency effects can reveal about whether and how a complex word is stored, the presence of these effects may still suggest the use of certain types of information during processing.

One of the studies which explores possible differences across suffixes is Bradley (1980), discussed in §2.2.1.3 above. In essence, Bradley found that lexical decision times to complex words matched in lemma frequency but with different morphological family frequencies generally varied according to the latter measure. However, this pattern also depended on which suffix the words ended with: reaction times to words suffixed with *-ness*, *-er*, and *-ment* correlated with the

[62] Cf. §5.2.
[63] Cf. §6.2.3.

overall frequency of the words' morphological families, while those words ending in *-ion* did not. Bradley (1980: 53) argues that the relevant distinction is one of morphophonological regularity, as the addition of *-ion* may trigger a phonological change in the base morpheme (e.g., *divide* vs. *division*). Furthermore – although she refers to it as 'a summary device' – she suggests that the results may reflect the division between 'word and formative boundary affixation,' that is, '+boundary' and '#boundary' affixation (Chomsky & Halle 1968: 66-67), or 'Level 1' and 'Level 2' affixation in the Level-Ordering architecture of Kiparsky (1982).

Vannest & Boland (1999) investigated this possibility further from a Level-Ordering perspective, conducting a similar study on words ending with a variety of suffixes which have been assigned, on theoretical grounds, to either Level 1 or Level 2. Like Bradley (1980), they used a visual lexical decision task with pairs of words matched to one another on one frequency measurement, and contrasted on another. These two frequency measurements are morphological family frequency and 'whole-word frequency,' which only refers to the frequency of the suffixed word itself.[64] Word pairs ending in the Level 2 suffix *-less* were tested, along with pairs ending with the Level 1 suffixes *-ity* and *-ation*, only the former of which causes a segmental phonological change when it is attached to the base (Vannest & Boland 1999: 326).

The lexical decision results revealed an interesting pattern (Vannest & Boland 1999: 327-28). While responses to words ending in *-less* varied according to family frequency as well as whole-word frequency, word pairs suffixed with *-ity* or *-ation* only led to different response times when the frequencies of the paired whole forms differed. Vannest & Boland argue that this indicates access to the base as part of the recognition process for words ending in Level 2 suffixes like *-less*, while the same is not necessarily true for words ending with Level 1 suffixes. Note that, although the addition of the suffix *-ation* does not induce any segmental changes to

[64] Although Vannest & Boland (1999) do not specify, I have assumed that they intend 'whole-word frequency' to refer to surface frequency, as they do not mention the inclusion of inflectional variants, and because this distinction is neutralised for those words they use which end in suffixes that do not take additional inflection (e.g., *seamless*).

its base, words ending in this suffix nevertheless patterned with those containing the other Level 1 affix, *-ity*. Contrary to Bradley's analysis, this pattern suggests that which frequency measurement has the stronger influence does not entirely depend on the complex word's morphophonological regularity.

Based on these results, Vannest & Boland probed this distinction further, applying these frequency manipulations to a variety of Level 1 and Level 2 suffixes. Words in the Level 2 group ended with *-ship*, *-ness*, *-less*, *-hood*, or *-er*. Words with Level 1 suffixes were divided into two groups. The first used words whose root portions had identical segmental phonology to the free roots (though some had different stress patterns), and ended with *-ous*, *-ory*, *-ity*, *-ian*, or *-ation*. The second group included words ending in many of the same suffixes (*-ous*, *-ity*, *-ian*, *-ary*, or *-ion*), but the root portions of the complex words in this group had different segments from the roots in isolation. Unlike in the first experiment, the lexical decision times for all three of these groups only varied according to differences in whole-word frequency (Vannest & Boland 1999: 329-30). When words were matched in word frequency, but differed in family frequency, mean responses times were statistically similar. In contrast to the first experiment, these results seem to suggest that the roots of these words are not necessarily directly involved in the recognition of the words as a whole.

However, Vannest & Boland propose that these apparently conflicting results might be reconciled if one considers how the individual suffixes *within* a level group might differ. They note, for instance, that the Level 2 suffix *-ness* is more productive than some of the other suffixes included in the Level 2 group. If the suffixes within a group vary in their productivity, they suggest, it is also possible that words with these suffixes vary in how apparent their morphological structure is, and thus how much this structure may be apparent in processing (Vannest & Boland 1999: 331). Although they also suggest a possible influence of the relative semantic transparency of the suffixed words – a factor which has been shown to affect recognition (Marslen-Wilson et al. 1994; cf. §2.2.1.4) – a further analysis of

the semantic transparency of their stimuli, as judged by speakers, did not reveal any significant differences.

There is, however, further evidence in support of the hypothesis that processing differences between complex words may be conditioned by whether they contain certain Level 1 or Level 2 affixes. Using a memory encoding task and fMRI data, Vannest et al. (2005) again compared the processing of words ending in either a Level 2 suffix (-*able*, -*less*, or -*ness*) or a Level 1 suffix (-*ity* or -*ation*).[65] They found that, relative to monomorphemic words, words ending in Level 2 suffixes elicited a greater increase in neural activity than words ending in -*ity* or -*ation* (Vannest et al. 2005: 72).[66] As the two groups of words were matched to one another in both family and surface frequency as well as length, the authors argue that the increased activation for words with Level 2 suffixes is due to the fact that the such words are decomposed during processing, while words ending in -*ity* and -*ation* are accessed as whole forms.[67]

While the above studies do not directly investigate the correlation between the relative productivity of a suffix and the recognition of words containing that suffix, the research of Bertram et al. (2000b: 489) and their colleagues on complex words in Dutch and Finnish supports an interpretation of affix-conditioned differences in terms of an interaction between 'word-formation type (roughly, inflection vs. derivation), productivity, and affixal homonymy' (i.e., whether two or more affixes are phonologically identical). They also use lexical decision tasks with frequency manipulations, in this case focussing on surface frequency and the lemma frequency of the base. Based on the series of results they obtain, they argue that whether responses to a complex word appear to be controlled by the lemma frequency of the base rather than the surface frequency of the complex word itself depends on (1) whether the affix is productive, with unproductively-

[65]Participants in this task were asked to remember the words they saw as well as possible, and were given periodic recall tests.

[66]Cf. Meinzer et al. 2009 and §2.3.5.

[67]Although this may seem to conflict with the priming found in Marslen-Wilson et al. (1994) for pairs like *serenity*/SERENE, it should be noted that access via a whole form does not necessarily preclude a morphologically-structured lexical entry as a target of that access.

suffixed forms affected only by surface frequency; (2) whether the affix has a productive homonym, with words ending in such homonymic suffixes again only affected by surface frequency; (3) and finally, the 'word-formation type' of the affix, whose influence is more complex (Bertram et al. 2000b: 500).[68]

Although not conducted on English, it seems reasonable to suggest that these results may apply there as well, and that apparent processing differences for words containing different affixes may be due to the inherent properties of the affixes (such as their meanings), as well as to their relationships with other forms in the language as a whole (such as homonymy and relative productivity). Additionally, there is further empirical evidence to support the claims which linguists have advanced – both on theoretical and intuitive grounds – regarding the differential productivity of various affixes (Baayen & Lieber 1991).

Whatever the underlying cause, the results of the studies reviewed above suggest that the recognition of complex words may not only be affected by information about the stem (or base, or root), but may also involve information about the affixes. While this point may not seem to be immediately pertinent to the case of CONVERSION (which, of course, does not involve overt affixes), recall that the earlier version of Level-Ordering offered by Kiparsky (1982) claims that the different directions of derivation (e.g., Verb → Noun or Noun → Verb) may be distinguished from one another in a manner similar to that of affixes assigned to different levels. As discussed in §1.4.1.1B, Kiparsky initially proposes that Verb → Noun conversion takes place on Level 1 – along with the attachment of suffixes like *-ity* – while Noun → Verb conversion occurs on Level 2, the level on which suffixes like *-ness* are also attached. He also argues that the latter process (Noun → Verb) is more productive (Kiparsky 1982: 140). Combining this suggestion

[68]Like Raveh & Rueckl (2000) in §2.3.1 above, rather than making a distinction between inflection and derivation *per se*, Bertram et al. (2000b: 500) argue for a continuum between the two, with the 'meaning-invariant' affixes (e.g., person and number marking) at one end, and words containing these affixes primarily affected by 'base' frequency, while 'meaning-changing' affixes (e.g., nominalising suffixes attached to adjectives) are at the other, and words containing such affixes are affected by both surface and lemma frequency. They place 'meaning-adding' affixes (e.g., diminutive and comparative suffixes) somewhere between these two extremes.

with the results of Vannest & Boland (1999) and Vannest et al. (2005), one might then propose that complex words formed by more productive Level 2 processes (e.g., words ending in *-ness*, verbs converted from nouns) may be more likely to have their morphological structure analysed or decomposed – a procedure which requires additional processing (Vannest et al. 2005) – as compared to complex words formed by Level 1 processes (e.g., words ending in *-ity*, nouns converted from verbs), which may instead be treated more like monomorphemic words.[69] In essence, if recognition for words ending with *-ity* proceeds differently than for words ending in *-ness*, then it is possible that apparent differences in the direction of derivation in conversion pairs may also pattern in a similar way.[70] Furthermore, if variations in the recognition of words with different affixes do indeed stem from characteristics such as those described by Bertram et al. (2011), these characteristics are also very likely to have an effect on recognition processes in CONVERSION.

2.3.4 Stem-suffix compatibility

Another issue of relevance to the current study is that of compatibility between a stem (or base) and a suffix. Under the label of 'stem-suffix compatibility,' I group the separate but closely related concepts of 'morphotactics' (Hankamer 1989) and 'transition probability' (Solomyak & Marantz 2010), with particular reference to the interaction of these properties in the case of conversion pairs.

Regarding morphotactics – specifically, the selectional restrictions on which word class(es) a stem must belong to in order for a particular suffix to be legally attached (cf. Bauer et al. 2013: 494) – consider, for example, the word *walker*. Ignoring, for the moment, the homonymy between the nominalising *-er* and comparative *-er* (or the much less frequently used nominal suffix in e.g., *six-footer*), we note that the former suffix only attaches to verbs, from which it forms a

[69] The possibility of certain types of words requiring additional processing will be explored in more detail in §2.3.5.

[70] Cf. §4.2.4 and §5.3.4.

noun. This, then, provides a cue as to the word class of the base, whereas the form *walk* in isolation is otherwise ambiguous regarding its status as a noun or a verb. Thus, the selectional restrictions of an affix, and the syntactic legality of a particular stem-suffix combination may be relevant in disambiguating between different uses of forms which may be involved in CONVERSION, as any attached affixes form part of the morphosyntactic context.

As for 'transition probability,' this term is used to describe the probability that a particular suffix will attach to a particular stem, for those stems which do meet the requirements of the morphotactics.[71] This issue is investigated by Solomyak & Marantz (2010), who define it as the ratio of an affixed form's surface frequency to the total frequency of its morphological family – in essence, transition probability is an estimate of the likelihood that, given a particular stem, that a particular affix or affixes will be attached.[72] Through the use of magnetoencephalography (MEG), Solomyak & Marantz (2010: 2052) found that morphologically-defined stem-suffix transition probability had an effect on brain responses during the recognition of complex words, and that this effect was separable from the (albeit highly correlated) orthographic effect of the transition probability defined across orthographic segments (cf. fn. 71 above).

The implications that the interaction between these factors might have for the current study are somewhat less clear, as only a few studies have directly investigated the effects of syntactic legality on priming (see Longtin & Meunier 2005; Meunier & Longtin 2007 below), and none have experimentally tested it in combination with issues of transition probability. However, the investigation of Taft (2004) regarding the Reverse Base Frequency Effect (cf. §2.3.2 above) along with its related discussion may begin to offer some ideas about how these proper-

[71]There is at least one other type of transition probability called 'bigram transition probability,' which Solomyak & Marantz (2010: 2047) use to refer to 'the frequency of the first two letters of the suffix given that...the last two letters of the root...appear in their position relative to the end of the word.' Although their data shows that this too is a possible factor in recognition, unless otherwise indicated, the term 'transition probability' here denotes only the higher level morphological characteristic described in this section.

[72]Solomyak & Marantz (2010: 2047) exclude compound words from the morphological family frequency count, although it is not entirely clear why.

ties might affect the recognition of conversion pairs. His experiments themselves, first of all, technically concern transition probability in a more general sense, as they compare lexical decision responses across words which vary according to their relative lemma and surface frequencies. For example, words in the 'low surface/high lemma' condition would have a *low* transition probability – i.e., having encountered the high frequency stem *seem-*, the probability of the word terminating in *-ing* to form the low surface frequency word *seeming* is quite low. As noted in §2.3.2, when Taft (2004: 756) included nonwords composed of real stems and real suffixes (e.g., **mirths*), words (like *seeming*) which had a low transition probability like *seeming* elicited *longer* lexical decision times. Taft suggests that this result – which is counter to what would be expected on the basis of these words' high lemma frequencies – arises from difficulty encountered at a later stage of recognition, in which stems and affixes are claimed to be recombined.

In addition to this experiment-based analysis, however, Taft (2004: 749-50) also offers speculation regarding how this proposed recombination might interact with transition probability, in particular when the situation is further complicated by 'interlemma competition' involving items whose base may belong to more than one word class – e.g., conversion pairs. The examples Taft gives are *timed* and *raged*: they have the same suffix and are matched on surface frequency, but *timed* has a higher lemma frequency. Based on this information alone, one might expect *timed* to be more quickly identified as a word, under standard lexical decision conditions. However, its base, *time*, is more typically used as a noun. Taft reasons, therefore, that the noun lemma representation would be more highly activated after *timed* has been decomposed into stem and suffix. He proposes that having the noun more highly activated would then cause difficulty at the recombination stage in a way similar to *seeming*, since *-ed* is a suffix which attaches to verbs. This difficulty could therefore negate the effect of any processing benefit gained by having a more frequent base. Taft argues that this interlemma competition – which I suggest is essentially the result of a particular

type of transition probability – must be taken into account in when investigating the recognition of morphologically-complex words in English.

While not disputing the possibility of interlemma competition, Crepaldi et al. (2010: 94) offer a different account which does not involve a recombination stage, in line with their model of visual word recognition (cf. §2.3.1). Although they acknowledge that Taft's explanation is reasonable, they argue that his experimental results may also be accommodated under their model, without assuming that the difficulty arises from the recombining of the stem and affix. Instead, they suggest that items with low transition probability, like *seeming* and *moons*, in fact suffer from competition on the level of the orthographic lexicon (cf. Figure 2.1 above), competing with the much more frequent unaffixed stem. This then leads to slower responses for the affixed forms. In addition, they claim that because real stem nonwords like **mirths* increased the overall difficulty of the task, and therefore the time taken to make lexical decisions, that this allowed more time for the competition effect to grow. If we assume that such competition underlies the apparent 'reverse base frequency effect,' rather than this effect arising from difficulties in recombination, it seems as though the processing of words like *timed* would also proceed in a similar fashion, according to the transitional probability between the stem *time-* and the suffix *-ed*.[73]

Regardless of whether or not there is indeed a recombination stage – which may be sensitive to both the selectional restrictions between stems and affixes (violated by nonwords like **joying*) as well as the probability that particular stem and affix morphemes are combined with one another – the type of processing that Taft suggests belongs to such a stage is not likely to take place during short SOA masked priming, though it may possibly occur when complex words are consciously perceptible. Studies in French using both masked priming (Longtin & Meunier 2005) and cross-modal priming (Meunier & Longtin 2007) in lexical decision indicate that whether or not a stem-suffix combination is syntactically le-

[73]Cf. §3.3.2.1 for a more detailed exploration of the implications of this assumption.

gal or semantically interpretable does not have an effect during the early stages of recognition. In the masked priming study, Longtin & Meunier (2005: 26) found that nonwords composed of real stems and real suffixes speeded recognition of those stems, whether the complex forms were potential words with a logically possible meaning (e.g., **rapidifier*, 'to quickify'), or whether they were syntactically (and semantically) non-legal combinations (e.g., **sportation*, where -*ation* only attaches to verbs, and *sport* is a noun). In contrast, when the same prime-target nonwords were used in a cross-modal priming task, only those nonwords which had interpretable meanings primed their stems (Meunier & Longtin 2007: 457).

This pattern of results is fairly unsurprising, in light of the general lack of semantic effects in short SOA masked priming (cf. §2.2.2.2) and the greater importance of meaning information when primes are fully perceptible and presented shortly before their targets (cf. §2.2.1.4). Still, one might suggest that the facilitatory effects found by Longtin & Meunier (2005) might have been mitigated if the stem had an orthographically-identical competitor, as is the case for words like *timed*. However, research conducted on the masked priming of homographs in Spanish (Badecker & Allen 2002: 132) does not appear to support this interpretation, as suffixed words whose stems had an unrelated stem homograph (e.g., *cerr-ar*, 'to close' vs. *cerr-o*, 'hill') facilitated responses to words containing this orthographically-identical stem. Based on this effect, Badecker & Allen (2002) suggest that interlemma competition, which may involve the use of information about the syntactic compatibility of a stem and suffix as a means of disambiguating between competitors (cf. Allen & Badecker 2002), does not become relevant until the complex word is consciously identified.[74]

To summarise, the compatibility of a stem and suffix in a complex word or nonword, in terms of both its syntactic permissibility and the overall likelihood of

[74]It should be noted that Badecker & Allen (2002: 130) used homographs which were similar to one another in surface frequency, which may have had an effect on the strength of any potential competition.

attachment, may affect the how the complex item is processed during recognition – though the particular time course of these two factors may differ. Regarding affixed words whose stems belong to conversion pairs, such words present an interesting case of how morphotactic restrictions and transition probability might interact, as some affixes which can attach to one of the stems will not be allowed to attach to the other. Furthermore, differences in the relative frequency of the nominal or verbal forms of these pairs may lead to word-class based differences in transition probability, since complex words formed with those affixes which attach to the more frequent word class will generally also occur more frequently.

Unfortunately, there is not yet any direct experimental evidence regarding how this particular interaction might affect recognition. As far as masked priming is concerned, however, it seems unlikely that these two factors will both have an effect during earlier stages – although there may be evidence of orthographic form competition, which may essentially be an expression of transition probability. Nevertheless, as this does not preclude the possibility of an interaction occurring at a later stage, these issues must be kept in mind when investigating conversion pairs experimentally.[75]

2.3.5 Levels of morphological complexity

It might have been noted that thus far I have not addressed what might seem to be an obvious question for an experimental investigation of morphological complexity: does greater morphological complexity lead to greater difficulty during recognition, due to requiring additional processing to conduct morphological analysis? Previous research is somewhat conflicting on this account, and, as is the case with conversion pairs, it may sometimes be difficult to separate differences in morphological complexity from variation on other dimensions like concreteness and imageability (Schwanenflugel et al. 1988; Altarriba et al. 1999; Barber et al. 2013, *inter alia*; cf. Cutler 1983).[76] That said, there does still seem to be scat-

[75] Cf. §3.3.2.1 and 4.2.2.2.

[76] For further discussion of concreteness, see §6.2.1.2.

tered evidence to suggest – all other things being equal – that words with more complex morphological structure may require greater mental effort in order to be fully processed.

For instance, in addition to their delayed priming experiments on inflection and derivation (cf. §2.3.1), Stanners et al. (1979) also investigated regular and irregular inflection in English, and report differences in response times for unprimed complex forms when compared to their unprimed stems. Irregular past tense forms like *hung* and *shook* – although they were matched to their base forms (e.g., *hang*, *shake*) in number of letters, and had similar or greater surface frequencies – produced reliably slower lexical decisions (Stanners et al. 1979: 405). For derived words, Stanners et al. (1979: 408) note that the difference in word length between derived forms and their bases meant that response times for items related in this way could not be directly compared. However, within the stimuli for their second test of priming with derived relatives, they included a set of (unrelated) derived noun primes and base verb targets which they matched pairwise in word length and frequency. When these words were presented without a preceding related prime, responses were found to vary according to whether the word was derived or not, with derived forms eliciting longer latencies (Stanners et al. 1979: 409). However, they do not specify which frequency measure was used to match the relevant pairs of words – presumably surface frequency, as the main comparison in the experiment was between derived words and their bases. As such, it is possible this result was affected by other unreported frequency measurements.

In contrast to the above, a number of other studies have failed to find a consistent difference in the apparent processing difficulty of morphologically simple vs. complex words. Henderson et al. (1984) compared lexical decision times for unaffixed words to those for prefixed, pseudoprefixed (e.g., *sublime*), suffixed, and pseudosuffixed (e.g., *danger*) words. Responses to prefixed words were, on average, statistically faster as compared to unaffixed words, while suffixed words

did not differ from simple forms (Henderson et al. 1984: 222). The results for prefixed words, while perhaps surprising at first glance, are not entirely unexpected in light of the apparent 'prefixation advantage' found by Schriefers et al. (1991).[77] The replication of this effect by Henderson et al. suggests that, in the case of prefixed words, we should not expect that morphological complexity will lead to an increase in processing costs. As for suffixed words, on the other hand, the evidence is less clear, as Henderson et al. (1984: 225) not only used both inflected and derived words, but also used a different suffix for each word. As discussed in §2.3.1 and 2.3.3, both of these factors may affect how complex words are processed. Furthermore, as seems to have been the case for the comparison in Stanners et al. (1979), Henderson et al. matched the different groups of words on surface frequency, but not on either lemma or family frequency.

Other studies which directly concern the issue of the relationship between morphological complexity and processing difficulty are noted in a review by Cutler (1983). She mentions two papers (Fay 1980; Taft, Forster, and Garrett 1974 in Taft & Forster 1975) which reported similar lexical decision times for prefixed and unprefixed words, as well as an unpublished investigation (Fowler and Napps 1982) which shows no difference between (inflected) suffixed words and simple words (Cutler 1983: 59-60). She also cites several studies which appear to support the theory that (derivationally-)suffixed words are more difficult to process than monomorphemic ones; however, as all of them had methodological issues of one type or another, they will not be considered further.[78]

On the whole, from the experiments mentioned above, it is not clear what effect, if any, that morphological complexity may have on how difficult a word is to process and recognise. Issues with stimulus construction and matching in several studies mean that both apparent effects and the lack thereof might be better explained as resulting from the influence of other factors. Still, the conflict across studies may also indicate that any effects on processing difficulty, if they

[77] Cf. §2.2.1.3.
[78] Cf. Cutler (1983: 61).

are to be found, may be more nuanced than is detectable with standard lexical decision tasks.

The fMRI data from the investigations of Meinzer et al. (2009) and Pliatsikas et al. (2014), which explored differences in the 'level of morphological complexity' of derived words in German and English, suggests that this might be the case. In the earlier study, Meinzer et al. (2009) compared groups of derived, suffixed words which appeared to be superficially similar, but in fact were underlyingly formed in different ways:

(2.3) a. *Deutung* ('interpretation') ← $deuten_{V}$ ('interpret')

b. *Gleichung* ('equation') ← $gleichen_{V}$ ('equal$_{V}$') ← $gleich_{Adj}$ ('equal$_{Adj}$')

(from Meinzer et al. 2009: 1968)

Although they share the same surface composition of stem+suffix, *Deutung* is only one step of derivation from its root, while deriving *Gleichung* from its root *gleich* takes two steps. Similarly-structured words ending in the nominal suffix *-keit* were also used. The '1-step' (a) and '2-step' (b) words were matched for surface frequency, word length, number of syllables, morphological family size, and number of orthographic neighbours, as well as in imageability and concreteness. The stimuli were then presented during fMRI in an unprimed lexical decision task (Meinzer et al. 2009: 1966).

The authors found evidence of significantly greater activity (i.e., greater blood flow to particular brain regions) during the processing of 2-step nouns as compared to 1-step nouns (Meinzer et al. 2009: 1967). This suggests that more complex nouns like *Gleichung* required more effort to process than less complex nouns like *Deutung*. Furthermore, a separately conducted task – in which participants rated the perceived complexity of the same set of words – indicates that this difference appears to derive from the underlying differences in the structure of these words, as participants did not appear to be consciously aware of the differences between the 1-step and 2-step groups (Meinzer et al. 2009: 1966).

Although the difference in neural activity was correlated with depth of morphological complexity, such a difference was not reflected in reaction times. Because the task run during the fMRI did not record this information, additional unprimed responses from an unpublished behavioural experiment on the same stimuli were analysed. No significant difference between the two groups of words emerged (Meinzer et al. 2009: 1968-69). This result, which is in line with several of the studies mentioned above, supports the proposal that latency measurements from unprimed lexical decision tasks on their own may not be sensitive enough to fully reveal the effects of additional levels of morphological structure.[79]

A later investigation by Pliatsikas et al. (2014), which is the first to report the results of a processing experiment on CONVERSION, found similar patterns to those of Meinzer et al. Using words suffixed with *-ing*, the authors also compared 1-step and 2-step forms, as well as simple words (e.g., *grumble*). Based on speaker ratings, words whose unaffixed forms were judged to be more verbal were placed in the 1-step condition (e.g., *soaking*), while those judged to be more nominal were placed in the 2-step condition (e.g., *bridging*). As in Meinzer et al. (2009), it was hypothesised that the 1-step *-ing* forms were only one step from their underlying base forms (*soaking* ← $soak_{V}$), while the others were argued to be two steps (*bridging* ← $bridge_{V}$ ← $bridge_{N}$). The *-ing* forms were matched as closely as possible on surface frequency, family frequency, neighborhood size, and concretness and imageability (Pliatsikas et al. 2014: 49).

The results revealed a greater degree of activity for 1-step words as compared to simple words, and for 2-step words as compared to 1-step words. Together with the experiment in Meinzer et al. (2009), this clearly suggests that, on some level, the processing system recognises when a word is underlyingly more morphologically complex than its surface structure indicates; this, in turn, may then lead to increased computational processing in order for such words to be identified.

[79] A study by Clahsen et al. (2003) on complex words in German further supports this idea for derived words. In this study, a primed lexical decision task revealed evidence of morphological decomposition for such words, despite a lack of this evidence in an unprimed task.

Furthermore, the presence of such increased processing in apparently derived members of conversion pairs provides support for one of the hypotheses which will be explored in the current study: that words formed by conversion are both derived *and* more morphologically complex.[80]

However, while the neurolinguistic results are straightforward, it is still not entirely clear whether and how this processing difference might translate into lexical decision latencies. The lack of an effect on unprimed reaction times in Meinzer et al. (2009), as well as the less than clear evidence from the other studies discussed above, suggests that the effect of complexity on the overall difficulty of recognition may not be as directly observable in unprimed lexical decision – particularly given the influence of the various factors discussed in the preceding sections. This latter issue therefore requires further investigation.

2.4 Conclusion

As suggested by this chapter, there is an extensive collection of literature regarding the effects of different aspects of morphological structure on word recognition. Though there are occasionally conflicting results across studies due to differences in the specific aims of the research, or in the particular methodologies used, it is clear that the morphological structure of a complex word has important consequences for the processes that take place during its recognition, as well as for how the word is (or is not) stored in the mental lexicon. In particular, I have noted how the stem/base of a complex word is involved in its recognition, as characteristics of the stem (such as its frequency) may affect recognition of the word as a whole. Although whether or not a complex word is stored in a morphologically-structured way seems to be dependent on whether or not the whole word is semantically related to its stem/base, the effects of morphological processing are not completely reducible to either this semantic relationship or to a phonological/orthographic one, nor are they simply due to a combination of

[80] Cf. §1.6, example 1.62.

the two. Instead, morphological processing is an independent – though related – type of processing, which attempts to determine the underlying morphological structure of a word.

In support of the separability of this kind of processing are the patterns revealed by two experimental tasks in particular: masked priming and delayed priming in lexical decision. The robustness of the morphological (or morpho-orthographic) priming effects found in these tasks – along with the lack of equivalent effects from purely semantic or phonological/orthographic relatives – suggests that these tasks may offer a means of exploring the extent to which the relationship between conversion pairs is *morphological*, rather than simply a case of combined semantic and phonological/orthographic similarity. It is these tasks, therefore, which will be utilised in the experimental investigations reported in the following chapters.

However, as indicated in §2.3, the size of the priming effect in these tasks is not merely illustrative of the presence or absence of a morphological relationship, as morphological processing does not seem to proceed in precisely the same way for all complex words. Instead, whether and how the analysis of morphological structure manifests is dependent on a number of interacting factors – some of which may therefore be manipulated in order to provide further insight into the more fine-grained distinctions among conversion pairs. Thus, the potential difference in lexical organisation between inflected and derived forms, and the accompanying differences in processing procedures, may suggest some possibilities for how the relationships between pairs involved in conversion (argued to be derivational) might differ from those which share an underspecified root (argued to be inflectional). Furthermore, if the *degree* of complexity found in a word's (underlying) morphological structure also affects how the word is treated during recognition, then it may be possible to discern whether one form in a conversion pair is more morphologically complex than the other, thus suggesting that it is derived from the other, less complex form. Following the proposal in Vannest et al. (2005) and

§2.3.3, such a distinction between base and derived may be further exaggerated in the case of pairs involved in Noun → Verb conversion, which has been claimed to belong to a more morphologically transparent and productive level of Lexical Phonology than Verb → Noun conversion (Kiparsky 1982). By exploiting these particular patterns of processing in terms of their relevance to CONVERSION, it may be possible to shed further light on the linguistic behaviour of conversion pairs, and in turn our theoretical understanding of this behaviour.

Equally, however, the wide variety of factors which influence morphological processing – particularly the different frequency measures and issues of stem-suffix combinability – necessitates a careful drafting of predictions and cautious interpretation of the results. Indeed, conversion pairs pose a particular difficulty in this respect, as the nature of the phenomenon means that different types of pairs, as well as members within those pairs, will often differ from one another on these kinds of parameters.[81] Because the linguistic data will not allow for complete control over some factors which may be of less immediate interest, it is essential to be aware of how these factors might impact the resulting experimental evidence.

Finally, for some of the factors considered in this chapter, it is not yet clear from the current state of research exactly under what linguistic and experimental conditions they will have an effect, if one is indeed revealed at all. In spite of this uncertainty, I have nevertheless attempted to integrate, as far as possible, the findings of the studies discussed above into the design and predictions of the experiments in the current investigation.

[81] Cf. §1.3.5; see also §6.2.1.2 and 6.2.3.

Chapter 3

Complexity in masked priming: Experiment 1

3.1 Introduction

The preceding two chapters have given some indication of the numerous considerations involved in an experimental study of CONVERSION. Based on the theoretical evidence in Chapter 1, I have argued that conversion pairs – even when limited to cases which seem to be more canonical – exhibit behaviour which suggests that they do not all belong to a single phenomenon. Rather, I have proposed that a distinction should be made between those pairs whose behaviour indicates that their nominal and verbal forms are *asymmetrically* related (cf. example 1.62), and those whose linguistic characteristics fall into more balanced, symmetrical patterns (cf. examples 1.63 and 1.64). It is examples of the former type – potential cases of *directional conversion* – which will be the primary focus of this chapter and the one to follow.

However, among those pairs which are most likely to represent cases of conversion, there is still a further distinction to be made. Recall the discussion in §1.3, in which it was argued that some pairs display patterns of asymmetry which suggest that the verbal form is dependent on its nominal counterpart (e.g., *bottle*), while

others suggest the reverse (e.g., *buy*). Because the model of conversion advanced in this study proposes that the dependent, *derived* member of a pair contains additional underlying morphological structure, determining which member of a pair has been converted from the other is fundamental to the issue of whether or not the pair is involved in morphological conversion. In essence, if the behaviour of one form suggests that it is more morphologically complex than its partner, then there are grounds for arguing that it is the derived output of the process of conversion. The central question addressed in the first two experiments is thus as follows: do we find experimental evidence that the relationship between the forms within a pair in which the verb is potentially derived from the noun (Noun → Verb) is treated differently during recognition from that of pairs in which the noun is more likely derived from the verb (Verb → Noun)?

In exploring this question, we must rely on the results of the earlier experimental research discussed in Chapter 2 in order to predict what such evidence might look like. However, as indicated throughout the discussion thus far, this evidence is not likely to be completely straightforward. The processing and storage of morphologically-complex forms appears to be dependent on a number of closely interacting factors, such as whether a word is inflected or derived; what type of affix it contains, and the relative productivity of the process by which it was formed; the relative frequency of the base morpheme as compared to the whole word, etc. – all of which may affect behavioural results in different ways. Furthermore, because of the variety of contributing factors, we may even find that conversion items are not treated by the mental lexicon in the same way as items that are morphologically related by overt markings.

Nevertheless, in §2.3.5 I have argued that recent fMRI studies (Meinzer et al. 2009; Pliatsikas et al. 2014) support the idea that the word recognition process is sensitive to the presence of morphological complexity below the level of surface structure, and that the processing of forms with a higher level of such complexity may require the use of additional cognitive resources. Apart from these

studies, however, previous research on morphological processing has tended to focus on the recognition of complex forms which are overtly different from their monomorphemic bases both in their phonology and in their orthography, whether through the addition of an affix (e.g., *friendly/friend*), or through a change in the stem vowel (e.g., *fell/fall*), etc. In such cases, there is a clear difference between the base on the one hand, and the derived or inflected form on the other – a difference which is present on the surface. This is of course *not* the case for CONVERSION, and the experiments here are thus additionally complicated by the need to determine which item is likely to be the base form, in the absence of any phonological/orthographic cues.

This chapter will therefore begin with a description of the methods I have used to assign asymmetrically-related conversion pairs to contrasting categories, based on which form was more likely to be the base (§3.2). This will be followed by details of the first experiment conducted in this study, which employs a masked priming lexical decision task (§3.3). Finally, I will offer a brief summary of the implications of this experiment, and begin laying the groundwork for the further investigation which will be undertaken in Experiment 2 (§3.4).

3.2 Operationalising directionality

One of the major questions in many studies of CONVERSION which assume directionality (cf. §1.4.1) concerns how one determines in which direction the apparent process should be understood to have proceeded. In pursuit of the answer to this question, I have chosen to survey the intuitions of native speakers in two separate surveys, the first of which ('Survey 1') is focussed on asymmetrical conversion pairs.[1] The motivations, methods, and results of this survey are discussed below.

[1]The second survey (cf. §5.2) will be primarily concerned with more symmetrical pairs, and will additionally take into account several issues raised by the first (cf. §5.2.1).

3.2.1 Motivations

The criteria proposed in the 1964 paper by Marchand (cf. §1.4.1.1A) is one of the few which explicitly offers a list of potential tools for establishing directionality, though there are scattered references to various patterns in other discussions.[2] This list (example 1.37) is repeated below for convenience.

(3.1) *Criteria for direction of derivation*:

a. semantic dependence

b. frequency/'range of usage'

c. semantic range

d. semantic pattern

e. phonetic shape

f. morphologic type, and

g. stress

(Marchand 1964: 10)

While potentially helpful in a number of cases, the last three criteria do not apply to monosyllabic pairs, where the bare stem provides no overt cue as to its word class membership. Therefore, apart from criterion b, the remaining characteristics concern the semantic properties of the forms in question.

Beginning with criterion b for the moment, we find that it may be problematic to assume that the form which is less frequent is necessarily derived. In the first place, it is not clear exactly how different the relevant frequencies must be in order for one form to be considered more frequent. Furthermore, as noted in §1.3.5, it is not always the case that a derived form is less frequent than its base – compare *beautiful* and its less frequent base, *beauty* (Haspelmath 2008: 12). Indeed, as Balteiro (2007: 125) points out, it is possible that a base which is restricted to certain contexts may 'derive a new word which may be unrestricted

[2] A more detailed analysis of these criteria is also provided by Balteiro (2007).

to those contexts and therefore the derivate may be more frequently used than the base.'

As for 'restriction of usage' (cf. §1.3.2), patterns such as the limitation of *remain*$_{\text{N}}$ to the form *remains* and *halt*$_{\text{N}}$ to the phrase *come to a halt* are not particularly useful for our purposes. Firstly, the methodological considerations in the design of the experiment (cf. §3.3.1) require that the stem form is acceptable in isolation. Secondly, although cases of such restrictions clearly exist, they are relatively uncommon, with many canonical conversion pairs (e.g., *walk*) failing to display such patterns.

As the remainder of Marchand's criteria indicate, however, the primary focus in his discussion of directionality is on the meanings of the two forms, with semantic dependency said to be 'sufficient in itself,' and argued to take precedence over other criteria like stress (Marchand 1964: 10; 17). Indeed, the majority of the directionality arguments found in earlier theoretical work are in fact based on semantic properties – more specifically, on semantic dependency and its intersection with semantic complexity (Kiparsky 1983; Arad 2003; Harley & Haugen 2007). As we have seen, however, while the application of these criteria may in some cases be relatively straightforward, the meanings of many other pairs appear to be compatible with definitions or paraphrases which point in either direction. Additionally, as evidenced by the disagreement found in the literature regarding certain pairs (e.g., *tape*), it is not always clear what sort of meaning relationship is necessary in order for a form to be considered semantically dependent.

Similarly problematic are the other semantic criteria of semantic pattern and semantic range. Recall that Marchand (1964: 15) argued with regards to semantic pattern that '[c]ertain words have characteristic meanings which mark them as derivatives.' In fact, this claim may roughly be reduced to a restatement of the semantic dependency criterion, as whether or not a form falls into a 'characteristic [pattern of] meaning' will depend on how its meaning is paraphrased (cf. example 1.25 and 1.26). Semantic pattern therefore encounters the same problems noted

above. Determining semantic range is likewise a complicated issue, as it concerns the generality of a form's meaning. This again entails a reliance on how a form – and potentially multiple senses of this form – is defined.[3] Furthermore, as Balteiro's remark above would suggest, it is not in fact clear whether the form with the more restricted semantic range must be derived, as it is entirely possible that a derived form might simply have or develop a meaning which is less restricted. For instance, while a *shepherd*$_{\text{N}}$ is a person who herds sheep, one may *shepherd*$_{\text{V}}$ most animate beings (Adams 1973: 55, noted in Balteiro 2007: 125). As the nominal meaning is more restricted, it might be suggested that the noun is derived from the verb. However, on other grounds – such as basicness intuitions, its origin as a compound and consequent level in Lexical Phonology, potentially also semantic dependency – this pair may be more correctly classified as Noun → Verb. Regardless of the difficulties in applying this criterion, it will in any case be less relevant for the purposes of this study, given that the pairs used in the experiments (as noted above) must not be so semantically restricted as to be unacceptable in isolation.[4]

Finally, one might also suggest the use of other indicators of directionality which may be more clearly assessed, such the presence of irregular inflected forms for one of the pair members. Although both theoretical (Kiparsky 1982, 1983) and experimental (Kim et al. 1991) evidence seems to support the idea that irregularly-inflected words are likely to be the base forms in directional pairs, the relative rareness of irregular forms in conversion pairs – as well as the fact that we do not seem to find irregular nouns paired with regular verbs – means that the applicability of this pattern is quite limited. Additionally, the inflectional class of a word may of course change over time, regardless of whether or not it is a member of a conversion pair with a particular relationship to its pair partner.[5] Consider, for example, the irregular verb *string*, whose past tense is *strung*. Initially, based

[3] Cf. §6.2.1.
[4] Cf. §3.3.1.1.
[5] Though cf. Raffelsiefen (1993).

on the meanings of the nominal and verbal forms of *string*, it might be suggested that the verb is derived from the noun, although it has also been argued that this pair of forms is a case of root-derivation (Kiparsky 1983; Arad 2003). In either case, the semantic evidence does not necessarily seem to be in line with the analysis of the noun being derived from the verb; rather, it is possible that the verb became irregularly inflected on analogy with verbs like *wring* or *sling*. Thus, although the presence of an irregular form is highly indicative that this form is not derived from its pair partner, the limited applicability of this feature means that it cannot be used as a primary indicator of direction.[6]

To summarise this brief discussion of the possible cues to the direction of derivation, we find that the criteria noted in the literature either have limited applicability, or are else not always well-defined or able to be applied in a completely systematic way. They may also disagree with each other, as seen here and in §1.3, and it is not always clear which criteria should be given more weight – nor in fact how relevant each pattern is in terms of its connection to speakers' mental representations.[7] Indeed, although the semantic characteristics of the two forms have generally been claimed to play a central role, a fully systematic and replicable application of these characteristics is difficult to achieve, and may be based to a large extent on intuition.ell

Still, all this should not be taken to mean that such criteria as proposed above are wholly invalid in terms of establishing directionality. However, in order to ensure that the relevant judgments are fairly consistent – particularly *across* a population, where individual judgments and experience may differ – I have opted to employ surveys of native speakers.

This method was selected for a number of reasons. Firstly, in view of the issues with applying the criteria described above, gathering native speaker intuitions may offer some advantages in terms of consistency and applicability. As noted in §1.3.6, they may also be able to better capture nuances of classification

[6]Though cf. §6.2.2.

[7]See also Balteiro (2007) for a discussion of the degree of concord between different criteria.

which may be lost when patterns are separated out into individual criteria.[8] Secondly, given the cognitive, experimental approach taken in this study, we may find that speaker intuitions are particularly useful as indicators of what types of information speakers will be using during processing and recognition. If speakers are sensitive to particular distinctions between different types of words in the surveys, it is likely that these will also be the distinctions which are important during processing. Should it indeed turn out to be the case that recognition proceeds differently for conversion pairs whose relationships suggest opposing directions, such cognitively salient distinctions would offer the best chance of uncovering this difference. Finally, as suggested previously, speaker perceptions of the analysability or morphological relatedness of existing items are important to how they form new words. This indicates that speakers' intuitions about the relationships between words are a part of their internal grammatical system.

Thus, for all the reasons outlined in this section, this study gives great weight to the intuitions of native speakers as elicited by these surveys. The question of whether these intuitions are in fact reliable is a valid one, though perhaps outside the scope of this investigation. However, as argued by de Lacy (2014) in his discussion concerning the analysis of evidence regarding word stress, 'impressionistic reports and intuitions cannot be dismissed lightly'; he goes on to note that

> Even if intuitions are a delusion, in some cases they are a shared and consistent delusion, and the source of this delusion might provide insight into phonological knowledge.
>
> (de Lacy 2014: 177)

Although de Lacy is concerned with phonological knowledge, the same may be said for morphological and semantic knowledge. Thus, if we find that there is a degree of consistency across speakers in terms of their judgments of conversion pairs, this will provide further support for the reliability of these judgments – regardless of whether they belong to the lower, less 'considered' levels of knowl-

[8] Cf. §6.2.

edge suggested by Clark & Clark (1979: 807-8; cf. §1.3.1.2 and 1.3.6) or should instead be viewed as more metalinguistic.[9]

3.2.2 Survey 1: Method and design

Pairs were chosen for inclusion in the survey from the set of monosyllabic forms which were listed as both a noun lemma (tagged 'N') and a verb lemma (tagged 'V') in CELEX (Baayen et al. 1993). Function words (determiners, conjunctions, pronouns), clippings, contractions, abbreviations, acronyms, proper nouns, unfamiliar or dialectal words, and pairs which were not semantically related (e.g., *peer*$_{\text{N}}$ 'a person who equals another/a member of a rank of hereditary nobility in Britain or Ireland'; *peer*$_{\text{V}}$ 'to look with difficulty or concentration') were excluded.

Forms were then selected based on whether they conformed to several qualitative criteria:[10]

> (1) The unaffixed form must be able to occur freely with both 'A/AN' and 'TO'.
>
> (2) The verb stem must be compatible with an *-ing* suffix (i.e., a form of the verb ending in *-ing* must appear in CELEX).
>
> (3) These verbal *-ing* forms should be disyllabic and stress-initial.
>
> (4) The unaffixed form should not also be listed in a word class function other than noun or verb.[11]

Where possible, pairs with *-ing* forms listed as belonging to another word class were also avoided; however, a number of such pairs were still included – e.g., *bite*, where *biting* is listed as both a verb form and an adjective.

[9] It should be noted that a lack of consistency may not necessarily indicate the *unreliability* of these judgments; see the section below, along with §5.2.1 and 6.4.

[10] Many of these requirements were made necessary by the design of the experiment – cf. §3.3.1.1.

[11] Two forms which were eventually included in the experiments (*slap* and *arch*) were in fact listed as members of an additional word class (as an adverb and an adjective, respectively). Although this fact was inadvertently overlooked, it should be noted that these forms occur infrequently in these functions (both <1 occurrence per million words) and are restricted to particular registers.

In addition to the above, pairs were further selected according to several frequency-based criteria, which were used for a couple of reasons. Firstly, as noted in §1.3.6 and discussed further in §2.3.2.3 (cf. Teddiman 2012), the relative frequency of occurrence of a conversion form in nominal or verbal contexts seems to be closely connected to how strongly that form is felt to be a member of one or the other of these word classes. Furthermore, comparatively lower frequency also often seems to coincide with intuitions of semantic dependency, as well as other accompanying characteristics which potentially suggest 'derivedness' (cf. §1.3.5). As suggested in §1.3.6, the clustering of characteristics like frequency and apparent semantic dependency may elicit stronger intuitions regarding basicness. If there are indeed processing differences which pattern with intuitions of basicness, the use of pairs which give rise to stronger intuitions may thus serve to increase the relative clarity of any differences in processing which might be revealed.

However, there is an additional reason for choosing pairs which displayed the frequency patterns described below. As we have seen in Chapter 2, frequency exerts a strong influence on word recognition in general, as well as morphological priming in particular. Nevertheless, the distributional patterns of conversion pairs do not allow us to control for frequencies in the standard way – indeed, as argued above, such controlled groups in this case may not accurately represent the behaviour of asymmetrical pairs. Therefore, by building in a particular pattern of frequency differences, it is possible to sketch predictions which account for these differences, and thus aid in interpreting the results.[12]

With these points in mind, the frequency criteria for survey inclusion were as follows:[13]

> (1) The combined lemma frequencies of the nominal and verbal forms fall within a certain frequency range (~8-45 occurrences per million words).

[12] Cf. §3.3.2.

[13] CELEX frequencies are based on the COBUILD corpus, which contains 17.9 million words (Bauer et al. 2013: 41). Unless otherwise stated, raw frequencies from CELEX have been normalised per million words.

(2) The frequency of each of the forms individually was greater than 15 occurrences.

These requirements ensured consistency across the eventual groups of pairs (cf. §3.3.1.2), and also made sure that forms were neither extremely frequent (and therefore possibly recognised too quickly to discern any effects of processing), nor extremely infrequent (and thus potentially marginal).

(3) The more frequent member of a pair should have a lemma frequency at least 50 raw occurrences (2.79 per million) greater than the lower frequency form.

(4) Conversely, the two forms could not differ by more than 400 raw occurrences (22.3 per million).

While these exact numbers are somewhat arbitrary, the goal of these criteria, as I have set out above, is to find pairs whose frequency (and basicness) asymmetry is relatively clear-cut; however, this distinction must nevertheless be balanced by the need to limit the strength of frequency's influence on processing to some extent, and to avoid overly-familiar or marginal words.[14]

To these more concrete criteria were added my own intuitions regarding which member of each pair was the base form, and which was derived. Only pairs whose hypothesised base was also the more frequent form were considered for inclusion in the survey. Furthermore, it was ensured that the morphological tagging of these pairs in CELEX also corresponded to these intuitions, with the hypothesised base tagged as 'M' (monomorphemic) and the hypothesised derivate tagged as 'Z' (zero-derived). These tags are based on a default assumption of Verb → Noun conversion, unless otherwise specified by the Shorter Oxford English Dictionary.[15] Although the motivations behind this tagging method are not entirely clear, the

[14]The pairs included in Survey 2 and its associated experiment were not subject to the same frequency restrictions; cf. §5.2.2 and 5.3.1.2.

[15]See page 54 of the CELEX user documentation, available at http://wwwlands2.let.kun.nl/members/software/celex_eug.pdf.

tags were matched to both my own intuitions and the frequency patterns of the pairs in question for the sake of consistency with Experiment 3, where intuitions were more symmetrical but a distinction between types of pairs was nevertheless required.[16]

Using the selection criteria described above, a total of 30 hypothesised 'verb base' (henceforth referred to as V_B) pairs and 30 hypothesised 'noun base' (N_B) pairs were chosen for the survey. Each respondent received a randomised list of the isolated unaffixed forms of these 60 pairs, and was asked to choose whether each item was a noun or a verb, without thinking too long or changing their answers.[17] Two versions of this survey were constructed, one in which references to nouns always preceded references to verbs in the instructions (and the 'Noun' choice was on the left), and one with the reverse pattern. The survey was administered online via the SurveyMonkey interface (www.surveymonkey.com). There were 65 respondents in total – 31 in one version, 34 in the other – all of whom were self-reported native speakers of various dialects of English.

3.2.3 Survey 1: Results

The results of the survey are summarised in Table 3.1 below, with V_B forms on the left, and N_B forms on the right. Percentages represent the proportion of respondents (out of 65) who chose 'Verb' (%Verb) or 'Noun' (%Noun).

There was generally a high level of agreement across responses, with the average (across the more frequently selected response for each form) at 82.51%. Responses were also overall in line with each form's pre-survey category (i.e., V_B or N_B). Respondents selected 'Verb' for V_B forms 80.62% of the time, and selected 'Noun' for N_B forms 81.13% of the time.

However, several forms did not themselves elicit consistent responses, with a few being split roughly evenly between 'Noun' and 'Verb.' It is worth noting that this lack of agreement is despite the large frequency differences as described above

[16] Cf. §5.2.2.
[17] Cf. §5.2.2.

Item	%Verb	%Noun	Item	%Verb	%Noun
shove	**98.46%**	1.54%	*bead*	1.54%	**98.46%**
shave	**96.92%**	3.08%	*spoon*	4.62%	**95.38%**
lick	**96.92%**	3.08%	*spice*	4.62%	**95.38%**
sniff	**96.92%**	3.08%	*cloak*	4.62%	**95.38%**
grasp	**96.92%**	3.07%	*cart*	4.62%	**95.38%**
bounce	**95.38%**	4.62%	*cage*	4.62%	**95.38%**
chase	**95.38%**	4.62%	*nest*	6.15%	**93.85%**
cheat	**93.85%**	6.15%	*tile*	6.15%	**93.85%**
dive	**92.31%**	7.69%	*trail*	9.23%	**90.77%**
blend	**90.77%**	9.23%	*nail*	9.23%	**90.77%**
howl	**90.77%**	9.23%	*mask*	9.23%	**90.77%**
gasp	**87.69%**	12.31%	*drum*	10.77%	**89.23%**
bite	**86.15%**	13.85%	*feast*	10.77%	**89.23%**
glare	**86.15%**	13.85%	*crown*	10.77%	**89.23%**
stroll	**84.62%**	15.38%	*flock*	12.31%	**87.69%**
sting	**83.08%**	16.92%	*knot*	12.31%	**87.69%**
slap	**83.08%**	16.92%	*arch*	13.85%	**86.15%**
probe	**81.54%**	18.46%	*herd*	15.38%	**84.62%**
pinch	**81.54%**	18.46%	*weed*	15.38%	**84.62%**
grip	**81.54%**	18.46%	*spear*	18.46%	**81.54%**
pose	**81.54%**	18.46%	*heap*	20.00%	**80.00%**
brew	**80.00%**	20.00%	*loop*	24.62%	**75.38%**
buzz	**75.38%**	24.62%	*scout*	27.69%	**72.31%**
drip	**73.85%**	26.15%	*hint*	33.85%	**66.15%**
dip	**69.23%**	30.77%	*brush*	38.46%	**61.54%**
curl	**67.69%**	32.31%	*flank*	41.54%	**58.46%**
dump	**58.46%**	41.54%	*grade*	41.53%	**58.46%**
blur	49.23%	**50.77%**	*reel*	46.15%	**53.85%**
bump	46.15%	**53.85%**	*tag*	**52.31%**	47.69%
bruise	9.23%	**90.78%**	*brake*	**55.38%**	44.61%

Table 3.1: Native speaker word class ratings for Survey 1

(e.g., $blur_{\mathrm{V}} = 12$ occurrences per million vs. $blur_{\mathrm{N}} = 3$ per million). For other forms, the majority of respondents even selected the far less frequent opposing category (e.g., *bruise*).

The results of this survey raise a number of interesting questions. For instance, why did none of the forms elicit complete agreement? There are a variety of reasons why this might be the case, one of which is for the same reason that 100% accuracy is not found in tasks like lexical decision – respondents may have

simply made a mistake. Another possibility is simply variation across speakers. As respondents' individual linguistic experiences and idiolectal grammars will differ, it is not completely unexpected that they may not always be in complete agreement, and different senses may be more strongly activated for different speakers.[18] A related issue is the likelihood of 'category contagiousness' – that is, unintentional interference from nearby items in the survey, which may have influenced speakers' responses to other items. Indeed, my own intuitions sometimes seemed to be influenced in this way, and speaker comments on Survey 2 (cf. §5.2.3) indicated that their responses may also have been affected by this kind of interference. In spite of this, it is likely that this effect was neutralised to a large extent by the fact that each participant received the list of items in a different random (or pseudorandom – cf. §5.2.2) order. Such issues in fact highlight the importance of verifying judgments *across* a population, so that it is more clear whether or not individual judgments may be suspect or idiosyncratic in some way.

Regardless of the lack of complete agreement, the overall consistency of the responses in this survey suggests that most of the forms within these two hypothesised groups do indeed contain some sort of information which causes speakers to make a distinction between them. Furthermore, the fact that consistent responses were obtained for the majority of the forms suggests that a *lack* of consistency may also be indicative of a further difference with regards to such information, and may therefore suggest that the failure of such forms to elicit agreement also warrants additional investigation.[19] That said, this survey and the results discussed above do not in themselves necessarily indicate exactly *what* information these responses reflect. As suggested throughout this study thus far, the answer to this question is almost certainly very complex, and it is likely that this information is based on an intricate combination of interacting factors whose influence

[18]Issues regarding disagreement across speakers will be further addressed in §5.2.1. Cf. also Croft 1998 and §6.4.

[19]Cf. §5.2.1.

may very well not be categorical, but instead more gradient in nature. As such, I will defer the investigation of this issue until Chapter 6 (§6.2), where further information contributed by the results of the experiments may offer additional insight. Despite this remaining question, the robustness of the differentiation between the proposed V_B and N_B words provides support for the hypothesis that these groups of words are sufficiently distinct in terms of how they are perceived by native speakers. Therefore, if such a distinction does indeed affect how these forms are processed and stored, then this effect should be revealed by the processing of (a subset of) the forms included in this survey.[20]

3.3 Experiment 1: Visual masked priming

Following the work by Rastle and colleagues (Rastle et al. 2000, 2004; Crepaldi et al. 2010), the first experiment takes the form of a masked priming lexical decision task. As discussed in §2.2.2.2, the results of Rastle et al. (2000) and Rastle et al. (2004), along with numerous other studies (cf. Rastle & Davis 2008), demonstrate that this experimental paradigm can reveal effects which reflect a specifically *morphological* level of processing – one whose effects are distinguishable from those of either semantic or purely orthographic processing. Moreover, the evidence provided by Crepaldi et al. (2010), explored in §2.3.1, further suggests that a masked priming task may allow us to tap into a putative *lemma level* (Crepaldi et al. 2010: 92), where 'lexical-syntactic' information (such as grammatical class) is stored. Such a level is precisely where one might expect information about a lexeme's morphological structure to reside, and it is therefore this level which would be expected to produce evidence of whether or not a particular lexeme is the result of a morphological conversion process.

The masked priming paradigm as implemented in the studies above offers several advantages. Firstly, although the theoretical model I have proposed argues that the relationship between the items in directional conversion pairs is

[20]For details regarding further selection processes for the experiment, see §3.3.1.2A.

morphological, the pairs dealt with in this study are also identical in phonological/orthographic form and closely related in meaning. Therefore, it is necessary to filter out the effects of such form/meaning overlap as much as possible, in order to be sure that the effects which emerge are truly morphological. As neither semantic nor purely orthographic relatedness should lead to priming in this type of task, it may be suggested that any facilitation which *does* occur in fact reflects the processing of morphological (or morpho-orthographic) information. Secondly, although the paradigm of *delayed* priming may also enable us to separate the influence of morphology from that of meaning or form alone (cf. §2.2.2.1), masked priming has the additional benefit of minimising the potential for strategic and episodic effects, as well as weakening the possible effects of target frequency (cf. §2.3.2.1).[21]

In addition to the above, however, we have also seen that if a form is potentially the result of multiple morphological processes – and if it is consequently more structurally complex – then this additional complexity may affect how it is processed and recognised, at least as reflected neurologically (Meinzer et al. 2009; Pliatsikas et al. 2014). Still, from the research discussed in §2.3.5, it is as yet unclear how this effect might or might not be manifested in reaction times. Although latency effects did not seem to emerge in a standard lexical decision task mentioned by Meinzer et al. (2009: 1968), this does not necessarily preclude a difference in patterns of priming. As noted particularly in §2.3.1, the ability of priming tasks to reflect the type of relationship between a particular prime and target – in clear contrast to unprimed lexical decision – suggests that a priming task may be able to provide greater insight into such relationships than is obtained from baseline recognition latencies. Masked priming in particular may be of use in discerning priming effects, as the short prime duration allows it to specifically target an earlier stage of processing – one which may be obscured by later effects under standard lexical decision conditions.[22] There is thus ample

[21] Regarding strategic and episodic effects, see the end of §2.2.2.1 and the beginning of §2.2.2.2.
[22] Cf. §2.2.2.2.

reason to expect that priming effects will also depend on a word form's level of (underlying) morphological complexity.

In view of the above considerations, the particular studies noted in this section have formed the primary basis for the development of the design and predictions of the first experiment. Although it is indeed possible that the pattern of effects predicted (cf. §3.3.2) will not materialise, the paradigm employed here will nevertheless help to ensure that any differences in priming which do emerge are a reflection of differences and processes that are morphological.

3.3.1 Method

3.3.1.1 Design

With the above in mind, the design of this experiment was therefore modelled after Crepaldi et al. (2010), and consisted of a visually-presented lexical decision task, with each target item preceded by a forward-masked prime. It was decided that the conversion forms (e.g., *nest*) would be used as the targets, and would be preceded by either 'A/AN' (e.g., A NEST) or 'TO' (e.g., TO NEST) in order to disambiguate between the nominal and verbal stems. The use of these forms as targets was primarily due to the frequency differences between the nominal and verbal forms within a pair, which have been found to be connected to speaker intuitions of basicness.[23] If these items were instead used as primes, this would necessitate separate matched unrelated controls for each pair member, and would also make direct comparison of the priming effects more difficult (Giraudo & Grainger 2000; cf. §2.3.2.1). On the other hand, by presenting the conversion pair stems as targets, it is then possible to select a single prime that is morphologically related to both pair members. This allows for more direct comparison of priming effects and avoids any additional effects that might arise from unintentional differences between the primes.

The main test items thus comprised 40 monosyllabic conversion pairs – 40

[23] See §3.2.2 and 3.2.3 above. Cf. §6.2.3.

noun targets preceded by the indefinite article 'A/AN,' and 40 verb targets preceded by infinitival 'TO'.[24] Twenty of these pairs were drawn from the V_B group of forms in Survey 1 (cf. §3.2.2), while the other twenty were drawn from the N_B group.[25] For each of these 40 target pairs, there were two prime conditions:

(1) *Related prime.* These primes consisted of the corresponding disyllabic *-ing* form of the conversion pair, e.g., for TO BITE/A BITE, *biting*.[26]

(2) *Unrelated control prime.* This condition consisted of *-ing* primes which had no orthographic, morphological, or semantic relationship to the targets, e.g., *coping*.

The *-ing* suffix was chosen over other possible suffixes, firstly due to its high productivity and regularity. It is able to be attached to 'all non-modal verbs,' and is 'entirely semantically regular' (Bauer et al. 2013: 539-40). It also seems to be 'primarily used as a verbal inflectional suffix' (Plag 2003: 90).[27] A suffix like *-s*, on the other hand, may either attach to nouns for form the plural, or to verbs to form the 3rd person singular present tense (e.g., *nests*). It would thus be less clear what type of item was being processed if such a form were used as the prime.

Although the verbal nature of the *-ing* suffix is comparatively more transparent than *-s*, it will be noted that *-ing* forms may also seem to occur in multiple syntactic contexts, 'from those in which it looks entirely verbal to those where it looks entirely nominal' (Bauer et al. 2013: 555). It has been argued to have a nominalising function in some words (Halle & Mohanan 1985: 63; Bauer et al. 2013: 202-03), and, as pointed out in Chapter 1 (cf. §1.2.1), forms suffixed with

[24] All nouns were preceded by the indefinite article, as it is less marked when presented outside of a sentential context (i.e., in lexical decision) – compare *a smile* vs. *the smile* (cf. Quirk et al. 1972: 154). See §5.2.2 for further discussion.

[25] See §3.3.1.2A for additional information regarding the selection of these pairs.

[26] As mentioned in §2.2.2.2, facilitation in masked priming appears to be unaffected by regular spelling changes such as dropping the final '-e' in *bite* to form *biting* or duplicating consonants as in *drum* → *drumming* (McCormick et al. 2008, 2009).

[27] The importance of this characteristic will be further explained in §3.3.2.

-ing are often also used as gerunds and adjectives (Huddleston & Pullum 2002: 77-82). There is no doubt that, as Bauer et al. (2013: 583) observe, the issue of how best to treat *-ing* forms is 'an intricate matter.' However, other possible suffixes were judged to be equally problematic – verb forms suffixed with *-ed*, for example, may also be used as adjectives (e.g., *a masked*$_{\text{Adj}}$ *man*; cf. references above). Furthermore, choosing only those verbs which can be attached to *-ed* (i.e., regular verbs) would artificially remove those pairs whose directionality may be connected to differences in inflectional regularity (cf. §1.3.3, Kiparsky 1982, 1983, and Kim et al. 1991). Thus, despite the possible issues, the more widely used *-ing* was chosen.

The unrelated control primes were matched to the related primes for frequency, number of letters, number of syllables, and stress pattern (cf. §3.3.1.2A). Using these stimuli, four experimental lists were created in a Latin square design. In each list, ten targets from the V_B category and ten from the N_B category were presented with their related *-ing* primes. Within each of those base categories, five of these targets were presented as nouns (e.g., A NEST), and five as verbs (e.g., TO NEST). The same design was applied to the other half of the targets, but these were instead paired with their corresponding unrelated control primes. In each list, each target and either its related or unrelated prime occurred only once, and of each conversion pair only the noun *or* the verb was presented. The makeup of this condition in each list is represented below:

40 total targets per list

Prime Type	20 with related prime				20 with unrelated prime			
Base Type	10 V_B		10 N_B		10 V_B		10 N_B	
Target Type	5 Verb	5 Noun	5 Verb	5 Noun	5 Verb	5 Noun	5 Verb	5 Noun

Table 3.2: Makeup of Conversion condition in each list

The four lists were counterbalanced so that, across all lists, all unaffixed target forms were thus presented in all four of the combinations illustrated in Table 3.3.

Prime Type	Target Type	Example
Related	Noun	*nesting* – A NEST
Unrelated	Noun	*bashing* – A NEST
Related	Verb	*nesting* – TO NEST
Unrelated	Verb	*bashing* – TO NEST

Table 3.3: Summary of Conversion prime-target combinations, Experiment 1

To mask the true objective of the task, 80 filler pairs were also created. These pairs also consisted of disyllabic, stress-initial, suffixed primes with monosyllabic verb or noun targets. Of these, 40 had primes ending in the suffix *-er*, and 40 had primes ending in *-less*. These suffixes were chosen because of their high productivity, allowing for a larger pool of words from which to choose. They were also selected for their ability to attach to verbs (*-er*) and nouns (*-less*). The *-er* primes were thus paired with 'TO' verb targets, half of which were morphologically related to their primes (e.g., *carver* – TO CARVE) and half of which were unrelated (e.g., *marker* – TO POUR). The *-less* primes were likewise paired with 'A/AN' targets, and were divided along the same lines. Each target was thus paired with only one prime, which did not alternate. Because a target which was morphologically related to these primes could often only belong to one word class, the same word class was consistently used for the targets paired with these suffixes, regardless of prime-target relationship. All 80 of the filler pairs were included in each of the four experimental lists, as shown below.

80 total targets

Prime Type	40 with related prime		40 with unrelated prime	
Suffix	20 *-er*	20 *-less*	20 *-er*	20 *-less*
Target Type	20 Verb	20 Noun	20 Verb	20 Noun

Table 3.4: Makeup of fillers in all lists

Furthermore, an additional set of test items were included in order to ascertain whether any effects observed in the Conversion condition might be attributable to semantic relatedness or processing – although the results discussed in §2.2.2.2 suggest that this is unlikely (cf. Rastle et al. 2000). This additional condition

comprised 60 monosyllabic targets, 30 of which were nouns with 'A/AN' and 30 of which were verbs with 'TO'. As with the conversion pairs and the fillers, these stimuli also included disyllabic primes suffixed with either *-ing, -er,* or *-less*, thus ensuring that the items in this condition would not noticeably differ from the rest of the list. In line with the filler pairs, the 20 targets matched with *-er* primes were all verbs, while the 20 targets with *-less* were all nouns. In order to then keep the number of targets even across the two word classes, ten of the targets paired with *-ing* primes were nouns, and ten were verbs. Due to these various formal constraints, the related prime-target pairs in this condition could not always be truly semantically related, but were instead *associatively* related (cf. §3.3.1.2B).

For each of the 60 related primes in this Associative condition, there was also an unrelated control prime, matched with the related prime for frequency, number of letters, number of syllables, suffix, and stress pattern. Neither of the primes had any orthographic, phonological, or morphological relationship to the target. For this condition, two lists were created. In the first list, half of the targets were presented with their related primes and half with the unrelated control primes, divided evenly across each suffix. In the second list, the opposite primes were presented. Because this condition only produced two lists, each Associative condition list was used in *two* of the four experimental lists, as opposed to the four different lists for the Conversion condition. The makeup of this condition in each list is shown below.[28]

60 total targets per list

Prime Type	30 with related prime				30 with unrelated prime			
Suffix	10 *-er*	10 *-less*	10 *-ing*		10 *-er*	10 *-less*	10 *-ing*	
Target Type	10 Verb	10 Noun	5 Verb	5 Noun	10 Verb	10 Noun	5 Verb	5 Noun

Table 3.5: Makeup of Associative condition in each list

Together with the Conversion condition (40 prime-target pairs per list) and the fillers (80 prime-target pairs per list), each list thus had a total of 180 prime-

[28]This design meant that the Associative condition was effectively run twice as many times as the condition on conversion pairs, with each set of prime-target pairings repeated every two participants instead of every four.

target pairs, with primes evenly divided across the three suffixes (60 each) and targets evenly divided across the two word classes (90 each).

To complete the lists, 180 nonword targets were also created, partially by hand and partially using the ARC Nonword Database (Rastle et al. 2002). To match the word pairs, the nonwords were also paired with disyllabic, suffixed word primes ending in *-ing, -er*, or *-less*, and were evenly distributed across the suffixes (60 each). As with the real word targets, all nonwords paired with *-er* primes were presented with 'TO,' all nonwords paired with *-less* were presented with 'A/AN,' and the nonwords paired with *-ing* were divided evenly between 'TO' and 'A/AN' targets, producing 90 of each target type. All nonwords were monosyllabic and pronounceable according to the phonological rules of English (e.g., TO PROY, A NUST). These nonwords were matched listwise with the words for number of letters (cf. §3.3.1.3). All 180 nonword prime-target pairs were presented in all four of the experimental lists, for a total of 360 prime-target pairs per list.

The order of items in the list was pseudorandomised according to the following criteria:

> (1) No more than five consecutive word or nonword targets were allowed.
>
> (2) Conversion or Associative targets should not appear in a trial immediately following another target beginning with the same letter or phoneme.

Aside from changes in the target type for the Conversion items (noun or verb), each target appeared in the same position in each list. Each complete list of 360 prime-target trials was divided into two blocks of 180 trials each.

3.3.1.2 Stimuli

(A) Conversion pairs Of the forms tested in Survey 1 (cf. §3.2.3), those which either elicited less than 75% agreement, or for which the agreement con-

Item	%Verb	%Noun	Item	%Verb	%Noun
shove	**98.46%**	1.54%	*spoon*	4.62%	**95.38%**
lick	**96.92%**	3.08%	*spice*	4.62%	**95.38%**
sniff	**96.92%**	3.08%	*cloak*	4.62%	**95.38%**
bounce	**95.38%**	4.62%	*cart*	4.62%	**95.38%**
chase	**95.38%**	4.62%	*cage*	4.62%	**95.38%**
cheat	**93.85%**	6.15%	*nest*	6.15%	**93.85%**
dive	**92.31%**	7.69%	*tile*	6.15%	**93.85%**
blend	**90.77%**	9.23%	*nail*	9.23%	**90.77%**
howl	**90.77%**	9.23%	*mask*	9.23%	**90.77%**
gasp	**87.69%**	12.31%	*drum*	10.77%	**89.23%**
bite	**86.15%**	13.85%	*feast*	10.77%	**89.23%**
glare	**86.15%**	13.85%	*crown*	10.77%	**89.23%**
stroll	**84.62%**	15.38%	*flock*	12.31%	**87.69%**
sting	**83.08%**	16.92%	*knot*	12.31%	**87.69%**
slap	**83.08%**	16.92%	*arch*	13.85%	**86.15%**
probe	**81.54%**	18.46%	*herd*	15.38%	**84.62%**
pinch	**81.54%**	18.46%	*weed*	15.38%	**84.62%**
grip	**81.54%**	18.46%	*spear*	18.46%	**81.54%**
pose	**81.54%**	18.46%	*heap*	20.00%	**80.00%**
brew	**80.00%**	20.00%	*loop*	24.62%	**75.38%**

Table 3.6: Native speaker agreement ratings for Conversion stimuli

flicted with its hypothesised base (e.g., *bruise*) were not chosen for inclusion in the experiment. Several additional items were removed when it was found that they did not conform to the initial criteria outlined in §3.2.2 (e.g., *trail*$_{\text{N}}$ was tagged as 'Z' in CELEX). If two forms were deemed to be too similar to one another, only one of these forms was included (e.g., *shove* was included, but not *shave*; *gasp* and *grip* but not *grasp*).[29] From the remaining items, the 20 forms with the highest agreement ratings in each group were selected for the task. These items, along with their agreement ratings, are listed in Table 3.6. The mean agreement proportion for the V_B forms was 88.39% (StdDev: 6.24%), while the mean for the N_B forms was 89.08% (StdDev: 5.75%).

As noted above, the unrelated primes were matched pairwise to the related

[29]While this step was taken in order to avoid possible confusion between these items in the task, it later became clear that this should not have been a cause for concern, provided the items were sufficiently separated from one another in the list.

primes in surface frequency, suffix, number of letters, and stress pattern. The related N_B primes and targets were also matched listwise to the related V_B primes and targets respectively on number of letters, and consequently on the proportion of orthographic overlap between prime and target.[30] The mean lengths and frequencies of the related primes and targets, as well as the overlap between them, are summarised below.

Stimulus Characteristic	N_BVerb	N_BNoun	V_BVerb	V_BNoun
Target Letters	4.35	4.35	4.65	4.65
Target Lemma Freq.	3.99	14.72	13.82	4.19
Target Surface Freq.	0.74	9.46	2.93	3.17
Prime-Target Overlap	0.77	0.77	0.74	0.74
Prime Letters	7.30	7.30	7.40	7.40
Prime Surface Freq.	0.99	0.99	4.48	4.48
Prime Lemma Freq.	3.99	3.99	13.82	13.82

Table 3.7: Conversion condition stimulus characteristics by target group

As described in §3.2.2, pairs were chosen so that their nominal and verbal forms consistently differed in lemma frequency. Thus, within the N_B group, we find that the nominal lemma is significantly more frequent than the verbal lemma [$F(1,38) = 80.48$, $p<.0001$], with the V_B group displaying the opposite pattern [$F(1,38) = 41.90$, $p<.0001$]. Furthermore, the 'base' groups (i.e., N_BNouns and V_BVerbs) are matched to one another in lemma frequency [$F(1,38) = 0.2719$, $p=.6051$], as are the 'derived' N_BVerbs and V_BNouns [$F(1,38) = 0.0541$, $p=.8174$]. As explained above, this particular pattern was chosen as a way of building in *consistent* frequency differences, so that the systematic frequency differences within conversion pairs might be preemptively accounted for in developing the predictions for this experiment (cf. §3.3.2).

In addition to the lemma frequencies of the four conversion target groups, I have also provided the surface frequencies of the unaffixed nominal and ver-

[30]The level of orthographic overlap was calculated following Rastle et al. (2000: 521-22), as 'the average proportion of concatenative letters in the prime also in the target and vice versa.'

bal stems.[31] These frequencies fall into the pattern noted in §1.3.5, where an unaffixed nominal form tends to account for a larger proportion of the lemma frequency of the noun than the unaffixed verbal form does for the verb (Sereno & Jongman 1992 in Sereno & Jongman 1997: 428). Because this experiment aims to investigate the basicness or derivedness of the nominal or verbal uses overall, the relative lemma frequencies of these categories are more relevant to the discussion. Nevertheless, as suggested in §2.3.2 and explored further in §3.3.2.1, it is also possible that these surface stem frequencies may modulate priming effects; I have therefore included them in the table above.[32]

As regards the prime frequencies, it is first necessary to clarify how these measurements were calculated. In contrast to the focus on target lemma frequencies above, the relevant frequencies for -*ing* primes are their *surface* frequencies, as the -*ing* forms with which were are concerned are particular forms of the verb, rather than lemmas in their own right; the prime 'lemma' frequency in Table 3.7 simply reflects the lemma frequencies of these verbs. However, for some of these -*ing* primes, it was discovered that the CELEX database contained not only the verbal word form, but additional forms belonging to other word classes as well (e.g., $gripping_{\text{Adj}}$). It was therefore decided that the frequency of the -*ing* prime would be calculated based on the combined frequency of all uses of that particular -*ing* form. By matching control primes to this higher combined frequency, the results are, at most, biased against the expected morphological priming (cf. §3.3.2).

Of perhaps greater interest is the difference in the frequency of the V_B primes versus the N_B primes – the V_B primes are significantly more frequent [$F(1,38) = 74.5540$, $p<.0001$]. This is not unexpected, as the -*ing* prime is an inflected form of the verb. If the verb lemma as a whole is more frequent, its various inflected forms will be more frequent as well. Because this difference in prime

[31] CELEX does not distinguish between identical unaffixed forms of the verb (e.g., *to bite, I bite, you bite, they bite*, etc.). The frequencies given here for the verbs thus reflect the total frequency of verbal or nominal use for a particular orthographic word.

[32] See also §4.3.1.

frequency may have an effect on the degree of priming (Giraudo & Grainger 2000; cf. §2.3.2.1), it is necessary to be mindful of the issue when interpreting the results, and possibly avoid comparing the N_B and V_B categories directly (cf. §3.3.2).[33]

(B) Associatively-related pairs As mentioned above, the prime-target relationship in this condition was an associative one rather than a semantic one. This was primarily due to the constraints imposed on the stimulus: primes had to be disyllabic and end in *-ing*, *-er*, or *-less*, and targets had to be monosyllabic nouns or verbs. This proved especially problematic in the case of the *-less* primes and their corresponding noun targets: because all of the primes were adjectives, it was difficult to find monosyllabic nouns that were truly semantically related. What was intended to be a semantic condition similar to that of Rastle et al. (2000) is thus a condition which investigates associative processing.

Though previous experiments in masked priming do not show semantic effects with briefly-presented primes (Rastle et al. 2000; Perea & Rosa 2002; cf. §2.2.2.2), a number of other studies have revealed the presence of associative priming effects under similar conditions (Sereno 1991; Perea & Gotor 1997; Perea & Rosa 2002; Badecker & Allen 2002). This suggests that, to some extent, associative links may be activated and semantic associates accessed *before* full semantic processing takes place. However, it is worth noting that – aside from a small effect in one experiment in Perea & Gotor (1997) – these associative effects were generally only found when the prime was presented for 60 ms or longer. Frost et al. (1997: 831-32) also point out that such 'effects are not robust, especially when the relationship is purely semantic.' In contrast, morphological and (non-semantic) morpho-orthographic facilitation effects emerge as early as 36 ms (Marslen-Wilson et al. 2008; cf. Rastle & Davis 2008 for a review). It is possible, then, that if the

[33]Other frequency factors that may affect lexical decision times, such as morphological family size/frequency (Pylkkänen et al. 2004) and phonological neighbourhood size/frequency (Stockall et al. 2004) should not have any effect within each base category, as the two members of a conversion pair will share the same morphological family and phonological neighbours. Cf. §5.3.1.2A.

primes in Experiment 1 are presented for less than 60 ms (cf. §3.3.1.4), we may find morphological priming without accompanying associative priming. Should this occur – and assuming that semantic associates are indeed accessed before full semantic processing takes place – it might then be suggested that the semantic relatedness of our Conversion stimuli is unlikely to be influencing the size of the priming effect.

With this in mind, the stimulus data for this condition are summarised in Table 3.8 below.[34] The related primes and targets in this condition were matched listwise to those of the Conversion condition for number of letters, number of syllables, and stress pattern, while unrelated primes were also matched to related primes on the basis of frequency in addition to these other characteristics. As in the Conversion condition, surface frequency was used for choosing unrelated primes for the *-ing* forms; however, unrelated *-er* primes were chosen on the basis of lemma frequency, since the plural form should share the same semantic representation as the singular.[35] For the *-less* primes, which have no inflected forms, this distinction is neutralised.

Stimulus characteristic	Mean
Target Letters	4.22
Target Lemma Freq.	72.13
Target Surface Freq.	35.58
Prime Letters	7.23
Prime Lemma Freq.	37.14
Prime Surface Freq.	9.54

Table 3.8: Associative condition stimulus characteristics

It will be noted that in the Associative condition both the primes and targets are overall more frequent than in the Conversion condition (Table 3.7); however, assuming that, following Giraudo & Grainger (2000; cf. §2.3.2.1), higher frequency primes have a facilitatory effect in masked priming, this merely biases the Associative condition towards greater priming where it is not necessarily

[34]Note that there was no orthographic overlap between primes and targets in this condition.
[35]Cf. §4.2.1.2B.

predicted to occur (cf. §3.3.2).

3.3.1.3 Summary of stimulus characteristics

Table 3.9 lists the primary characteristics of the test items included in this experiment. As described in §3.3.1.1, nonword targets were preceded by real word primes, in order to avoid any cues as to the lexical status of the target.

Stimulus Characteristic	Conversion	Associative	Words	Nonwords
Target Letters	4.50	4.22	4.36	4.30
Target Lemma Freq.	9.18	72.13	40.66	–
Target Surface Freq.	4.07	39.22	21.65	–
Prime Letters	7.35	7.23	7.29	7.28
Prime Lemma Freq.	8.91	35.58	22.25	7.26
Prime Surface Freq.	2.74	9.54	6.14	2.85

Table 3.9: Summary of stimulus characteristics by condition

3.3.1.4 Participants and procedure

Sixty-one participants between the ages of 18 and 78 (34 female; mean age: 24.1) participated in the experiment.[36] Participants were native speakers of any variety of English and were recruited through mailing lists at the University of Oxford. Participants gave signed consent of their participation and were compensated £5.00 for their time.

Fifteen participants were assigned to three of the four experimental lists, and 16 participants to the fourth. Participants were instructed that a series of hash marks (#########) would appear on the screen, followed by a word in uppercase letters (e.g., AN APPLE). They were instructed to press 'YES' if the word was a real word of English, and 'NO' if it was not. Participants were not informed about the existence of a prime.

Each of the 360 trials began with a series of nine hash marks (the number of letters of the longest prime), presented for 500 ms. This was immediately

[36] Although there is a possibility of age effects for the oldest participant, this participant's responses did not differ from the group as a whole, with a mean RT well within two standard deviations. Cf. §3.3.3.

followed by the prime, presented in lowercase for 50 ms. This prime duration was chosen for several reasons. Firstly, it coincides with 3 full screen redraws at a refresh rate of 60 Hz. Secondly, this duration is a compromise between several masked morphological priming studies, as it avoids conscious processing as much as possible while maximising priming effects (Peter Hansen, personal communication; cf. Rastle & Davis 2008). Finally, as mentioned in §3.3.1.2B, by selecting a prime duration of less than 60 ms, semantic and associative effects may likely be minimised.

Immediately after this 50 ms presentation of the prime, the target was then presented for 1000 ms. Response times were measured from the onset of the target, and timed out after 2000 ms. The screen was left blank for 1200 ms between the offset of the target and the start of the next trial. All text was presented in size 50 Courier Bold font, in black on a grey background.

Participants were seated approximately three feet from the screen in a sound-proof booth. Reaction times were measured using a serial response box with the 'YES' button controlled by the participant's dominant hand. Participants were instructed to hold the box in their hands for the duration of the experiment and press the buttons with their thumbs. Before beginning the experiment, participants were given 10 practice trials which did not share any stimuli with the main task. The experiment itself was approximately fifteen minutes long, and was divided into two blocks of approximately 7.5 minutes. Participants were given a short break between blocks.

The experiment was run using Presentation Version 13.1 (Build 05.30.09) on a Dell computer running Windows XP.

3.3.2 Predictions

Having related the particular design and implementation of this masked priming investigation, how would we expect the *-ing*, TO, and A forms of putative directional conversion pairs to be treated in such a task? As noted in the introduction,

there has not previously been much experimental work regarding the processing of either (a) complex forms which have resulted from non-concatenative morphological processes in English, or (b) forms which are the result of multiple processes.[37] When this gap in the literature is combined with the variety of factors which may impact morphological processing (cf. §2.3), as well as the fact that different experimental paradigms may be differentially affected by one (or several) of these factors, we find that the answer to the opening question is not entirely straightforward, as it is difficult to anticipate which aspects of a relevant conversion wordform will exert the strongest influence. Nevertheless, on the basis of the effects observed thus far in masked priming (cf. §2.2.2.2ff), I will outline in this section two primary sets of predictions for how conversion forms might be processed in this task – although there may of course be additional possibilities.[38]

3.3.2.1 Morpho-orthographic segmentation and competition: the model of Crepaldi et al. (2010)

The predictions described in this section take as a starting point the model of word recognition proposed by Crepaldi et al. (2010) in their investigation of the behaviour of irregular verbs in masked priming. As discussed in §2.3.1, Crepaldi et al. find that irregular past tense forms like *fell* primed their bases (e.g., FALL) under the same experimental conditions in which both derived forms (e.g., *dealer*) and pseudoderived forms (e.g., *corner* = *corn*+*er*) primed their true or apparent bases (e.g., DEAL and CORN, respectively).[39] However, while morphologically related irregular pairs like *fell* – *fall* showed facilitation, pseudoinflected pairs (e.g., *tell* – TALL) did not (Crepaldi et al. 2010: 91). Because only the truly related pairs elicited facilitation, Crepaldi et al. propose that recognition in masked priming may make use of true morphological links (Crepaldi et al. 2010: 91-2). It is suggested that the organisation of these links differs depending on

[37] There is, however, a substantial body of research on Hebrew (e.g., Bentin & Feldman 1990; Frost et al. 2000, *inter alia*).

[38] Cf. also §3.3.4.

[39] Cf. §2.2.2.2, particularly Rastle et al. (2004).

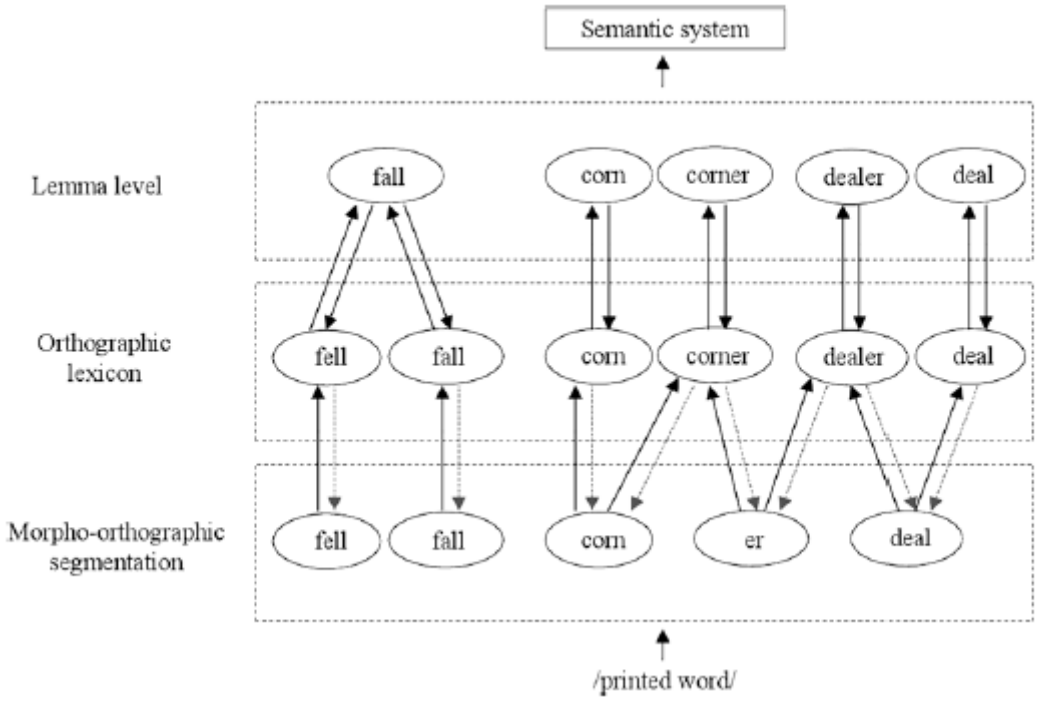


Figure 3.1: Extended morpho-orthographic segmentation model (from Crepaldi et al. 2010: 93)

whether the morphological relationship in question is inflectional or derivational. As a result, the difference between inflection and derivation is argued to have important consequences for the processing of complex items (Crepaldi et al. 2010: 95).

The model offered by Crepaldi et al. to account for both irregular verb priming and morpho-orthographic (*corner* – CORN) priming is illustrated in Figure 3.1 (repeated from Figure 2.1 for convenience).[40] As noted previously, the key argument behind this model is that the various inflected forms of a stem share a node on the lemma level, while derivationally-related forms do not. This allows for the fact that *fell*, which is not morpho-orthogaphically segmentable, still primes its stem form FALL through its connection to a single lemma node. The derived form *dealer*, on the other hand, is not directly connected to the base

[40]Reprinted from *Journal of Memory and Language*, 63(1), Crepaldi, D., Rastle, K., Coltheart, M. & L. Nickels, "'Fell" primes "fall", but does "bell" prime "ball"? Masked priming with irregularly-inflected primes', Pages 83-99, Copyright (2010), with permission from Elsevier.

DEAL on this lemma level. Instead, the priming effect observed for these pairs appears to result from the morpho-orthographic segmentation process, and the subsequent activation of the orthographic nodes corresponding to the resulting segments, along with their respective lemma nodes. Importantly, this equates the lemma level relationship between *dealer* and DEAL with that between *corner* and CORN – more precisely, there is no relationship on this level. This absence of a deeper link between truly derivationally-related items is argued to be the reason why the priming effect in these pairs is equivalent to that of *corner*-CORN pairs, which cannot be said to have any kind of morphological relationship at all.

A further relevant point concerns the predictions this model makes for priming in regularly inflected pairs like *cats*-CAT. In such cases, *cats* should activate the node for CAT not only because of a morpho-orthographic relationship, but also because they share a lemma node, in the same way as *fell* and FALL. The lemma node for a regularly inflected item like CAT should thus benefit from two sources of activation when primed by its inflected relatives.

Given this strong theory of how visual word recognition proceeds in masked priming, as well as the working model of directional conversion suggested in §1.5, what sorts of patterns might be predicted for TO and A conversion pair targets and their related *-ing* forms? Figure 3.2 offers a proposal for how these stimuli might behave within Crepaldi et al.'s model.[41] Following example 1.62, this illustration assumes that the nominal and verbal forms in this experiment are related through *derivation*. As such, each form has a separate (and unconnected) lemma node, along the lines of DEALER and DEAL. Furthermore, it assumes that the *-ing* form is an inflected form of the verb – thus, like the regularly inflected *cats*, it does not have its own lemma node, but instead directly contacts the node for the verb.[42] These assumptions are then combined with the general morpho-

[41] Recall that facilitation in masked priming is robust to regular spelling changes such as dropping the final '-e' in *bite* to form *biting* (McCormick et al. 2008, 2009; cf. §2.2.2.2).

[42] Although the behaviour and classification of *-ing* forms is a complex issue (cf. §3.3.1.1), I would nevertheless argue that these forms *minimally* occur as inflected forms of the verb, even if they also appear in other contexts.

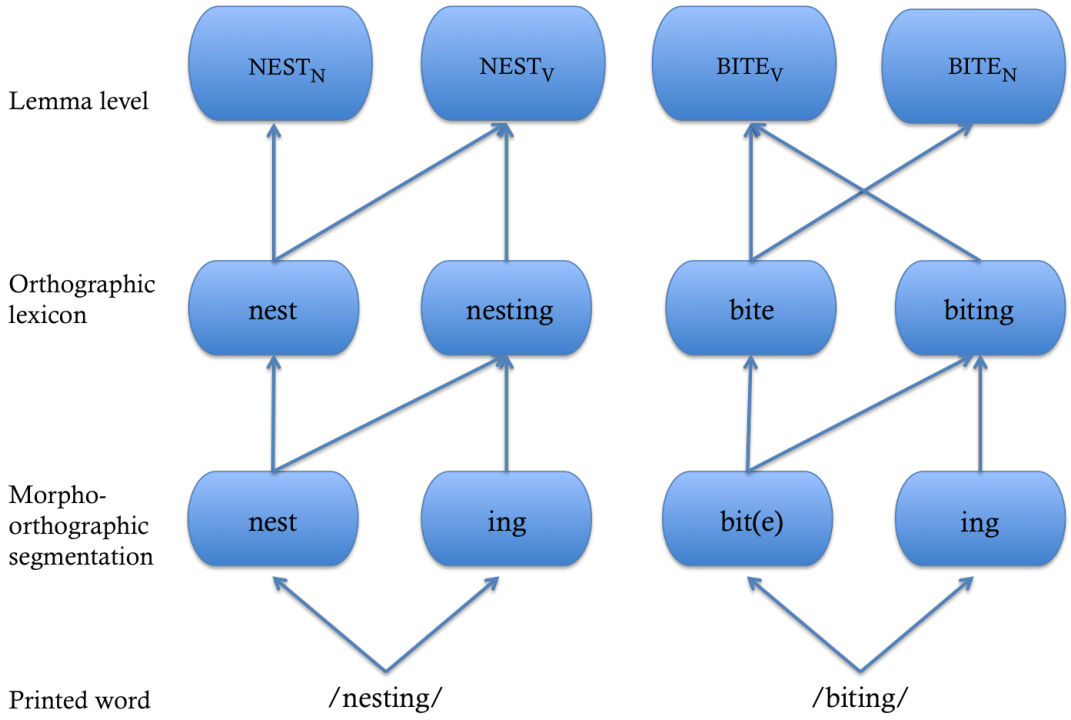


Figure 3.2: Conversion pairs in the extended morpho-orthographic segmentation model

orthographic segmentation process: the prime is broken down into the base + *-ing*. This, in turn, activates the orthographic form of the unaffixed base (e.g., 'nest,' 'bite') along with that of the *-ing* form (e.g., 'nesting,' 'biting') at the level of the orthographic lexicon. From this level, the full '-ing' form then activates the verb lemma only. The orthographic base form, meanwhile, should activate both lemma nodes, as it may be a form of either one.

Based on this model of processing, we can make clear predictions with regard to activation levels and the size of the resulting priming effects. Setting aside, for the moment, the significant frequency differences which are particular to the stimuli, we might generally expect that the degree of priming for each target should reflect the number of activation sources. Firstly, following Rastle et al. (2000) and the discussion in §3.3.1.2B, facilitation is not expected to emerge in the Associative condition, especially given the short SOA in this task. We do, however, expect significant priming for all target types in the Conversion condi-

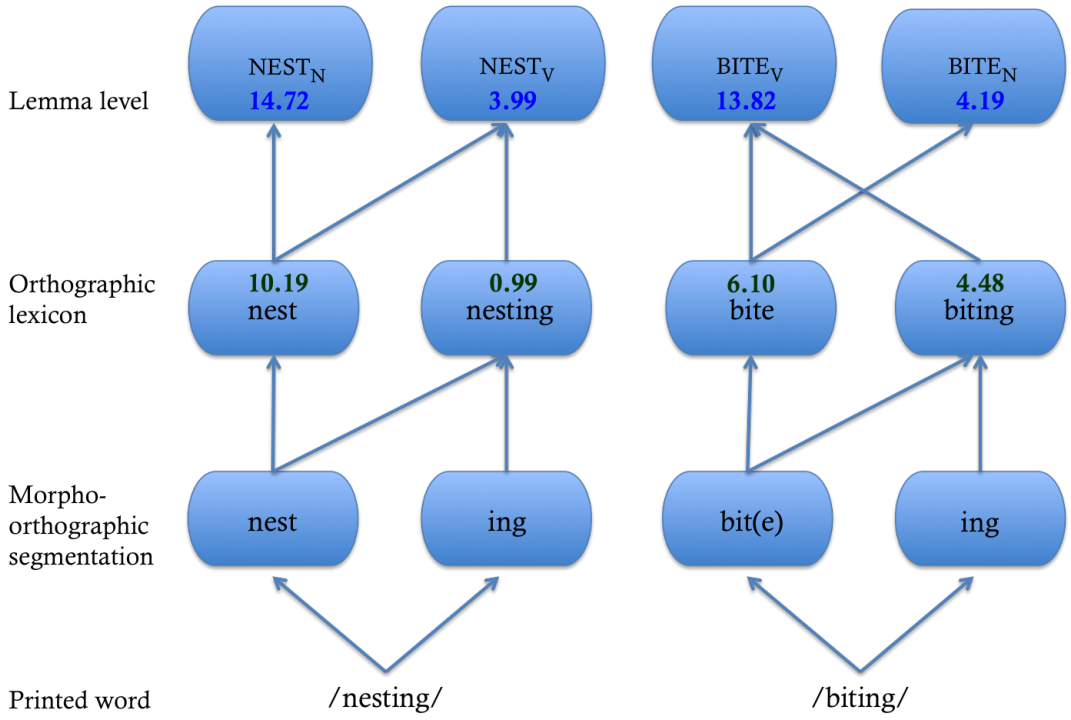


Figure 3.3: Conversion pairs in the extended morpho-orthographic segmentation model (with frequencies)

tion, as each has at least one source of activation. However, because the verbs have *multiple* activation sources, they should exhibit relatively greater facilitation than the nouns, which are only activated through their morpho-orthographic relationship to the prime.

Of course, the various relevant frequencies in the stimuli are *not* perfectly matched, and so we must modify our predictions somewhat. For ease of understanding, mean frequency counts have been added to the relevant nodes from Figure 3.2 above. Firstly, note that the mean frequencies of the unaffixed forms on the orthographic lexicon level represent the frequency of the particular letter strings in question, and have been calculated by combining the mean surface frequencies of both the nominal and verbal stems within each base category.[43] As might be expected for the N_B pairs where the noun is more frequent, we find that the unaffixed form is also far more frequent than the '-ing' form [t(19) = 9.42,

[43]Cf. Table 3.7 and §2.3.2.

p<.0001]. Due to the higher prevalence of affixed forms among verbs, however (cf. §1.3.5), the relevant orthographic forms of the V_B items are much closer in frequency, though they still differ significantly [t(19) = 2.42, p=.0259]. Could this imbalance have a significant effect on activation levels and priming?

For a possible answer to this question, let us reconsider the Reverse Base Frequency Effect of Taft (2004), and in particular Crepaldi et al.'s interpretation of Taft's results.[44] Recall that Taft (2004) found, using unprimed lexical decision, that responses to items with a high lemma frequency and a low surface frequency were slower than responses to items with a medium lemma frequency and a low surface frequency. However, this effect only emerged when real stem-real suffix nonwords (e.g., **mirths*) were included in the task; in contrast, faster response times were found when nonwords only contained real suffixes (e.g., **milphs*). Taft (2004: 762) explains this pattern in terms of the difficulty encountered at the 'recombination stage,' where he argues that decomposed stems and affxes are recombined in the recognition process. Low surface frequency/high lemma frequency items, he claims, are more difficult to recombine because their stems appear more frequently in an unaffixed form for various functional reasons (Taft 2004: 750).

Crepaldi et al. (2010), however, propose a different interpretation of these results in terms of their masked priming model, without reference to a recombination stage. Instead, they advance the possibility that the Reverse Base Frequency Effect stems from competition between similar nodes on the orthographic lexicon level, with the less frequent affixed forms being inhibited by the far more frequent unaffixed forms. This inhibitory effect, they argue, grows over time; in addition, the inclusion of real stem nonwords like **mirths* serves to make the task more difficult, thereby increasing response times and allowing the inhibition to grow further (Crepaldi et al. 2010: 94).[45] In fact, as pointed out in §2.3.4, there is

[44] Cf. §2.3.2.2, 2.3.4, and Crepaldi et al. (2010: 94).

[45] Crepaldi et al. do not make clear, however, why this inhibition should be so insignificant as to produce faster reaction times for high base/low surface frequency forms when presented with more obvious nonwords like **milphs*.

evidence to suggest that recombination – if it exists – does not become relevant to recognition until a much later stage than that ostensibly targeted by short SOA masked priming (Longtin & Meunier 2005; Meunier & Longtin 2007). The lower likelihood of a recombination stage in early word recognition thus provides indirect support for the alternative explanation of Crepaldi et al..

If this alternative explanation is accepted, it may easily be extended to the stimuli of this experiment. To begin with, the orthographic node for the '-ing' form of N_B items (e.g., 'nesting') should be inhibited to some extent by the much more frequent unaffixed form, thus reducing its activation strength. In contrast, the base node of the V_B should inhibit the '-ing' node much less, due to their more similar frequencies.

However, when this pattern of (non-)inhibition is combined with the difference in prime frequencies across the two base categories, as well as considerations relating to the number of activation sources as discussed above, the predicted pattern of results becomes somewhat more complex. Firstly, following Giraudo & Grainger (2000), the higher frequency primes of the V_B items should lead to greater facilitation overall as compared to the N_B items. Within the V_B category, although the unaffixed form (e.g., 'bite') is more frequent, this difference is small enough that it should not inhibit the '-ing' form node a great deal. The verb targets in this category should thus still have two sources of activation as compared to the one for the noun targets, and the verbs should therefore show greater priming.

As for the N_B items, Crepaldi et al.'s model predicts that rare '-ing' forms like 'nesting' will face strong inhibition from the highly frequent base forms. It is possible that this inhibition may be strong enough to make the additional activation that the verb target receives from the '-ing' form negligible. If this is the case, then the size of the priming effect for noun and verb targets in this base category should be more similar.

It may be noted that allowing the possibility of competition and inhibition on

the orthographic lexicon level also raises the issue of whether there might be additional competition on the lemma level. The facilitatory effects found in Badecker & Allen's (2002) masked priming study of Spanish homographs suggests that such competition occurs later in the selection process; however, their homographs were matched in frequency, and it is possible that items which significantly differ may not be processed in quite the same way.[46] In any case, if there is indeed any additional competition on the lemma level, it should favour the higher frequency N_BNouns and V_BVerbs, thus strengthening the patterns predicted above.

The model described in this section has the advantage of taking into account both inflectional and derivational relationships, and the possible differences in lexical organisation that may result from a distinction between the two. Unfortunately, as may have been noted, it may not actually provide a great deal of insight into the relationship between members of conversion pairs. If, as proposed in example 1.62, these pairs are cases of two separate lexical items related through derivation, then this particular model does not suggest a means of distinguishing the derived form from the base, since derivationally-related lexemes are not assumed to be in any way connected on the lemma level. Furthermore, it may not even indicate whether the two forms are morphologically related at all – after all, *corner* and CORN cannot be said to be related in this way. Still, depending on the results, it may be possible to determine whether or not these conversion pair items share a lexical entry. In such a case, this model would predict no difference in the degree of priming for nominal and verbal forms within a base category, as it would only be possible to activate one lemma node. However, should the results turn out to be more similar to the former set of predictions – i.e., a greater difference between the two V_B groups than between the two N_B groups – it may not yet be possible to know whether or not a directional morphological relationship exists. Further research using other experimental approaches may therefore be required.

[46] Cf. §2.3.4.

3.3.2.2 '1-step/2-step' and morphological complexity

The segmentation model advanced by Crepaldi et al. above seems to suggest that the usefulness of masked priming for investigating deeper morphological structure may be rather limited. However, the evidence of Meinzer et al. (2009) and Pliatsikas et al. (2014) (cf. §2.3.5) also indicates that complex forms with additional underlying structure *beyond* the stem+affix (or pseudostem+pseudoaffix) tested in most other priming studies may actually give rise to different processing results. Recall, for instance, the experiment reported by Meinzer et al., which employed fMRI to investigate '1-step' and '2-step' items – that is, items which are morphologically closer or further from their root.

(3.2) a. *Deutung* ('interpretation') ← $deuten_{\mathrm{V}}$ ('interpret')

b. *Gleichung* ('equation') ← $gleichen_{\mathrm{V}}$ ('equal$_{\mathrm{V}}$') ← $gleich_{\mathrm{Adj}}$ ('equal$_{\mathrm{Adj}}$')

(from Meinzer et al. 2009: 1968, repeated for convenience)

Items like *Gleichung*, which is two morphological steps from its ultimate root *gleich*, elicited increased blood flow to a number of brain regions as compared to items like *Deutung* (Meinzer et al. 2009: 1969). Although on the surface *Deutung* is similar to *Gleichung* in containing a base+suffix, it is still only one step from its root (Meinzer et al. 2009: 1966). This difference in the level of activity across the two types of stimuli suggests that the brain may, on some level, be sensitive to the fact that *Gleichung* is more underlyingly morphologically complex than *Deutung*. To put it more simply, Meinzer et al. (2009) (and later Pliatsikas et al. 2014) argued that greater morphological complexity may lead to increased processing costs.

As further indicated by the parallel results of Pliatsikas et al. regarding *-ing* forms in English, this concept may also be applied to the stimuli in the present experiment. As in these fMRI studies, the primes in this task appear to have the same surface morphological structure (i.e., base+*-ing*), but potentially differ

in their underlying morphological complexity. Following the proposal made in example 1.62, let us first consider the hypothesised structure of the primes:

(3.3) a. N_B *nesting*: [[[*nest*$_N$]$_V$]*ing*]

b. V_B *biting*: [[*bite*$_V$]*ing*]

If, as proposed, the verbs in the N_B group are derived from the nouns through the addition of further morphological structure, the *-ing* forms, as inflected forms of the verb, will also reflect this derivational process. Thus, as in Pliatsikas et al. (2014), these primes will be '2-step' items. In contrast, the V_B items would not be derived in this way, and would then be '1-step' items, being only one (inflectional) step away from their ultimate roots.

So, what effect, if any, might this difference in the number of 'steps' have on the degree of priming? As suggested by the different behaviour of inflected as compared to derived forms in Crepaldi et al. (2010), the effect of this difference in structure will likely depend on the particular relationship between the prime and the target – that is, how many steps separate the *-ing* form and the target? The hypothesised answer to this question is illustrated in Table 3.10 below.

Condition	Relationship	# Steps
N_BVerb	*nesting* ← *to nest*$_V$	1
N_BNoun	*nesting* ← *to nest*$_V$ ← *a nest*$_N$	2
V_BVerb	*biting* ← *to bite*$_V$	1
V_BNoun	*biting* ← *to bite*$_V$ → *a bite*$_N$	2

Table 3.10: Morphological steps from prime to target

As proposed in §3.3.2.1 above, the *-ing* primes here are assumed to (minimally) be inflected forms of the verb, and consequently are only one step from their verb targets, regardless of the base category. Both types of noun targets, on the other hand, should be *two* morphological steps from their respective primes if the conversion pairs in question are related through derivation. Based on these facts alone, we might predict a pattern along the lines of the one suggested by Figure 3.2, with a greater degree of priming for verb targets. This should apply

to both base categories, as only one step of morphological analysis would have to be completed in order to reach and activate the verb. In comparison, completing the two steps illustrated above in order to reach the nominal forms should be relatively more difficult.

Crucially, however, although the number of steps between the prime and the target is conditioned by the latter form's word class, the primes are nevertheless proposed to *differ* in their underlying structure according to which base category they belong to, as example 3.3 above illustrates. When this consideration is combined with the number of steps between the prime and target – and bearing in mind the potentially greater priming with higher frequency primes (Giraudo & Grainger 2000) – two primary possibilities regarding the ensuing effects of these characteristics emerge.

One possibility is that the relationship between the N_B -*ing* forms and their corresponding nominal targets may be viewed as more 'direct' than that between the V_B -*ing*s and V_BNouns, despite the fact that both types of noun target are two steps from their primes. In essence, the proposed structure of *nesting* (3.3a) suggests that the base form $nest_N$ is an essential component of the -*ing* form. Consequently, the target $nest_N$ would be expected to be strongly activated during the processing of the prime *nesting*.

However, the same cannot be said for the V_B group – the noun $bite_N$ is not at all part of the structure of its -*ing* form. The presence of a morphological relationship between these derived nouns and their primes should still give rise to facilitation; however, this facilitation would not be further increased by the underlying structure of the prime.

Under this view, if the verb targets generally show greater facilitation due to their '1-step' relationship with the primes, we would expect that the degree to which the priming differs between the noun and its related verb should also differ across the two base categories. V_BVerbs should be primed significantly more than V_BNouns, as the nouns are two steps away from the prime. As noted,

the V_BNoun should be activated as a morphological relative, but should not be immediately involved in the processing of the prime. In contrast, the base noun in the N_B group *is* involved in the processing of the prime. The two types of N_B targets should therefore show more similar, or possibly even equal, levels of priming. Although the nouns in this group are still two steps away from the *-ing* prime, the route is more direct, and may thus allow for stronger activation of the noun, and an accompanying decrease in the importance of the 1-step/2-step distinction for such items.

However, as suggested by the increased processing generated by the 2-step items in Meinzer et al. (2009) and Pliatsikas et al. (2014), we might also find that the opposite situation obtains. Instead of *increasing* the strength of activation of the N_BNoun, the presence of the noun base in *nesting* may in fact be a disadvantage in processing, in that the overall complexity of the prime is higher than in the V_B group. Thus, any facilitation of the N_BNoun may be mitigated by the greater processing cost of breaking down multiple layers of morphological structure. In the processing of the V_B primes, on the other hand, activation would be free to travel 'downstream' from the verb root to the derived noun, without any additional accompanying processing costs. This asymmetrical processing procedure may be further accentuated by the potential 'level' distinction discussed in §2.3.3 (cf. Vannest & Boland 1999; Vannest et al. 2005), whereby the processing of complex words formed on Level 2 in level-ordered Lexical Phonology seems more likely to involve the analysis of internal morphological structure, as compared to complex words formed on Level 1. If, following Kiparsky (1982), N_BVerbs are derived on Level 2 and V_BNouns on Level 1, we may see more of a contrast between the treatment of base and derived among the N_B groups, as the N_BVerbs will be treated as morphologically complex; Level 1 V_BNouns, on the other hand, will not.

In this scenario, therefore, although we still expect some facilitation in all groups, along with relatively greater priming for verb targets, the 'difference of

differences' is reversed from the previous possibility outlined above. In other words, while the former proposal ('version 1') suggests that the degree of priming will differ more between the two V_B groups than between the N_B ones, the latter proposal ('version 2') suggests the opposite. The additional decompositional step required in the processing of the more complex *nesting* could potentially diminish the facilitatory effect of morphological relatedness for the N_BNouns, while this issue would not be relevant to the targets of the V_B primes.

Based on the research conducted thus far, it is not clear which of these two scenarios is the more likely. An additional difficulty concerns the fact that version 1 of these predictions is broadly similar to the predictions of the Crepaldi et al. (2010) model in §3.3.2.1, when frequency differences are taken into account. Should the results suggest a greater difference between V_BNouns and V_BVerbs, it may be difficult to interpret our findings. However, if the results more closely pattern with version 2 (i.e., a greater difference between N_BNouns and N_BVerbs), we may argue that the particular hypotheses regarding morphological structure and processing which we have presented here are well-supported.

3.3.3 Results

Results were cleaned and analysed using the JMP (10.0) statistical package. In addition to the reaction time and accuracy data discussed below, it was also noted that 11 of the 60 participants reported being aware of the presence of an additional stimulus between the hash marks and the target (i.e., the prime), though they were unsure of what it was. Of these, only one participant reported 'words in lowercase,' of which she estimated she could read approximately 50%; this subject's data were therefore removed from further analysis, leaving the responses of 15 participants in each experimental list.

The remaining data were then cleaned by removing individual trials in which the subject failed to respond before the trial timed out (0.23% of the data), of which 76% were fillers or nonwords. As we cannot be sure whether this was due

to subject error or possible equipment error, these points were treated as missing and were not included in further analyses.

Overall accuracy was high, with all remaining subjects having an error rate of ≤15% (Mean: 4.29%). However, two subjects were excluded from two different lists due to mean correct response times greater than two standard deviations from the group mean (Mean: 694.5 ms; 2StdDev: 825.2), removing 3.3% of the remaining data.[47] Due to the differences between the Conversion condition and the Associative condition (different types of targets, frequency differences – cf. Table 3.9), further analyses were performed separately for each condition.

3.3.3.1 Conversion condition

One stimulus pair (*probe*) was removed from the V_B condition when it was discovered that it did not comply with the original selection criteria, as its noun form was tagged 'M' in CELEX, and its verb form 'Z'.[48] Both the nominal and verbal targets of this form were thus excluded (2.5% of the remaining Conversion data). All remaining items had error rates ≤15% (Mean: 3.2%). For the reaction time analysis, the standard deviation was calculated for correct responses, and individual data points more than two standard deviations from the mean RT for Conversion items were also removed (Mean: 659.8 ms; 2StdDev: 937.1 ms; 5.0% of remaining responses). Mean correct reaction times in milliseconds (from stimulus onset) and error rates (percentages in parentheses) are summarised in Table 3.11.

(A) Reaction times Reaction time data for correct responses were analysed by a three-factor linear mixed effects model, with Subjects and Items as random factors. The main factors were Prime Type (Related vs. Unrelated), Base Type (N_B vs. V_B), and Target Class (Noun vs. Verb). In order to investigate the degree to which these responses might be the result of the systematic

[47] Cf. Rastle et al. (2000: 514).
[48] Recall that an 'M' stands for 'monomorphemic' and 'Z' for 'zero-derived'. Cf. §3.2.2.

frequency differences, the surface frequencies and lemma frequencies of the targets were included as covariates. Because these two measures are highly correlated [$F(1,2072) = 2038.8$, $p<.0001$], lemma frequency was residualised on surface frequency following Ford et al. (2010: 120), in order to minimise the collinearity between them. Thus, surface frequency and residualised lemma frequency were entered into the model as covariates.[49]

The adjusted R^2 for this model was 0.311. There was a significant main effect of Prime Type [$F(1,1940) = 66.76$, $p<.0001$]. Participants responded, on average, 31.4 ms faster to conversion pair targets when they were preceded by their related *-ing* prime than when preceded by an unrelated control. There were no other significant main or interaction effects. When the analysis was performed without the frequency covariates, the pattern of effects was unchanged.

In particular, the interaction between Prime Type, Base Type, and Target Class was not significant [$F(1,1939) = 1.62$, $p=.2030$]. Planned comparisons of each of the four Conversion groups revealed a significant difference in responses following a related prime as compared to a related prime, with facilitation occurring in all cases [N_BVerbs: 43.5 ms, $t(1940) = 5.66$, $p<.0001$; N_BNouns: 22.4 ms, $t(1940) = 2.95$, $p=.0032$; V_BVerbs: 30.6 ms, $t(1940) = 3.96$, $p=.0001$; V_BNouns: 29.2 ms, $t(1940) = 3.72$, $p=.0002$]. However, the difference in the amount of facilitation between the N_BVerbs and the N_BNouns approached significance [21.1 ms, $t(1939) = -1.95$, $p=.0508$], with the verb targets showing a larger effect; there was no difference between the two V_B categories [1.4 ms, $t(1939) = -0.131$, $p=.8961$].

(B) Error rates The error rate data were analysed using a binomial generalised linear model (GLM), which included the same fixed factors and frequency covariates as the reaction times.[50] The analysis revealed a main effect of Prime

[49]Prime frequency was not included as a covariate, as it is not relevant to responses in the unrelated condition. Furthermore, an attempt to operationalise the prime frequency difference in categorical terms of 'high' and 'low' would completely overlap with the factor of Base Type (i.e., V_B targets had higher frequency primes).

[50]Unless otherwise indicated, error rate analyses reported in this and subsequent sections do not include Subjects or Items as random factors. Likewise, all reported error rate percentages are the results of a contingency analysis, and do not include either random factors or frequency

Type [χ^2 = 7.03, p=.0080]. Participants made 2.1% fewer errors when targets were preceded by a related prime. No other main or interaction effects reached significance. Planned comparisons for the individual target groups revealed a significant improvement in accuracy following a related prime for N_BVerbs only [χ^2 = 4.16, p=.0413].[51]

Target	Unrelated	Related	Priming Effect	Diff. in Effect
N_BVerb	667.6 (6.2%)	624.1 (2.8%)	43.5** (3.5%*)	
				21.1 (2.5%)
N_BNoun	656.4 (3.8%)	634.0 (2.8%)	22.4** (1.0%)	
V_BVerb	651.5 (2.6%)	620.9 (1.1%)	30.6** (1.5%)	
				1.4 (0.7%)
V_BNoun	655.8 (4.4%)	626.6 (2.2%)	29.2** (2.2%)	
Overall	657.8 (4.3%)	626.4 (2.2%)	31.4** (2.1%)	

Table 3.11: Results of Conversion condition (Experiment 1)

3.3.3.2 Associative condition

One item in this condition (*a dolt*) was excluded (1.7% of remaining Associative responses) due to an error rate greater than two standard deviations from the mean in this condition (60.3%; Mean: 3.7%; 2StdDev: 20.4%). For the reaction time analysis, the standard deviation was calculated for correct responses, and individual data points more than two deviations from the mean RT for Associative items were also removed (Mean: 654.3 ms; 2StdDev: 911.2 ms; 4.7% of remaining responses). Mean correct reaction times and error rates are summarised in Table 3.12.

(A) Reaction times Reaction time data for correct responses were analysed by a one-factor linear mixed effects model, with Subjects and Items included as random factors. Because this condition only included one group of items, frequency covariates were not included. The main fixed factor was Prime Type

covariates.

[51] Unless otherwise indicated, * = significant at p <.05, ** = significant at p<.01.

(Related vs. Unrelated).

The adjusted R^2 for this model was .315. There was a small but significant main effect of Prime Type. Responses to targets were, on average, 5.8 ms faster following a related prime [F(1,3054) = 3.92, p=.0478].

(B) Error rates The error rate data were analysed using a binomial GLM, which included the same fixed factor of Prime Type. There was no significant effect of this factor on accuracy [χ^2 = 2.20, p=.1382], though participants made 0.8% fewer errors in responding to targets following related primes.

Unrelated	Related	Priming Effect
642.1 (3.1%)	636.3 (2.3%)	5.8* (0.8%)

Table 3.12: Results of Associative condition (Experiment 1)

The general pattern of priming in this experiment is illustrated in Figure 3.4. Figure 3.5 represents the size of the priming effect in each condition, calculated by subtracting the mean RT for targets following related primes from the mean RT following unrelated primes.[52]

3.3.4 Discussion

As shown in Figures 3.4 and 3.5, prior presentation of a related prime produced a facilitatory effect in all conditions, at least to some extent. Firstly, contrary to what was predicted on the basis of the discussion in §3.3.1.2B (cf. §2.2.2.2), there was a small but consistent degree of facilitation for targets preceded by semantic associates, even at an SOA of 50 ms. However, this small effect is not entirely unexpected – the masked priming study reported by Perea & Gotor (1997: 228), for instance also found facilitation from semantic associates in Spanish, using the same SOA. Although this result seems to indicate that at least some semantic processing of the prime may be occurring, it is clear that the degree of semantic

[52] As in the tables, * = significant at p<.05, ** = significant at p<.01.

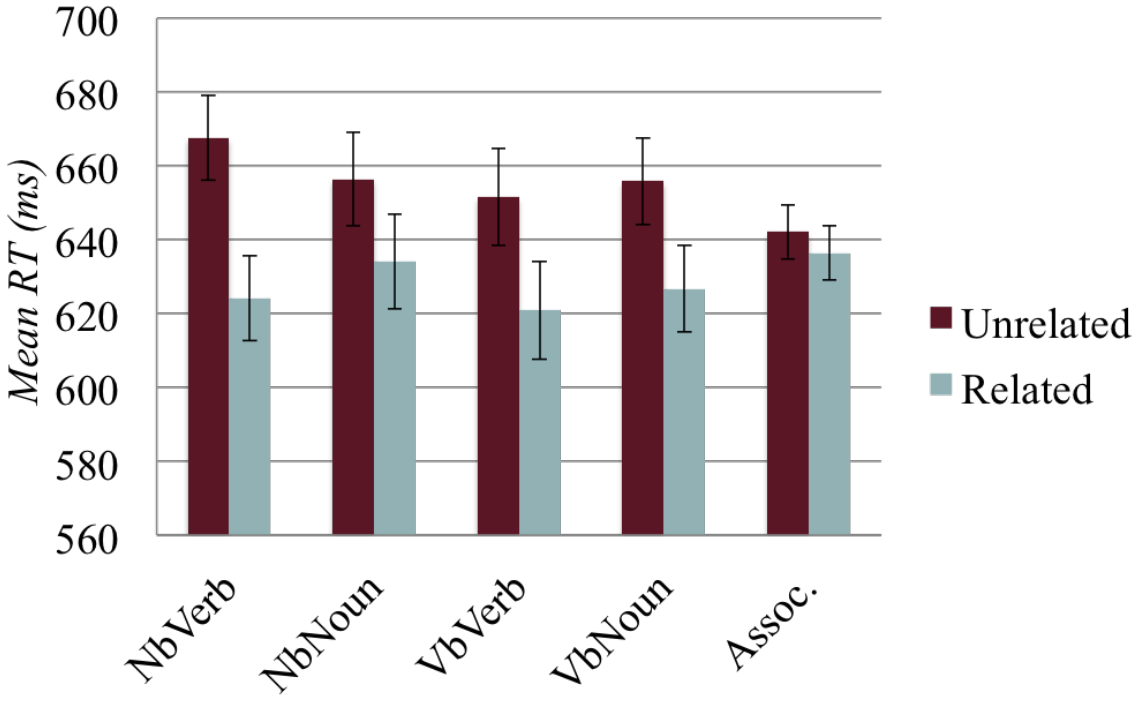


Figure 3.4: Mean RT and standard error (in ms) for all conditions (Experiment 1)

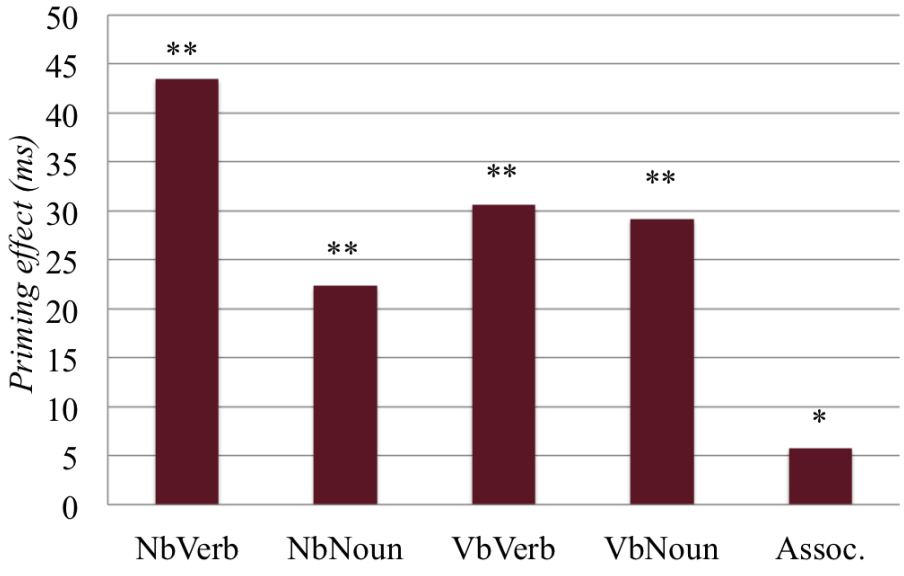


Figure 3.5: Mean priming effect (in ms) for all conditions (Experiment 1)

relatedness between the prime and the target cannot entirely account for the robust facilitation produced in the Conversion conditions.[53]

For these groups, presentation of a related prime elicited response times which were, on average, 31 ms faster across the four target types. In general, the level of priming in each of these groups *individually* was roughly the same, though N_BVerbs were facilitated to a somewhat greater degree than N_BNouns. It is possible that this difference partially stems from the slightly slower baseline RTs of the N_BVerbs – likely due to their lower frequency – with the rest of the difference perhaps explained by random variation. In any case, the lack of an effect at $p<.05$ (recall that the difference between the N_B groups only reached $p=.0508$) requires us to be cautious in ascribing too much weight to this difference.

These results are interesting for a number of reasons. Firstly, they do not seem to correspond to any of the predictions described in §3.3.2. The clearest case of this divergence is in the predicted effect of prime frequency: although the V_B *-ing* forms were far more frequent than those of the N_B groups, this does not seem to have influenced the degree of priming across the two base categories. Contrasts of the interaction between Prime Type (Related vs. Unrelated) and Base Type (N_B vs. V_B) revealed very similar levels of facilitation, with a 33.0 ms improvement in N_B response times [$t(1940) = 6.10$, $p<.0001$] and a 29.9 ms improvement in V_B times [$t(1940) = 5.42$, $p<.0001$; overall interaction: $F(1,1940) = 0.16$, $p=.6912$].

Furthermore, there is no evidence in this experiment that activation patterns for the verbs proceeded any differently, or earlier than, the activation of the nouns. Thus, the results do not suggest that the processing of the prime involved identifying it as an inflected form of the verb as opposed to the noun; nor was there any clear indication of frequency-based competition on either the orthographic or

[53] After the experiment had been run, a possible methodological issue was noted in the design: for all prime-target pairs (including fillers) in which there was orthographic overlap, the target was always a word. It is possible that this pattern may have biased the results toward showing priming in the morphological conditions, and no priming in the Associative condition. This issue was avoided in Experiments 2 and 3.

lemma levels; nor indeed any evidence that the system recognised that the stem of the *-ing* form was unlikely to be a noun, whatever the relationship between the *-ing* form and the verb might be. Most importantly for our purposes, there is also not much support for a difference between the underlying morphological structures of N_B and V_B primes – although there is a numerically greater difference in the level of facilitation across the two N_B target groups as compared to the V_B groups, this difference is not significant [19.7 ms, t(1939) = -1.28, p=.2022], and, as noted, it is not clear whether any distinction has been made between the nominal and verbal relatives of the *-ing* forms.

In fact, overall it seems as though the primes have been processed in an automatic fashion – that is, the targets have all been facilitated due to the fact that they are morpho-orthographically related to their *-ing* primes. Essentially, it seems as though the *-ing* forms have been treated in the same way as both *darkness* and *corner*: because their orthography suggests that they are exhaustively decomposable into base plus suffix, they are first broken down in this way. Any items which have the same orthographic form as the base are then activated, regardless of how (or whether) they are otherwise related to the prime.

In support of this possibility, let us reconsider the nonword priming study of Longtin & Meunier (2005), discussed in §2.3.4. In a masked priming task, the authors found that nonwords composed of an existing stem and a syntactically and semantically non-legal suffix (e.g., *sportation*, where *sport* is a noun and *-ation* attaches only to verbs) nevertheless primed their 'stems' (Longtin & Meunier 2005: 26). Furthermore, another study by Badecker & Allen (2002: 132) also found priming between complex words whose stems were orthographically identical but semantically unrelated (e.g., *cerr-ar*, 'to close' primed *cerr-o*, 'hill'). While it was suggested that these results indicate a lack of recombination in the early stages of recognition (cf. §3.3.2.1), they are also compatible with an interpretation of parsing in masked priming as driven primarily by (morpho-)orthographic form, with no recourse to any higher level information. Instead of removing the *-ing*

suffix and being left with a verb stem, one might suggest that the parser, upon removing the suffix, simply does not yet have access to information regarding the word class of the resulting stem – the sort of information that should be stored on a putative lemma level. Under this view, the short SOA and masking procedure used in masked priming restricts the processing of the prime in a way which does not allow for access to a lemma level.

Without access to the lemma level at which the organisation of individual lexical entries is argued to be represented, we would predict that facilitation in masked priming should *not* differ according to whether the relationship is inflectional or derivational (or non-existent). In such a case, the processing of the prime would never proceed far enough to access information about whether the form had a separate lexical entry or not.

However, while this completely automatic processing account – and the accompanying lack of a lemma level – seems to be in line with the results of Experiment 1, it leaves us without an explanation for the priming found with irregular past tense verbs in Crepaldi et al. (2010). In that regard, it will be useful to briefly examine the results of a masked priming investigation by Morris & Stockall (2012), published after Experiment 1 was conducted. In this study, the authors compared the priming effects of inflected forms of regular and irregular verbs, using both masked priming and EEG recording. According to Crepaldi et al.'s model, if a lemma level is accessed in masked priming, then regularly-inflected forms should facilitate their stems more than irregularly-inflected forms (Crepaldi et al. 2010: 95). Thus, due to activation from both a shared lemma node *and* a morpho-orthographic relationship, a form like *cats* should prime its base CAT to a greater degree than *fell* primes FALL (cf. §2.3.1).

The patterns of priming in the response times of Morris & Stockall (2012: 90) did indeed match this predicted pattern, with greater facilitation from regular past tense forms than from irregular forms. However, the ERP responses suggested a slightly different picture, with equivalent priming effects for regular

and irregular forms appearing at the early time windows of the N250 and N400 (200-500 ms after target onset). Only later, at the *Late Positive Component* or 'LPC' (around 500 ms after target onset) did a difference between regular and irregular past tense priming emerge, falling into the same pattern as the reaction times (Morris & Stockall 2012: 91).

While these results seem slightly puzzling, Morris & Stockall (2012: 87) note that previous research suggests that the LPC may index 'stimulus evaluation and comparison processes,' thus more closely reflecting the decision stage of lexical decision, and more closely patterning with RTs. It is therefore suggested that both irregular and regular past tense forms are rapidly analysed during early word recognition purely on the basis of morpho-orthographic regularities (Morris & Stockall 2012: 91). It is then only at the decision making stage that RTs seem to be affected by the difference between irregular and regular forms. While it is still not clear from this study if any additional processes may come into play during masked priming, Morris & Stockall's results seem to suggest that there is no accessing of a lemma level during the processing of short duration masked primes; instead, the primes' orthography is automatically analysed on the basis of the orthographic patterns found across morphologically related words in the language. Following this argument to its logical conclusion, it may therefore be argued that the masked priming paradigm may not allow for any deeper processing of the prime, but rather only processing which relies solely on morpho-orthographic information present in the surface form. Along with Morris & Stockall (2012), the results of Experiment 1 seem to support this proposal, with the degree of facilitation across the four morpho-orthographically related Conversion conditions being roughly the same.

Despite this evidence to suggest that the pattern in Figure 3.5 reflects a completely automatic parsing process, an alternative possibility also presents itself. Recall example 1.64 – and more particularly, Farrell (2001; §1.4.2) – where it was suggested that some (or potentially all) conversion pairs may actually be two in-

flected forms of the same underspecified root. Such 'pairs,' it is claimed, are not new lexical items, but rather belong to a single lexical entry. With these kinds of pairs, we would in fact *expect* the same degree of priming for both the nominal and verbal forms, as the lexical entry activated by the prime would be the same entry for both target types. It is possible, then, that the pairs selected for this experiment are in fact cases of this word class underspecification. However, due to the considerations noted above, we cannot draw any firm conclusions as to whether or not this is the case.

To summarise, the results of Experiment 1 indeed support the theory that mechanisms of morpho-orthographic segmentation occur early in the process of word recognition, before the presence of a word reaches a level of conscious awareness. Furthermore, there seems to be some small degree of semantic processing taking place at this early stage, though it may only involve the automatic contacting of semantic associates, rather than any higher levels of meaning. However, it is not clear whether the masked priming paradigm may offer any insight into deeper information regarding lexical organisation, structure, or relatedness – especially given that later research seems to suggest that it may only target an early, automatic level of processing which is insensitive to true morphological relatedness (cf. the priming of CORN by *corner*; §2.2.2.2). It may therefore be necessary to employ different methods for investigating the nature of the relationships in conversion pairs.

3.4 Conclusion

The survey and experiment reported in this chapter have provided a first look into the possible cognitive representation of conversion pairs in the mental grammar of current speakers. In particular, the results of the survey (§3.2.3) suggest that speakers are sensitive to potential asymmetries between the nominal and verbal forms of some conversion pairs.[54] Furthermore, at least for certain forms,

[54]For a deeper look into the possible sources of these asymmetries, see §6.2.

speakers' intuitions about whether these forms are nominal or verbal are fairly consistent across individuals. This suggests that there is some degree of psychological reality to these intuitions.

Nevertheless, the results of the masked priming task do not reveal an obvious answer to the question posed at the start of this chapter: do we find experimental evidence that pairs in which the verb is potentially derived from the noun (Noun → Verb) are treated differently during recognition than pairs in which the noun is more likely derived from the verb (Verb → Noun)? As discussed above, although Crepaldi et al. (2010) argued that masked priming is able to provide access to a pre-semantic lemma level, later research (Morris & Stockall 2012) suggests that masked priming effects stem purely from automatic morpho-orthographic processing. The effects in the current experiment also seem to be aligned with this latter interpretation, although it is also possible that the distinction between Noun → Verb and Verb → Noun is simply not relevant to processing in recognition. It may also be the case that the particular survey procedure used may not be appropriate for distinguishing the different directions of asymmetries, or that this information does not otherwise affect how these items are cognitively represented. The experimental results do not yet allow us to disambiguate between these possibilities, although it is worth noting that the consistency of the survey results is of interest in itself.

Despite these uncertainties, the particular constraints placed on processing by briefly presented masked primes, and the subsequent targeting of the earlier stages of recognition in this paradigm suggests that it may still be possible to observe effects of directionality or morphological complexity on processing through the use of a *different* paradigm – one which allows for deeper processing of the prime. By moving past the stage at which items that only *appear* to be related are also activated during prime presentation, we may then be able to detect more easily any true, underlying morphological relationships. It is these considerations which therefore motivate the design of Experiment 2.

Chapter 4

Complexity in delayed priming: Experiment 2

4.1 Introduction

As noted above, the results of the survey in Chapter 3 seem to indicate that there are indeed certain systematic asymmetries within and across certain conversion pairs, and that speakers may draw upon information about these asymmetries in assigning a word class to a form.[1] However, these asymmetries were not clearly reflected in the visual masked priming task conducted on a subset of the words used in the survey. I have suggested above that this lack of a clear effect may be at least partially due to the limitations of the masked priming paradigm. In contrast to the proposals of Crepaldi et al. (2010), this paradigm may in fact target only an early, automatic stage of decomposition – one which is sensitive to morpho-orthographic regularities, but blind to underlying morphological relationships. Later research by e.g., Morris & Stockall (2012) seems to further support this idea. Given the potential lack of deeper processing under these experimental conditions, it is still possible that we may observe processing differences based on the underlying morphological structure of conversion pairs may be observed, provided the experimental methods are modified.

[1] Cf. §6.2.

Therefore, in light of earlier research within the delayed priming paradigm (§2.2.2.1), which allows both full processing of the prime as well as the potential for distinguishing the effects of morphological relatedness from those of semantic and phonological relatedness, the forms used in the previous experiment were re-assessed under these new conditions. This chapter thus begins with a description of this experiment, with particular reference to the changes made in view of the results of the first task (§4.2). §4.3 then offers a brief summary of the first two experiments into the processing of directional conversion pairs, suggesting both alternative interpretations of the results, as well as areas where the methods may be improved upon. The chapter then concludes with §4.4.[2]

4.2 Experiment 2: Auditory delayed priming

As mentioned above, this experiment employs a delayed priming paradigm, in which there is an extended delay between presentation of the prime and presentation of the target. By using this paradigm, it is hoped that we might gain further insight into stages of lexical processing which potentially involve deeper morphological analysis. In particular, the results of Experiment 1 suggest that facilitation in masked priming occurs in any and all cases in which the prime and target are morpho-orthographically related, regardless of whether they are truly related at all (cf. *corner* – CORN). However, this type of relatedness is not expected to elicit facilitation in a delayed priming task (Drews & Zwitserlood 1995), and it may thus be easier to discern differences in the processing of various types of morphological structure. Furthermore, because of the delay, it may also be possible to use this paradigm to tap into any additional processes which may occur *after* the lexical decision to the prime, thereby providing more information as regards the relationship of the prime form to other forms in the mental lexicon.

[2]Experiments 2 and 3 have been reported and expanded upon in an article with Aditi Lahiri published in *The Mental Lexicon* (Darby & Lahiri 2016); see www.benjamins.com/#catalog/journals/ml.11.2.02dar/details. The experiments are reported in this thesis with the kind permission of John Benjamins.

Of course, it may also be noted that as compared to the masked priming task, delayed priming may be relatively more susceptible to the influence of strategic and episodic effects (cf. §2.2.2.1). It is therefore necessary to be mindful of this issue in designing this experiment and interpreting its results.

In addition to this change in paradigm, however, this experiment also differs from Experiment 1 in terms of the presentation modality – i.e., the stimuli were presented *auditorily*. This choice was made partly in order to further investigate the contribution of modality to the processing of these pairs, and partly in an attempt to increase the overall difficulty of the experiment – both in order to allow time for deeper processing, as well as to level out any potential differences in baseline responses.[3] Although many other aspects of this experiment remain similar to the previous one, the new task necessitated several changes to the design, as detailed below.

4.2.1 Method

4.2.1.1 Design

The Conversion condition, as before, consisted of 40 monosyllabic conversion pair targets (40 'A/AN' nouns and 40 'TO' verbs), 20 of which were N_B and 20 of which were V_B. Each conversion pair had a corresponding related *-ing* prime (e.g., *biting* – A BITE) and a matched, unrelated *-ing* prime. Presentation of primes and targets was divided and counterbalanced across four experimental lists as described in §3.3.1.1. Table 4.1 (from Table 3.2, repeated for convenience) illustrates the makeup of this condition for each of these lists.

40 total targets per list

Prime Type	20 with related prime				20 with unrelated prime			
Base Type	10 V_B		10 N_B		10 V_B		10 N_B	
Target Type	5 Verb	5 Noun	5 Verb	5 Noun	5 Verb	5 Noun	5 Verb	5 Noun

Table 4.1: Makeup of Conversion condition in each list

A second condition which investigated the relative contribution of semantic

[3] Cf. §3.3.4 and 4.2.1.2D.

relatedness was also included. As the new design allows fully conscious lexical access, and therefore full semantic processing of each item, a new set of stimuli was created with the goal of selecting prime-target pairs which were more closely related in meaning, in order to be relatively sure that any facilitation observed was morphological in nature. This Semantic condition consisted of 40 pairs of primes and targets, with matched unrelated control primes. In line with the Conversion condition, primes were stress-initial and disyllabic, and were composed of a stem and a suffix. The targets were monosyllabic words of any word class. For each prime-target pair, another disyllabic, suffixed prime was chosen which had no semantic or phonological relationship to the target.

The third and final test condition was designed to investigate the effects of phonological overlap between primes and targets. This Form condition comprised 40 prime-target pairs which shared initial phonemes, and included matched, unrelated control primes. As in the other conditions, primes were disyllabic and stress-initial, and targets were monosyllabic items of any word class.

The Semantic condition and the Form condition were both divided into two groups. Each group contained all targets only once, with half preceded by the corresponding related prime, and half following an unrelated prime. These prime conditions were reversed in the second group. The general makeup of the Semantic and Form condition items included in each list is summarised below.[4]

40 total targets per list (each condition)		
Prime Type	20 with related prime	20 with unrelated prime

Table 4.2: Makeup of Semantic/Form condition in each list

Each group was combined with *two* of the four experimental lists containing the Conversion condition, for a total of 240 word stimuli (120 disyllabic primes and 120 monosyllabic targets) in each list. As in Experiment 1, this design meant that the full range of prime-target combinations in the Semantic and Form conditions

[4]For more detailed information regarding the structure of the items in the Semantic and Form conditions, see the respective descriptions in §4.2.1.2.

was run twice as many times as the Conversion condition.

In addition to the word stimuli described above, 240 nonword stimuli were also created, 120 of which were disyllabic and stress-initial, and 120 of which were monosyllabic. All 240 nonwords were presented in each of the four experimental lists, for a total of 480 stimulus items in each list. Due to the structure of the disyllabic nonwords (cf. §4.2.1.2D), and in order to facilitate pseudorandomisation of the items in the list (see below), the disyllabic nonwords bore no relationship to the monosyllabic nonwords.[5] The total proportion of related items in each list was 25%.

Prime-target word pairs, both related and unrelated, were arranged so that there were 5-7 items intervening between the prime and its target. Because there were no filler words, words which were part of a prime-target pair often served as one of the intervening items of another pair. The order of items in the list was then pseudorandomised according to the following criteria:

> (1) No more than five consecutive word or nonword trials were allowed.
>
> (2) No items (other than the related prime) which were related in meaning or began with the same phoneme as a test target were allowed within the ten trials preceding that target.

Aside from changes in the prime type (Related or Unrelated) and the target type of the Conversion items (Noun or Verb), the overall order of items remained the same across the four lists. Each complete list of 480 items was divided into three blocks of 160 items each.

[5]Although this was cited as a possible methodological issue in Experiment 1 due to the potential bias in favour of prime-target pairs with orthographic/phonological overlap (3.3.4), this bias should not arise in a delayed priming task. As described in §4.2.1.6 below, participants were unaware of any distinction between prime and target, and responded to every stimulus in the same way; thus, each trial was equally as likely to require a 'word' or 'nonword' response.

4.2.1.2 Stimuli

(A) Conversion pairs The Conversion condition used the same stimuli as Experiment 1.[6] However, because all words were presented auditorily, it was necessary to match the unrelated *-ing* primes to the related *-ing* primes in number of phonemes rather than number of letters. While most of the original unrelated primes already happened to be matched, for some stimuli, new ones had to be chosen. It was ensured that these primes, like the others, were also matched to the related primes in stress pattern and surface frequency (calculated as in §3.3.1.2A). The mean lengths and frequencies of the targets and primes in this condition are summarised below, along with the mean proportion of phoneme overlap between them.

Stimulus Characteristic	N_BVerb	N_BNoun	V_BVerb	V_BNoun
Target Phonemes	3.40	3.40	3.60	3.60
Target Lemma Freq.	3.99	14.72	13.82	4.19
Target Surface Freq.	0.74	9.46	2.93	3.17
Prime-Target Overlap	0.81	0.81	0.82	0.82
Prime Phonemes	5.45	5.45	5.65	5.65
Prime Surface Freq.	0.99	0.99	4.48	4.48
Prime Lemma Freq.	3.99	3.99	13.82	13.82

Table 4.3: Conversion condition stimulus characteristics by target group

(B) Semantically-related pairs As noted above, the primes in the Semantic condition were stress-initial disyllables composed of a stem and a suffix. In order to provide a larger pool of words from which to select more closely related pairs, a wide variety of suffixes was used for the primes, with no particular restriction on the number of stimuli that contained each suffix. The distribution of suffixes is listed in Table 4.4 below; the most common were *-er* and *-ness*.

[6] As noted in the Conversion analysis section of Experiment 1 (§3.3.3.1), one of the pairs in the V_B condition (*probe*) was excluded from the final analysis when it was discovered that it did not comply with the original selection criteria, as its noun form was tagged 'M' in CELEX and its verb form 'Z'. In light of the design of Experiment 3 (§5.3.1), it is particularly important to keep this tagging consistent. Unfortunately, this issue was not discovered until after both Experiments 1 and 2 had been run, and so this pair was included in Experiment 2.

Suffix	# Primes	Example
-er	12	*gambler*
-ness	6	*fondness*
-less	5	*hairless*
-y	5	*gloomy*
-ing	4	*crying*
-ly	2	*closely*
-ful	2	*restful*
-ive	1	*massive*
-al	1	*thermal*
-ish	1	*waspish*
-en	1	*slacken*

Table 4.4: Prime suffixes in the Semantic condition

The targets for the Semantic condition were monosyllabic words of any word class. The word class restriction used in the previous experiment was also removed in order to facilitate closer semantic relatedness between prime and target. As a result of any word class being allowed (including adjectives), the targets were not preceded by 'A/AN' or 'TO'; this also helped to increase the similarity of the Semantic condition targets to those in the Form condition (see below). Finally, unrelated primes were chosen, and each was matched to the corresponding related prime in lemma frequency, stress pattern, number of syllables and phonemes, and in suffix.[7] The stimuli were then shown to several native speakers, who judged the related prime-target pairs to be sufficiently related in meaning, and the control primes to be semantically and formally unrelated to the corresponding targets. The primes and targets were matched listwise to the primes and targets of the Conversion condition in stress pattern, number of syllables, and mean number of phonemes. The stimuli in the Semantic condition, however, tended to be more frequent (cf. §4.2.1.4). The table below summarises the mean lengths and frequencies of the targets and primes in the Semantic condition.

[7]Lemma frequency was judged to be the most relevant frequency measure for these primes, given that all of their word forms should share a semantic representation, and thus be equally as likely to prime the targets.

Stimulus characteristic	Mean
Target Phonemes	3.25
Target Lemma Freq.	92.49
Target Surface Freq.	70.37
Prime Phonemes	5.38
Prime Lemma Freq.	12.76
Prime Surface Freq.	7.14

Table 4.5: Semantic condition characteristics

(C) Phonologically (form)-related pairs The majority of stimuli in this condition were drawn from several of the previous papers investigating form priming: Rastle et al. (2000); Rastle & Davis (2003); and Rastle et al. (2004).[8] As mentioned above, related primes were disyllabic, stress-initial, and unsuffixed. In some cases, the prime was only phonologically related to the target (e.g., *brothel*–BROTH). However, also included were cases of what Rastle et al. (2000, 2004) characterised as 'opaque morphologically-related pairs' – that is, (morpho-orthographic) pseudosuffixed primes and related targets (e.g., *witness*–WIT). As noted above and in Chapter 2, while facilitation has been found for these pairs in masked priming, this effect disappears at longer prime durations (Rastle et al. 2000, 2004; Drews & Zwitserlood 1995). Such pairs are therefore expected to behave similarly to non-pseudo-suffixed pairs in a delayed priming task.[9] In addition to allowing us to distinguish morphological effect from those based on formal similarity, this condition has an added benefit in that it may help us to determine whether the results of the delayed priming task are based on lexical information or are instead episodic in nature (cf. §2.2.2.1). Thus, if facilitation is not observed in this condition, we may suggest that any morphological effects which emerge are not reducible to episodic factors.

The targets in this Form condition were monosyllabic, and were identical to the first part of the related prime – typically the first syllable, though often the

[8] Cf. 2.2.2.2.
[9] Cf. §4.2.3.3 and 4.2.4.

first syllable and onset of the second syllable (e.g., *jerkin* – JERK). Targets were not preceded by 'A/AN' or 'TO' for two reasons: (a) many were not nouns or verbs, and (b) it was felt that the intervening particle might artificially bias against priming on the basis of phonological similarity. Unrelated primes were also chosen, and were matched to the related primes in lemma frequency, stress pattern, and number of syllables and phonemes.[10] They were not related to the targets either semantically or phonologically. As in the Semantic condition, primes and targets were matched listwise to the primes and targets of the Conversion condition in stress pattern, number of syllables, and mean number of phonemes. The Form stimuli likewise tended to be more frequent than the Conversion items, though the Form targets were not quite as frequent as the semantically-related pairs. The mean lengths and frequencies of the items in the Form condition are represented in Table 4.6, along with the mean proportion of phoneme overlap.

Stimulus characteristic	Mean
Target Phonemes	3.80
Target Lemma Freq.	47.73
Target Surface Freq.	27.56
Prime-Target Overlap	0.83
Prime Phonemes	5.70
Prime Lemma Freq.	23.23
Prime Surface Freq.	16.50

Table 4.6: Form condition characteristics

(D) Nonwords The 120 monosyllabic nonwords were taken from Experiment 1 and were phonologically legal and pronounceable according to the rules of English. To mirror the word conditions, 40 of these items were preceded by 'A/AN' or 'TO' (20 of each), and 80 were not. These items were matched listwise to the target words in number of phonemes (cf. §4.2.1.4).

The 120 stress-initial, disyllabic nonwords were composed of existing word

[10]Lemma frequency was also judged to be the most relevant measure of prime frequency for the Form condition, as all the forms of the prime should be equally related to the target.

stems which were monosyllabic and monomorphemic, plus existing suffixes (e.g., **spineful*). The inclusion of these nonwords served a dual purpose. Firstly, recall that in Taft & Forster's study using *prefixed* nonwords, they found that it took longer to reject a nonword containing a real (bound) stem attached to a real prefix *(e.g. *dejuvenate*) than it did to reject a pseudostem nonword with a real prefix *(e.g., *depertoire*) in a lexical decision task (cf. 2.2.1.1). They suggest that these items are being automatically decomposed into a stem and prefix before lexical search takes place – if they were simply being looked up via the whole nonword, there would be no difference between these two types of nonwords, as they are equally similar to real words, and equally non-existant (Taft & Forster 1975: 644). If this is the case, then the inclusion of real-stem-real-suffix nonwords here may help to encourage morphological decomposition of complex items, which may be of concern in light of the fact that auditory information can *only* be received in a 'left-to-right' fashion. While this may appear to be artificial in forcing decomposition, any asymmetry in the processing of N_B items and V_B items (cf. §4.2.2.1) will still suggest that there is some type of distinguishing information available that speakers can make use of, even within a time span which is too brief for metalinguistic reflection.

The second motivation for including these nonwords in the experiment was to further increase the overall difficulty of the task, and thus the average length of responses (cf. Taft 2004). As noted in §3.3.4, it is possible that the somewhat greater degree of priming in the N_BVerb condition was partially due to baseline differences in RT for the two types of N_B targets. By increasing the difficulty of the task as a whole, it may be possible to reduce differences in baseline response times, and any similarities and differences between priming effects may be clearer.

The suffixes used for the disyllabic nonwords were the same as those in the Semantic condition, with the addition of several other '+-boundary' suffixes (Chomsky & Halle 1968: 66-67).

Suffix	# Nonwords	Example
-ful	20	*shockful*
-ing	15	*pathing*
-ly	12	*frownly*
-er	10	*foaler*
-ment	10	*hopement*
-ness	9	*poachness*
-ist	8	*heartist*
-ish	8	*blamish*
-less	7	*botchless*
-en	7	*bleachen*
-y	6	*flingy*
-ous	4	*haltous*
-al	4	*brainal*

Table 4.7: Suffixes in disyllabic nonwords

The stems for these nonwords were taken from the fillers used in Experiment 1. These disyllabic nonwords were also matched listwise to the word primes for number of phonemes (cf. §4.2.1.4).

4.2.1.3 A note on frequencies

Before proceeding, it is necessary to explain some considerations underlying the methods used to calculate different types of frequencies in this experiment. For the Conversion condition, the frequencies were determined in the same way as in Experiment 1 (§3.3.1.2A). However, because the targets in the Semantic and Form conditions were not preceded by 'TO' or 'A/AN,' the frequencies for these conditions were calculated differently.

Although, as mentioned above, the stimuli in the latter two conditions tended to be more frequent, this may be partially due to the difference in the frequency calculations. Like the Conversion targets, many of the targets (and several of the primes) in the Semantic and Form conditions were in fact members of multiple word classes. However, without a preceding 'TO' or 'A/AN', it is not entirely clear which of these word classes is being responded to – or indeed, if any distinction

between them is even required (Onifer & Swinney 1981).[11] The lemma and surface frequencies for these items thus consisted of the combined frequencies of all of the word classes which appeared for that form.

4.2.1.4 Summary of stimulus characteristics

Table 4.8 lists the primary characteristics of the items included in this experiment, including the mean number of initial phonemes shared between the prime and the target for the Conversion and Form conditions. For reasons of space, the monosyllabic nonwords are listed as targets, and the disyllabic nonwords as primes.

Stimulus Characteristic	Conversion	Semantic	Form	Words	Nonwords
Target Phonemes	3.50	3.25	3.80	3.52	3.63
Target Lemma Freq.	9.18	92.49	47.73	41.85	–
Target Surface Freq.	4.07	70.37	27.56	26.52	–
Prime-Target Overlap	0.81	–	0.83	–	–
Prime Phonemes	5.55	5.38	5.70	5.54	5.63
Prime Lemma Freq.	8.91	12.76	23.23	14.72	–
Prime Surface Freq.	2.74	7.14	16.50	8.79	–

Table 4.8: Summary of stimulus characteristics by condition

4.2.1.5 Stimulus creation

The auditory stimuli for the experiment were recorded by a female native speaker of Standard Southern British English. The audio files were then edited using Praat (version 5.1.32). They were cut into individual items at the nearest zero-crossings, with every effort taken to minimise clicks. For the Conversion items and similarly-structured nonwords, the 'TO' and 'A' particles were recorded separately in the proper phonetic environments, by pronouncing them before words beginning with each of the initial consonants used in the Conversion pairs. The content words were then removed at the nearest zero-crossing, leaving only the

[11] However, cf. Forster & Bednall (1976).

particle. During the experiment, the appropriate version of each particle was spliced in so that it immediately preceded each Conversion item (or relevant non-word). This made it possible to use the same audio file for both the noun and verb targets of the Conversion items, thus ensuring that there were no unintentional phonetic differences between the two forms.

It should be noted that, although the same file was used for both the nominal and verbal variants of a Conversion item, the stimuli of course differed according to whether this file was preceded by 'TO' or 'A/AN'. In an effort to maximise the naturalness of the particle+Conversion item combination, the lengths of the particles were not manipulated from their original, spliced off forms. This led to quite different particle lengths across the four Conversion groups, with the 'A' particles shorter than their verbal counterparts, particularly within the N_B category [N_BNouns: 88.78 ms; N_BVerbs: 116.42 ms; V_BNouns: 116.43 ms; V_BVerbs: 130.94 ms]. However, as the crucial comparisons will involve responses to the *same* group of stimuli (i.e., only one of the four groups) in both unprimed and primed conditions, such a difference is not expected to affect the pattern of results in a substantial way; furthermore, this difference may be argued to parallel the consistent (and unavoidable) difference in the number of letters of 'TO' vs. 'A' in the visual experiments.

4.2.1.6 Participants and procedure

Fifty-two participants between the ages of 18 and 62 (27 female; mean age: 23.5) participated in the experiment. Because the stimuli were pronounced by a speaker of British English, participants were limited to native speakers of British English. Participants were recruited through mailing lists at the University of Oxford. They gave signed consent of their participation, and were compensated £5.00 for their time.

Thirteen participants were assigned to each of the four experimental lists. Participants were instructed that they would initially hear a series of tones, fol-

lowed by a single tone which would precede each spoken stimulus. They were instructed to press 'YES' if they heard a real word of English, and 'NO' if they heard a nonword.

Each list of 480 trials was divided into three blocks of 160 trials each. A block began with three short tones before the trials were presented. Each individual trial began with one short tone and a 200 ms pause. The stimulus was then played, followed by a pause of 1500 ms before the next trial began. Reaction times were measured from stimulus onset, and timed out at the start of the next trial.

Participants were tested individually or in groups in a quiet room. The stimuli were played over headphones, and reaction times were measured using a serial response box with the 'YES' button controlled by the participant's dominant hand. Participants were instructed to hold the box in their hands for the duration of the experiment and press the buttons with their thumbs. The experiment itself was approximately 21 minutes long, with the individual blocks running for about 7 minutes each. Participants were instructed to respond to every stimulus item, and were given short breaks between each block.

The experiment was run using XMOD data gathering software (v. 1.1; Reetz & Kleinmann 2003) on an Apple MacBook Pro running OS X.

4.2.2 Predictions

Although the same conversion stimuli were used, the research discussed in Chapter 2 suggests that the change in experimental paradigm and design will involve new considerations. The predictions therefore require certain modifications, in order to take into account issues which do not appear to arise in short-presentation masked priming, but which may be more influential in the later stages of lexical decision.

4.2.2.1 '1-step/2-step' and morphological complexity

The predictions for this scenario remain largely the same as in §3.3.2.2. Recall that, under this model the results will reflect the combined influence of the number of 'morphological steps' from the prime – effectively, whether the target is a verb or a noun – and an additional level of complexity which is argued to be part of the structure of N_B primes, but not of V_B primes. It is expected that both verb target categories should be facilitated, as they are only one step from the inflected *-ing* prime.

The noun targets, on the other hand, are predicted to be differentially affected by their related primes, depending on (1) whether or not the noun is basic and (2) what kind of effect this has on processing. Following example 4.1 (repeated from 3.3), the former characteristic is argued to be reflected in the differing underlying structures of the primes:

(4.1) a. N_B *nesting*: $[[[nest_N]_V]ing]$

b. V_B *biting*: $[[bite_V]ing]$

As outlined in §3.3.2.2, the way in which this kind of structural difference will manifest depends on whether morphological 'closeness' (version 1) or complexity (version 2) have a greater effect. Thus, the fact that the structure of *nesting* contains as a component the nominal form $nest_N$ may result in a level of facilitation which is closer in magnitude to that of the N_BVerbs. V_BNouns, on the other hand, would be primed much less than their verbal counterparts, as they are neither inflectionally related to the prime nor contained within the *-ing* form.

In contrast, a pattern based on the overall *complexity* of the prime may also emerge. If the processing of N_B primes causes greater difficulty due to the additional layer of morphological structure, it is possible that the degree of facilitation from which the N_BNoun can benefit will be mitigated to some extent, as the prime will require more effort to fully decompose it into this base form. The facilitation of the V_BNouns, on the other hand, will not be affected in this way, instead sim-

ply receiving a somewhat lesser degree of priming than the inflectionally-related V_BVerbs.

As noted previously, all targets are expected to be facilitated on the basis of their morphological relationships with the prime. However, while in one case the predictions based on the assumption of underlying differences in morphological structure suggest a greater difference in facilitation between the two V_B groups (version 1), in the other, the two N_B groups are expected to behave differently from one another (version 2). The results of Experiment 1 have not helped to clarify which of these projected situations is more likely.

What we may predict with a degree of certainty, however, is the lack of an effect in both the Form and Semantic condition. Based on the research discussed in §2.2.2.1, for those pairs whose relationship is phonological – either purely phonological or else morpho-phonological – we do not expect significant facilitation. Likewise, following e.g., Henderson et al. (1984), the presence of a semantic relationship between prime and target is not predicted to facilitate responses. The pattern of predicted effects in these two conditions remains roughly the same regardless of the predictions for conversion pairs (though cf. §4.2.2.2, fn. 13).

Although it is not yet clear which version of these predictions should be expected to emerge, if the results resemble one of the patterns described above, they will begin to lend further support to the theory that these conversion pairs differ according to whether the nominal or verbal form is the morphological base. However, in order to confirm this interpretation, it will be necessary to consider the other ways in which the processing of these forms might be affected.

4.2.2.2 Frequency and Recombination

The predictions in this section are based on an extension of the proposed 'reverse base frequency effect' in Taft (2004), discussed in detail in §2.3.2.2. It will be noted that in the predictions for the previous experiment (§3.3.2.1), it was argued that the results of Taft (2004) might in fact be better accounted for by the

extended morpho-orthographic segmentation model of Crepaldi et al. (2010).[12] However, this model did not correctly predict the behaviour of conversion pairs. It is therefore suggested that Taft's recombination account should be reconsidered, particularly in light of the similarity of the nonwords included here (cf. §4.2.1.2D) to those used in Taft (2004), as well as the fact that the primes in Experiment 2 are presented for a much longer duration than in either Experiment 1 or Crepaldi et al.'s study, thus allowing for a potential recombination stage.

Recall that, although Taft does not explicitly discuss how difficulty at the recombination stage might affect priming, he does offer suggestions for how differences in the frequency of the nominal and verbal uses of a stem may affect the processing of complex words which contain this stem – conversion pairs, for example. Taft (2004: 749) argues that a word like *timed* – which has verbal inflection attached to a stem that occurs more frequently as a noun – will cause processing difficulty at the recombination stage. This difficulty is said to be caused by competition with the noun; in other words, "...the functional information that is most strongly activated when *timed* is presented will suggest that *time* is a noun, which, therefore, cannot take the past tense." This conflict, he suggests, may not only counteract any benefits of having a high-frequency base (such as faster recognition), but may also give items like *timed* the appearance of being recognised on the basis of its low surface frequency (Taft 2004: 750).

This argument may be applied to the conversion stimuli in the present experiment, as the relative noun/verb frequencies in the N_B pairs fit this description (cf. Table 4.8). Extending this reasoning to patterns of priming, we would predict that for V_B primes like *biting*, the *-ing* is first removed, followed by strong activation of the higher-frequency verb – though the noun should be activated as well. The *-ing* will then be reattached to the verbal stem with little difficulty. This series of events should produce a larger facilitatory effect for the V_BVerbs, along with a somewhat lower degree of facilitation for the nouns.

[12] Cf. §2.3.4.

The N_B primes, on the other hand, should be processed more like *timed*: after the *-ing* is removed, the higher-frequency *noun* will be activated more strongly. The verb will also be activated, but to a lesser degree. At the recombination stage, however, the processor will encounter a problem: *-ing* does not generally attach to a noun.

How would this conflict affect the level of priming? We might first expect that the stem would be reanalysed as the lower-frequency verb. Despite this reanalysis, the initial stronger activation of the noun, as well as the difficulty encountered during the attempt to recombine stem and suffix, would likely interfere with the overall activation strength of the verb, leading to a reduced amount of priming. As for the noun, the mismatch at the recombination stage and the possible reanalysis of the stem may also interfere with its activation strength, again leading to a smaller priming effect than might otherwise be expected.

Because conversion pairs were not Taft's primary concern, it is not entirely clear exactly how these activations and conflicts might interact – for instance, whether the initial activation of the N_BNoun might be strong enough to counteract the recombination mismatch to some extent, or, conversely, whether the reanalysis of the corresponding bare stem as verbal might partially overcome its initial lesser degree of activation. Regardless, this model predicts a relatively straightforward difference between the level of priming for V_BVerbs and V_BNouns. In contrast, for the N_B items, we might expect a comparable degree of facilitation for both target groups, as both are predicted to receive a degree of activation as well as suffer from competition and conflict. Lastly, as regards the Semantic and Form the conditions, we again do not predict any straightforward effects of either purely semantic or phonological relatedness.[13]

As with the predictions based on the model advanced by Crepaldi et al. (2010),

[13]Unfortunately, because morpho-phonological priming was not expected in a delayed priming task, the possibility of (incorrect) decomposition and subsequent recombination for *corner*-CORN-type pairs was overlooked. Due to the inclusion in the Form condition of both morpho-phonological pairs and purely phonological pairs (e.g., *pulpit*-PULP), it is not possible to make straightforward predictions for this condition which will address this. However, see the *post-hoc* analysis of this factor in §4.2.3.3.

it is worth pointing out the similarity of this pattern with that of version 1 in §4.2.2.1. On the one hand, the resemblance between the recombination predictions and those of Crepaldi et al. (2010) is not surprising, given that Crepaldi et al.'s proposal of competition on the level of the orthographic lexicon is an alternative account for the 'reverse base frequency effect' in Taft's study. However, although Crepaldi et al.'s model is intended to apply to visual word recognition in general, it was not supported by the results of Experiment 1, and thus is not predicted to apply in Experiment 2. If, on the other hand, we assume Taft's recombination model, it is possible that its effects might only be apparent in tasks like delayed priming, in which the stimulus is presented for a longer duration and is thus fully perceptible.[14] The apparent lack of influence from recombination in Experiment 1 therefore does not necessarily preclude its relevance to the task in Experiment 2. Furthermore, Taft argues that the inclusion of real-stem-real-suffix nonwords may increase the importance of the recombination stage, thus further exaggerating its effects. Should Experiment 2 produce results along the lines of those described above, this would provide some support for Taft's model, as well as for an analysis of the processing of conversion pairs which is based primarily on their relative nominal and verbal frequencies. However, it may not be possible to entirely disentangle the issues of frequency, recombination, and the underlying morphological structure of the forms in question under the particular experimental conditions employed in this task.

4.2.3 Results

Results were cleaned and analysed using the JMP (10.0) statistical package. As might be expected due to the combination of real-stem-real-suffix nonwords and auditory modality (cf. §4.2.1.2D), a number of participants noted that they found the task somewhat difficult – particularly those items composed of a particle and a word or nonword (i.e., conversion targets and similarly-constructed nonwords),

[14] Cf. §2.3.4.

due to confusion with disyllabic words and nonwords. Consequently, mean response times and error rates in this experiment are much higher than in the visual masked priming task.[15]

The data were first cleaned by removing individual data points for which the subject responded before the stimulus began or after the trial timed out (0.92% of the data), of which 65% were nonwords. As in Experiment 1, these points were treated as missing and were not included in any further analyses. One stimulus pair from the V_B category was also removed when it was discovered that it did not comply with the original selection criteria (cf. §3.3.3.1). A number of items in each condition were also found to have high-frequency, unrelated homophones, and were thus removed (1 V_B, 3 Semantic, and 2 Form).

Four subjects were also excluded (one from each list). Three of these subjects were excluded due to an overall error rate greater than two standard deviations from the group mean (Mean: 8.5%; 2StdDev: 17.0%), while one subject was removed due to a mean correct word response time greater than two standard deviations from the group mean (Mean: 933.2 ms; 2StdDev: 1083 ms), removing 7.7% of the remaining data. As with the previous experiment, further analyses of the Conversion, Form, and Semantic conditions was performed separately, due to the different types of targets across conditions, and in particular due to the large frequency differences (cf. Table 4.8).

4.2.3.1 Conversion condition

Four additional items had an overall error rate greater than two standard deviations from the condition mean (Mean: 17.6%; 2StdDev: 48.3%). These items (3 V_B, 1 N_B) were removed, along with their pair partners (≈11% of total conversion target responses). The results were further cleaned by removing target responses for which the response to the related prime was either incorrect or

[15] Additionally, as the response times are measured from stimulus onset, the means given include the (full or partial) duration of the auditory stimulus which was played before participants responded.

missing (3.8% of remaining responses). For the reaction time analysis, the standard deviation was calculated for correct responses, and individual data points more than two standard deviations from the mean RT for this condition were also removed (Mean: 980.6 ms; 2StdDev: 1320 ms; 4.0% of remaining responses). Mean correct reaction times in milliseconds (from stimulus onset) and error rates (percentages in parentheses) are summarised in Table 4.9.

(A) Reaction times Reaction time data for correct responses were analysed by a three-factor linear mixed effects model, with Subjects and Items as random factors. The main factors were Prime Type (Related vs. Unrelated), Base Type (N_B vs. V_B), and Target Class (Noun vs. Verb). Target surface frequency and residualised lemma frequency were included as covariates as in Experiment 1 (§3.3.3.1).

The adjusted R^2 for this model was .407. There was a significant main effect of Prime Type [$F(1, 1175) = 22.57$, $p<.0001$]. Participants responded, on average, 29.1 ms faster to conversion pair targets when they were preceded by their related *-ing* prime than when preceded by an unrelated control.

Target Class (Noun vs. Verb) was also a significant factor [$F(1, 61.15) = 6.89$, $p=.0415$], with responses to Nouns 46 ms slower than Verbs (992.2 ms vs. 946.4 ms). The factor Base Type (N_B vs. V_B) was also significant [$F(1, 60.05) = 3.52$, $p=.0218$], and responses to V_B targets were 39.4 ms quicker overall (N_B: 989.0; V_B: 950.0). There were no other significant effects.

Notably, the interaction between Prime Type, Base Type, and Target Class did not reach significance [$F(1, 1173) = 1.94$, $p=.1643$]. However, planned comparisons of the priming effects in each of the four target categories revealed a distinct pattern. The V_BVerbs and V_BNouns were facilitated to a similar degree [V_BVerbs: 25.7 ms, $t(1174) = 2.16$, $p=.0313$; V_BNouns: 31.6 ms, $t(1174) = 2.38$, $p=.0177$; Difference: 5.9 ms, $t(1173) = 0.3271$, $p=.7437$]. In contrast, N_BVerbs were significantly facilitated [43.7 ms, $t(1174) = 3.91$, $p=.0001$], while N_BNouns were not [15.5 ms, $t(1174) = 1.25$, $p=.2118$]. However, the difference between

the latter two groups did not quite reach significance [28.2 ms, t(1173) = 1.69, p=.0918].

(B) Error rates The error rate data were analysed using a binomial generalised linear model (GLM), which included the same fixed factors and frequency covariates as the reaction times. The analysis revealed a main effect of Prime Type [χ^2 = 5.74, p=.0166]. Participants made 5.2% fewer errors when targets were preceded by their related *-ing* prime.[16] The main effect of Target Class was also significant [χ^2 = 54.3, p<.0001], with participants responding more accurately to Verb targets overall (Verbs: 7.2%; Nouns: 21.9%). Furthermore, the main effect of Base Type was significant as well [χ^2 = 4.10, p=.0430], though participants' accuracy only improved 2.1%. Planned comparisons of the error rates in the four target conditions revealed a significant facilitatory effect of Prime Type only for the N_B targets [N_BVerbs: χ^2 = 7.20, p=.0073; N_BNouns: χ^2 = 4.18, p=.0409].[17]

Target	Unrelated	Related	Priming Effect	Diff. in Effect
N_BVerb	999.2 (12.0%)	955.6 (4.8%)	43.7** (7.1%**)	
				28.2 (1.5%)
N_BNoun	1008.4 (26.6%)	992.8 (18.0%)	15.5 (8.6%*)	
V_BVerb	928.3 (5.6%)	902.5 (5.7%)	25.7* (-0.1%)	
				5.9 (3.7%)
V_BNoun	999.5 (22.8%)	968.0 (19.2%)	31.6* (3.6%)	
Overall	983.8 (17.0%)	954.7 (11.8%)	29.1** (5.2%)	

Table 4.9: Results of Conversion condition (Experiment 2)

Interestingly, the GLM analysis also revealed a significant effect of the surface frequency of the target [χ^2 = 10.86 p=.0010].

[16]Unless otherwise indicated, error rate analyses reported in this and subsequent sections do not include Subjects or Items as random factors. Likewise, all reported error rate *percentages* are the results of a contingency analysis, and do not include either random factors or frequency covariates.

[17]Unless otherwise indicated, * = significant at p <.05, ** = significant at p <.01.

4.2.3.2 Semantic condition

Two additional items had an overall error rate greater than two standard deviations from the condition mean (Mean: 3.7%; 2StdDev: 13.8%). These items were removed (≈5.4% of total semantic target responses). As with the other conditions, target responses for which the response to the related prime was either incorrect or missing were also removed (5.6% of remaining responses). Reaction times were further cleaned by removing incorrect responses and individual data points more than two standard deviations from the mean RT for this condition (Mean: 849.9 ms; 2StdDev: 1190 ms; 4.6% of remaining responses). Mean correct reaction times in milliseconds and error rates (percentages in parentheses) are summarised in Table 4.10.

(A) Reaction times Reaction time data for correct responses were analysed using a linear mixed effects model, with Prime Type (Related vs. Unrelated) as the main fixed effect, and Subjects and Items as random factors.

The adjusted R^2 for this model was 0.459. There was no significant effect of Prime Type [$F(1, 1380) = 0.47$, p=.4909]. Participants responded, on average, only 3.7 ms faster to targets preceded by a semantically-related prime.

(B) Error rates The error rate data were analysed using a binomial GLM, which included the same main factor as the reaction times. The analysis revealed no effect of Prime Type [$\chi^2 = 0.69$, p=.4066]. Participants made 0.7% fewer errors when targets were preceded by a semantically-related prime.

Unrelated	Related	Priming Effect
835.1 (3.1%)	831.4 (2.4%)	3.7 (0.7%)

Table 4.10: Results of Semantic condition (Experiment 2)

4.2.3.3 Form condition

Two additional items had an overall error rate greater than two standard deviations from the condition mean (Mean: 7.3%; 2StdDev: 28.7%). These items were removed (≈5.1% of total Form target responses). As with the other conditions, target responses for which the response to the related prime was either incorrect or missing were also removed (4.6% of remaining responses). Reaction times were further cleaned by removing incorrect responses and individual data points more than two standard deviations from the mean RT for this condition (Mean: 874.8 ms; 2StdDev: 1208 ms; 4.6% of remaining responses). Mean correct reaction times in milliseconds and error rates (percentages in parentheses) are summarised in Table 4.11.

(A) Reaction times Reaction time data for correct responses were analysed using a linear mixed effects model, with Prime Type (Related vs. Unrelated) as the main fixed effect, and Subjects and Items as random factors.

The adjusted R^2 for this model was 0.395. The analysis revealed that, although participants responded, on average, 5.7 ms faster to targets preceded by a phonologically-related prime, this difference was not reliable, and thus failed to reach significance [$F(1, 1404) = 1.00$, $p=.3176$].

However, as mentioned in §4.2.2.2, fn. 13, it is possible that the structure of this condition – the inclusion of morpho-phonologically-related pairs (e.g., *splinter*-SPLINT) as well as purely phonologically-related pairs (e.g., *brothel*-BROTH) – may obscure a pattern of differences in the level of priming. To investigate this possibility, a *post-hoc* analysis was run. This analysis was identical to the overall analysis, with the exception of Morphological Relatedness (Morpho-phonological vs. Non) as an additional fixed effect, along with its interaction with Prime Type.

The adjusted R^2 for this model was 0.395. Neither Prime Type nor Morphological Relatedness were significant factors, nor was the interaction between them [$F(1, 1412) = 0.88$, $p=0.3485$].

(B) Error rates The error rate data were analysed using a binomial GLM, which included the same fixed effect as the reaction times. The analysis revealed no significant effect of Prime Type [$\chi^2 = 1.00$, p=.3171]. Participants made 1.1% fewer errors when targets were preceded by a phonologically-related prime. As with the reaction time data, a *post-hoc* analysis including the factor of Morphological Relatedness was also run. No significant effects emerged.

Unrelated	Related	Priming Effect
860.9 (5.7%)	855.2 (4.6%)	5.7 (1.1%)

Table 4.11: Results of Form condition (Experiment 2)

The general pattern of results in this experiment is illustrated in Figure 4.1. Figure 4.2 represents the size of the priming effect in each condition, calculated by subtracting the mean RT for targets following related primes from the mean RT following unrelated primes.[18]

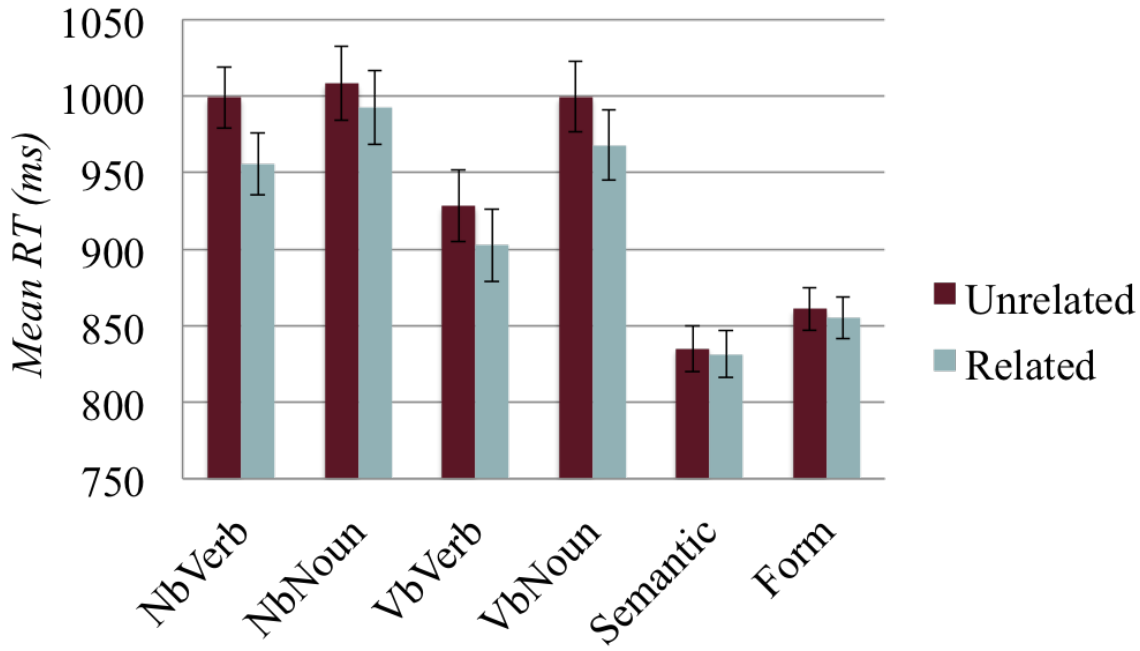


Figure 4.1: Mean RT and standard error (in ms) for all conditions (Experiment 2)

[18] As in the tables, * = significant at p<.05, ** = significant at p<.01.

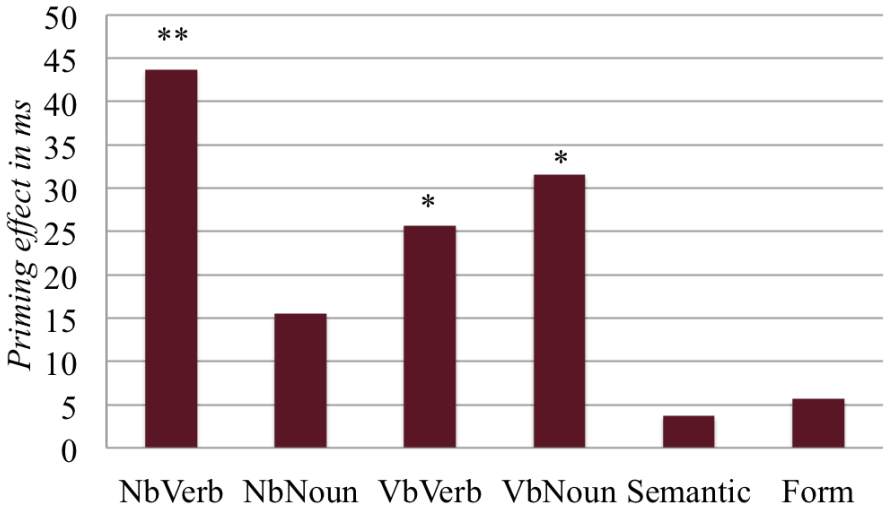


Figure 4.2: Mean priming effect (in ms) for all conditions (Experiment 2)

4.2.4 Discussion

Figure 4.2 reveals a striking pattern of effects. Unlike in the masked priming task, we find that presentation of a related prime does not uniformly facilitate recognition of targets – rather, whether or not responses are significantly speeded depends on the type of relationship between the prime and the target. Participants' response times to targets in the Semantic and Form conditions did not differ according to whether or not they had heard a semantically or phonologically related item 5-7 trials earlier. It is therefore unlikely that the particular pattern of priming effects across the four Conversion groups is solely attributable to differences in meaning relatedness or phonological overlap.

In fact, morphologically-related primes overall produced a facilitatory effect of ≈29 ms, well above that of the other two conditions. However, the extent to which target recognition was facilitated varied across the different Conversion target groups, with only the N_BNouns failing to receive significant priming following their related *-ing* primes. In contrast, presentation of a N_B prime like *nesting* decreased the time it took to correctly respond to TO NEST by almost 44 ms. V_BVerbs and V_BNouns, meanwhile, were roughly similar to one another in their

degree of priming, with a 26 ms and a 32 ms effect size, respectively.

Broadly speaking, this pattern of results seems to more closely resemble the predictions based on hypothesised differences in underlying morphological complexity (§4.2.2.1), rather than those based on differences in frequency and concomitant difficulty during a proposed recombination stage (§4.2.2.2). In particular, the much higher frequency of the nominal form of N_B stems (cf. Table 4.8) does not seem to have in any way hindered the activation of the N_BVerb, instead producing (numerically) the largest facilitatory effect. Likewise, the lack of significant priming for the high-frequency N_BNouns would seem to suggest that this frequency advantage over the verbal forms did not result in stronger activation. The discussion in §4.2.2.2 initially appears to offer an explanation for the latter result, suggesting that the difficulty encountered when reattaching the verbal suffix -*ing* to an apparently nominal stem, along with a possible reanalysis of the stem as verbal, could conceivably interfere with the overall degree of priming for the N_BNouns. However, this seems unlikely, given that there is no indication of any influence of this recombination difficulty on the facilitation of the N_BVerbs. Furthermore, as regards the V_B items, the predictions made in §4.2.2.2 do not seem to be borne out. Following Taft's argument, one would expect the higher frequency of the V_BVerb to lead to a higher level of activation for the verbal form as compared to the nominal form, followed by a relatively straightforward reattachment of the -*ing* suffix. The V_BNoun, on the other hand, would not be as strongly activated – indeed, its activation could even be impeded slightly upon recombination, as the interpretation of the stem as belonging to a verb might be strengthened by the addition of the suffix. However, the results do not support this analysis. Instead, we find an approximately equal amount of priming in both V_B groups, with V_BNouns even showing a slightly larger difference between responses in the Related and Unrelated conditions.

Turning now to the morphological complexity model, it seems that the pattern of effects predicted by this model for the N_B items more closely parallels

the results found in Experiment 2. If we assume that primes like *nesting* contain an extra level of morphological structure due to the fact that the verb is derived from the noun by means of a category-changing morphological process (e.g., [[[$nest_{N}$]$_{V}$]*ing*]), we would expect that full decomposition of the N_B prime into the nominal base would be more difficult than simply removing the -*ing* and arriving at the verb stem. Because of the greater difficulty of full decomposition, the N_BNoun would not have the opportunity to receive as much activation as its verbal counterpart. The relative size of the priming effects in the N_B groups in this task appears to be in line with these predictions.

Most notably, we find an important difference as compared to Experiment 1: while N_BNouns were significantly facilitated in the earlier task [22.4 ms, $t(1940) = 2.95$, $p=.0032$], response times to these items in the delayed priming experiment were not significantly faster following the related -*ing* form. As was suggested in §4.2.2.1, it seems likely that this difference is due to a facilitatory effect in Experiment 1 from the *appearance* of a morphological relationship – in other words, a morpho-orthographic priming effect. While items that appear to be composed of a stem and a suffix (e.g., *corner*) do indeed speed responses to the apparent stem (e.g., CORN) in visual masked priming tasks, such a relationship does not consistently produce a facilitatory effect in delayed priming (Drews & Zwitserlood 1995). Indeed, the lack of a significant priming effect for N_BNouns, which are of course morpho-phonologically related to their primes, in itself seems to support this suggestion. Furthermore, although the Form condition contained both purely phonologically related pairs in addition to those with a *morpho*-phonological relationship, the *post-hoc* analysis run in §4.2.3.3A, which treated these groups separately, did not reveal a significant effect of either type of related prime. It therefore seems unlikely that differences in the morpho-phonological relationship between the Conversion targets and their primes had a large degree of influence on the pattern of effects illustrated in Figure 4.2.

As for the priming of the V_B target groups, the pattern of effect sizes once

again differs somewhat from that predicted by the '1-step/2-step' account. According to this model, we would expect greater activation – and thus greater priming – of the V_BVerb, as it is the stem to which the *-ing* suffix is directly attached. As the hypothesised base form of the conversion pair, this activation should not be impeded by any additional decomposition. The V_BNoun, on the other hand, though still facilitated due to its morphological relationship with the prime, would be predicted to be activated to a lesser degree than the Verb, as it is an additional derivational step away. In contrast to these predictions, we find in the delayed priming task that the effect size for V_BNouns is not *less* than that of V_BVerbs, but rather slightly more, though not by a statistically-significant margin.

Nevertheless, there are theoretical models which may offer a means of accounting for the similar levels of priming in the two V_B groups, particularly in regards to the contrasting behaviour of the N_B items. Kiparsky's Level-Ordering approach, for example, locates Verb → Noun conversion on a different level of the Lexical Phonology from Noun → Verb conversion (Kiparsky 1982: 140). As discussed in §2.3.3, the results of a number of experimental studies suggest that this kind of distinction in the level at which a morphological process is located may lead to a difference in how items which have undergone that process are analysed during on-line recognition. In these studies, items with Level 1 suffixes, such as *-ity* and *-ion*, appear to be less likely to be treated as being composed of a stem and a suffix, in contrast to items suffixed on other levels. As Kiparsky argues that V → N conversion is also located on Level 1, it is possible that nouns derived in this way may not be processed as though they were morphologically complex. While this may provide some explanation for the apparently similar treatment of V_BVerbs and V_BNouns in processing, it is still not entirely clear why no distinction would be made between the verb stem – to which the *-ing* suffix is ostensibly attached – and the noun stem, which is only indirectly related to the prime. Some additional efforts to account for these results will be explored

in §4.3 below.

Finally, apart from the overall pattern of priming effects, we must address a number of other somewhat unexpected effects which emerged in the Conversion condition. In addition to the significant effect of Prime Type (Related vs. Unrelated), there was also a significant difference in response times according to the word class of the target – i.e., Verb vs. Noun. Overall, participants took far longer to confirm that nouns of the structure 'A NEST' were words than they did for verbs, regardless of what the base form was hypothesised to be. It is not clear precisely why this is; however, comments from some participants after the task suggest that it may be due to the fact that the nouns were only presented with a preceding unstressed vowel (aside from those presented with 'AN'), while the verbs were preceded by the somewhat clearer 'TO'. This may have made it more difficult to distinguish a two-element item like A NEST from a disyllabic nonword – indeed, at least one participant explicitly noted this difficulty. Possibly also related to this issue is the significance of the factor of Base Type, which revealed quicker responses to V_B targets than to N_B ones. Because the target groups differed in their mean lemma frequency (cf. Table 4.8), one might expect responses to be generally slower for the lower frequency groups (N_BVerbs and V_BNouns), and faster for the higher frequency groups (N_BNouns and V_BVerbs). For the V_B items, the mean response times fit this pattern. However, if nouns overall were more difficult to distinguish from nonwords, response times to N_BNouns might more closely resemble those of N_BVerbs, despite the difference in frequency. The combined influence of these elements may thus have resulted in much slower times for N_B items as a whole.

An additional issue concerns the effects found in the analysis of the error rates. While the main effects of Prime Type and Target Class are in line with the response time analysis, the planned comparisons also showed a significant decrease in the number of incorrect responses for both N_B target groups when following a related prime. As N_BVerbs benefitted from the largest degree of facilitation on

response times, it is unsurprising that responses to these targets should also show a significant increase in accuracy. That responses to N_BNouns should also be more accurate is somewhat puzzling. It is possible that this effect is connected to the above-mentioned difficulty of correctly parsing the noun targets when presented auditorily – perhaps this greater difficulty provided more opportunity for the facilitation of accurate responses in the Related condition. The significant effect on the error rates for N_BNouns may thus be a result of the high number of baseline errors. Nevertheless, the presence of this effect supports the idea that the N_BNoun targets are not simply remaining entirely unactivated upon presentation of the related *-ing* prime, but instead are perhaps receiving a partial activation.

Though the significant reduction in incorrect responses to N_BNouns may partially be a baseline effect, the pattern of response time facilitation in this experiment does not appear to be merely a case of baseline differences across the Unrelated prime condition. In contrast to Experiment 1, the mean response time to N_BNouns preceded by an Unrelated prime was similar to – and even numerically slower than – the mean response time to unprimed N_BVerbs. Despite this, responses to N_BNouns were not significantly faster following a related prime, while those to N_BVerbs were. Crucially, significant priming was even found for the group with the fastest baseline responses, the V_BVerbs. The presence of this facilitatory effect suggests that the overall pattern of priming is not only unlikely to be the result of differences in the baselines, but is also most likely not due to a ceiling effect either. In other words, the lack of significant facilitation for N_BNouns is not because responses to these items in the Unrelated condition were already as quick as possible – in fact, all three of the other groups produced shorter average response latencies when following a related prime.

Furthermore, the absence of full priming for the N_BNouns in itself supports the idea that the results of the Conversion condition are also not purely the product of strategic or episodic effects (cf. §2.2.2.1). Some participants did, of course, recognise that some of the items they heard were similar to ones they had

heard before. However, if they had actively been using this knowledge to increase the speed and accuracy of their responses, this strategy should have been equally applied to N_BNouns. It is also unlikely that purely episodic effects have given rise to the particular patterns in this experiment, since all of the groups in the Conversion condition, as well as the stimuli in the Form condition, were designed to have a similar degree of formal overlap between the prime and the target (cf. §4.2.1.2).

Finally, it must be noted that the particular design of this experiment may have proved to be slightly problematic in terms of the amount of useable data produced. Although somewhat higher error rates were expected due to the auditory presentation and the structure of the nonwords, the particularly high number of errors in the Conversion condition, and especially the noun target groups, unfortunately reduced the number of data points which could be included in the analysis. This issue must be kept in mind, both when interpreting the results of Experiments 1 and 2, and in understanding the changes made in the design of Experiment 3 (§5.3 and following). Nevertheless, while the results of Experiment 2 may have raised further questions regarding the processing of conversion pairs, they have also provided the groundwork upon which further experiments providing deeper insight may be built. Potential issues to consider in the creation of these further investigations will be discussed in greater detail below.

4.3 Interim summary: Conversion and morphological priming in lexical decision

With all of the above in mind, we may begin to consider how the experiments described in Chapters 3 and 4 fit into the wider contexts of CONVERSION, and of morphological processing and word recognition in general. The first question concerns a goal specific to the current study: whether and how the perceived 'nouniness' or 'verbiness' of a form affects the processing of the semantically-

related nominal and verbal expressions of that form, and if this might provide any indication of how these forms are represented mentally. Looking only at the results of the masked priming task in Experiment 1, one might suggest that this quality does not have an effect, at least not directly. If, as proposed by Farrell (2001; cf. Teddiman 2012), this intuition is primarily influenced by the relative frequencies with which the forms occur in nominal or verbal functions, then it may be suggested that speaker intuitions are, at best, only indirectly connected to baseline lexical decision times via frequency.[19] However, given the somewhat different pattern of results in the delayed priming task, it seems more likely that the higher level information associated with these perceptions does not become available until later in the recognition process, at some point after the early stage which short-SOA masked priming targets. Other research seems to confirm this interpretation, suggesting that facilitation in masked priming is purely automatic and morpho-orthographic, without any influence from factors such as morphotactic restrictions, or any information which may be connected to the sharing or not sharing of a lexical entry (Morris & Stockall 2012). Thus, as noted in §3.3.4, it does not seem as though the masked priming results can provide much insight into possible differences in complexity across different members of conversion pairs.

Despite this lack of a clear effect in the masked priming task, it seems equally clear from the delayed priming results that we cannot completely dismiss the possible influences of systematic differences between the stimuli in the N_B and V_B groups on how these same items are processed online. I have offered in the discussion above an interpretation of these differences in terms of the presence of an additional layer of morphological complexity in the N_B primes, with an attendant increase in processing difficulty as compared to V_B primes. However, the evidence for this interpretation is not completely unequivocal, as the results of Experiment 2 are also compatible with at least two alternative accounts. These

[19] Cf. the results of Experiment 1 in Table 3.11, as well as §3.3.4.

alternatives will be outlined in further detail in the following section; the implications they may have for the results of Experiment 3 will later be expanded upon in §5.3.2.

4.3.1 Alternative interpretations

As noted above, while there does seem to be some indication that N_B *-ing* forms are treated differently than V_B *-ing* forms in a delayed priming task – particularly as regards their relationship with their corresponding nouns – we cannot yet discern from the data of Experiment 2 alone exactly what information about the stimuli the results might be reflecting. While I have proposed that patterns of priming in this experiment are based on the underlying morphological structure of the primes in speakers' mental lexicons, it is possible that systematic differences in these structures are not, as I have argued, due to the distinction between the derivational processes of Noun → Verb conversion and Verb → Noun conversion as described in example 1.62 (cf. example 1.60). Instead, we return to the discussion of Distributed Morphology in §1.4.3.2 for another potential explanation.

As explained in the brief introduction in that section, this theory assumes that the individual atomic roots which correspond to the lexical concepts expressed in a language (i.e., traditional lexical items) are not inherently marked as members of a particular word class. Rather, as noted, these roots only surface as 'nouns,' 'verbs,' 'adjectives,' etc. when they appear in particular syntactic environments – such as below a little *v* head in the case of verbs (Harley & Noyer 1999: 4). However, the environment in which nouns surface is a matter of contention across the literature, with some researchers assuming a little *n* head roughly analogous to little *v* (Arad 2003; Embick & Marantz 2008; Lowenstamm 2008; Acquaviva 2009; Marantz 2013), and some arguing that there is no need for such a head (Harley 1999; Harley & Noyer 1999; Alexiadou 2001). Under this latter view, an atomic root appears on the surface as a noun when its 'nearest c-commanding [morpheme] is a Determiner.' If it is not somehow contained within some type

of Determiner Phrase (DP), it is not otherwise morphologically marked as a noun. While I have thus far assumed something like a little *n* in my discussion of the possible representations of morphological conversion (cf. example 1.60b), applying the latter understanding to the stimulus groups in Experiment 2 may also offer a means of accounting for its results.

If we reconsider the hypothesised N_B and V_B groups tested here under the assumption that there is no little *n*, we will still find that there is arguably a difference in the underlying morphological structures of the members of one group as compared to the other. However, the relevant distinction here will not be in terms of a difference in the complexity of the two types of prime. Rather, the difference exists in the complexity of the targets – more specifically, that of V_BNouns as opposed to the other three target types. If we assume a representation of Verb → Noun conversion along the lines of example 1.60b, but with DP as the nominal environment rather than little *n*, we may suggest that the four target groups in this experiment have roughly the underlying structures shown below.[20]

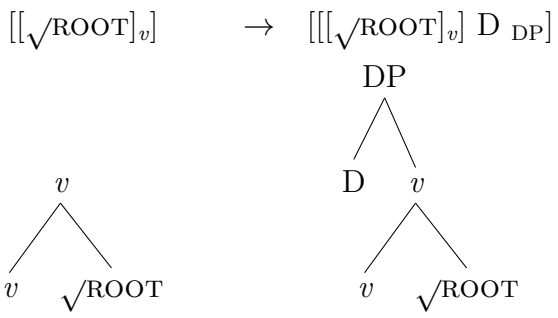
Looking first at the process of Verb → Noun conversion in 4.2a, we see that the change from the use of a nominal or 'little *n*' head to a DP environment for forming nouns does not affect the difference we are concerned with in any substantive way.[21] The derived noun is still formed by building upon the verbalised root, adding another level of structure and thereby increasing complexity. Crucially, both the verb and the noun involved in this process contain some type of verbal element, here represented as little *v*.

[20]For the purposes of this discussion, it is not important where in the linear surface structure the determiner (D) appears, although in English it generally appears prior to the lexical root.

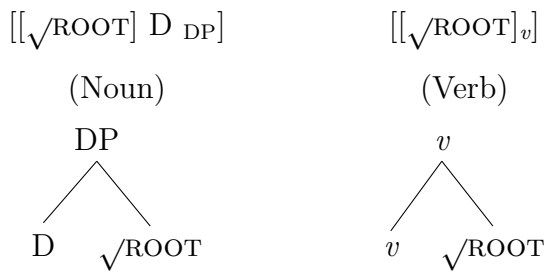
[21]Depending on the theory, both the verb and the noun in 4.2a may arguably contain further structure than that depicted here; however, the crucial point is that the deverbal noun will always contain an additional layer of structure (i.e., the DP) above that of its verbal base. Cf. Alexiadou (2001: 19).

(4.2) *Morphological conversion without little* n:

a. Verb → Noun:



b. 'Noun → Verb':



A somewhat different situation obtains between the N_B forms in 4.2b. Firstly, as suggested above, the otherwise unmarked root of such an item surfaces as a noun only when it appears in a DP environment. However, the corresponding verbal form cannot be created by attaching a little *v* head above this point – as Harley (1999: 83) notes, '...in order to incorporate (in English), the $\sqrt{}$ must be bare, not contained within a DP.' After all, non-phrasal/non-idiomatic verb stems in the language, such as the kind we are concerned with here (e.g., $nest_V$) do not, on their own, contain a determiner. Therefore, the only way for a phonologically identical, semantically related verb to be formed in a way which relates it to its corresponding noun is via root-derivation (cf. §1.4.3.2). Following the *Locality constraint* of Arad (2003: 747; 759) discussed in Chapter 1, the consequence of this restriction to root-derivation is that pairs of forms within the N_B group would not have access to the morpho-syntactic interpretation of their pair partner, as this interpretation only becomes available after the root has already been placed in the syntactic environment.

Under a 'DP' analysis like the one described above, two important points

emerge. The first is that putative N_BVerbs do not contain any underlying structure which encompasses the noun, nor do they (necessarily) involve a more complex structure. Secondly, N_BNouns may be distinguished from all other target groups by their *lack* of little *v*. Given these two points, we are led quite naturally to an explanation of the priming results in Experiment 2 in terms of the sharing (or not sharing) of a little *v* head between prime and target. If we assume, following the discussion in §3.3.1.1, that the *-ing* primes are primarily verbal, then they too must contain little *v*.[22] Upon presentation of these primes, it might then be suggested that there is activation of the interpretation which each particular lexical root has under little *v*, potentially in conjunction with activation of the little *v* element itself. As V_BVerbs, V_BNouns, and N_BVerbs each also contain the same $[[\sqrt{\text{ROOT}}]_v]$ structure as the primes, responses to these items will be facilitated. Responses to N_BNouns, on the other hand, should not be, as they in no way contain or have access to the root within the context of little *v*. This pattern, in which all target types other than N_BNouns are facilitated, is precisely what obtains in Experiment 2. This alternative, which I will refer to as the *DP analysis*, must therefore be borne in mind in attempting to design Experiment 3 in the following chapter, and in the interpretation of its results.

A further alternative which I have thus far not addressed in detail concerns the possible effects of the frequencies of the various targets – more specifically, the surface frequencies of the unaffixed nominal and verbal stems. Because the survey and experiments were concerned with the relative differences between the noun and the verb as unique 'lexical items,' the stimuli were chosen so that the nominal and verbal forms systematically differed in *lemma frequency* (cf. §3.2.2 and 3.3.1.2A). However, as noted in §2.3.3, there is evidence which suggests that derived forms in particular may, depending on the circumstances, elicit effects which correlate with both their lemma frequencies *and* their surface frequencies (Bertram et al. 2000b). Furthermore, due to the patterns found across the rel-

[22]The assumption of the presence of little *v* in *-ing* forms is also in line with several accounts within DM (Marantz 1997; Harley & Noyer 1999; Alexiadou 2001).

ative frequencies of unaffixed and affixed forms of nouns as opposed to verbs in English (Sereno & Jongman 1992 in Sereno & Jongman 1997: 428; cf. §1.3.5), the frequencies of the unaffixed forms in Experiments 1 and 2 also fall into an interesting asymmetrical pattern. Table 4.12 revisits these frequencies, reported in §3.3.1.2A and 4.2.1.2A above.

N_BVerb	N_BNoun	V_BVerb	V_BNoun
0.74	9.46	2.93	3.17

Table 4.12: Conversion condition unaffixed surface frequencies by target group

Because the N_BNouns have a higher lemma frequency than their verbal counterparts, it is not surprising that they should also have a higher unaffixed form surface frequency. However, this difference is further exacerbated by the tendency mentioned above, wherein the unaffixed forms of nouns tend to be proportionally more frequent in relation to their lemma frequencies as a whole than verbs do. In contrast, verbs generally occur *less* often in their unaffixed form. Thus, the N_BNoun stems are significantly more frequent than the N_BVerb stems [$t(19) = 9.32$, $p<.0001$]. The two V_B groups, on the other hand, have much more similar unaffixed form frequencies, due to the combination of the word class pattern just noted and the higher lemma frequency of the verbal form [$t(19) = 0.43$, $p=.6685$].

Based on these patterns – and on the results of several earlier experiments which suggest that higher frequency forms may benefit relatively less from repetition priming (Scarborough et al. 1977; Forster & Davis 1984; cf. §2.3.2.1) – it is reasonable to suggest that the results of Experiment 2 might simply reflect the surface frequencies of the unaffixed forms of each target type. The N_BNouns, having the highest frequency, might therefore be facilitated the least. The next most frequent targets would be the two V_B groups, with roughly equal degrees of facilitation as compared with one another, but somewhat more than N_BNouns. Finally, the low frequency N_BVerbs would benefit the most from prior presentation of a related prime. Although it is not entirely clear whether the effects found in the delayed priming task are due solely, or even primarily, to stem surface

frequency – particularly given the fact that this measure was not a significant predictor of RTs when included as a covariate in the analysis – it is clear that this is also an issue to be aware of in designing the following experiment.

Both of the alternatives presented here may offer further insight into not only the results of the experiments conducted here, but also into the mental representation of conversion pairs generally. As such, each of these threads of reasoning will be taken up again in the following chapter, particularly §5.3.2, in an effort to discern whether one or more of these possibilities might be identified as being more likely than the other(s).

4.3.2 Moving forward: methodological issues

Given the complexity of the matters explored thus far, and the questions raised by the results of the survey and experiments, it will be necessary to note certain methodological issues which have emerged, in order that they may be avoided where possible in conducting further investigations.

The first issue concerns the overall difficulty of Experiment 2, and the subsequent loss of data which accompanied this difficulty. Although the design of the experiment was to a certain extent *intended* to increase the difficulty of the task, in order to compensate for potential baseline differences in the targets (cf. §4.2.1.2D), the real-stem-real-suffix nonwords together with the auditory presentation of Conversion items preceded by 'TO' and 'A/AN' seem to have caused problematic levels of difficulty. As mentioned in §4.2.4, the complications caused by this issue motivated several of the decisions taken in constructing Experiment 3 (cf. §5.3.1).

A further point pertains to an issue which affected the survey, and consequently may have affected both experiments. Recall that in §3.2.2, one of the criteria which a form was required to meet in order to be selected for the survey was that it should be freely allowed to occur with both infinitival 'TO' and 'A/AN.' While this was simultaneously for the purposes of ensuring that the form was part

of a potential conversion pair, as well as being aimed at ensuring the acceptability of presenting the form with the less marked indefinite article (cf. §3.3.1.1, fn. 24), it is possible that this requirement may have systematically excluded forms with certain kinds of semantic and (morpho-)syntactic characteristics. As the relationships between these characteristics and both speaker intuitions and processing may be highly relevant to an investigation of complexity and directionality (cf. §5.2.2), the exclusion of such items may have had important implications for the results of Experiment 1 and 2.[23] The methods used in Survey 2 and Experiment 3 (§5.3.1.1) therefore attempt to correct for this issue.

These considerations, along with the questions raised by the alternative interpretations of the results of Experiment 2 as discussed above, clearly must be addressed in moving forward with the experimental work on conversion pairs, so that any evidence which is revealed by additional tests may be more straightforwardly interpreted with regard to the more subtle, underlying information with which this study is actually concerned.

4.4 Conclusion

The results and discussion presented in this chapter have begun to shed some light on the processing of those conversion pairs which elicit the strongest intuitions regarding the word class to which their unaffixed forms belong. However, as indicated in §4.2.4 and 4.3, we are also left with a number of unanswered questions, and the results obtained in the auditory delayed priming task are not completely unequivocal. Therefore, the work conducted in the following chapters will aim to provide further insight into the answers to these questions, in the hopes of also increasing our understanding of the preceding sets of results.

[23] Cf. also §1.3.1.6 and 6.2.

Chapter 5

Complexity and underspecification in delayed priming: Experiment 3

5.1 Introduction

Following on the investigations of ostensibly directional conversion pairs, we now turn our attention to an exploration of those pairs which are proposed to be non-directional. More precisely, and roughly following the model of Farrell (2001), I will argue that the differences in the linguistic behaviour of such pairs are related to the fact that they are instances of a single *underspecified* lexical item.[1] Recalling the discussion of this model in §1.4.2 and 1.5, the crucial argument is that the shared root of a 'u' pair does not, on its own, have a feature which indicates whether it is a noun or a verb; rather, it may receive either typically nominal *or* verbal inflection, before (potentially) receiving a word class specification in a sentential context. As suggested in example 1.64, I will argue that these apparently 'nominal' and 'verbal' uses are not new lexical items in the way suggested for the outputs of root-derivation (cf. §1.4.3.2 and example 1.63). Instead, following

[1]For the sake of convenience, I will designate these pairs as 'u' throughout this and the following chapter.

Farrell's model – which posits a shared, if partially underspecified, semantic representation – I argue that these forms belong to a single lexical entry. As such, one would make different predictions for the treatment of 'u' pairs as opposed to root-derived pairs during processing (cf. §5.3.2).[2] This distinction, as well as its possible implications, will be explored further in Chapter 6.

In view of this background, the experiment in this chapter may be understood as having two principal aims. The first of these is to explore how the recognition and processing of proposed 'u' pairs might differ from that of hypothesised directional pairs, and to what extent any differences might be attributable to the sharing of an underspecified root. However, in addition to addressing this main objective, the experiment also offers the opportunity to refine some of the methods used in the previous tasks, both in stimulus selection and in experimental design. In doing so, it may be possible to further clarify the particular combination of factors which may have led to the results observed in Experiments 1 and 2. Improving upon these methods, and the questions which they have raised, is therefore an important secondary goal of the research discussed in this chapter.

As in Experiment 1, however, this investigation must also further explore the issues involved in differentiating between pairs which are more likely to involve morphological conversion in one direction or the other from those pairs which suggest underspecification (cf. §3.1). I will thus begin this chapter with a reconsideration of how to operationalise directionality (§5.2), followed by a discussion of the survey employed for this purpose and its accompanying results. The main body of this chapter will then be devoted to the visual delayed priming study conducted on some of the forms from this survey (§5.3). Finally, I will consider the implications of the results of this task, and note some of the questions which still remain (§5.4). These questions will be addressed in further detail in Chapter 6.

[2]As discussed in §1.5, this is not to imply that cases of root-derivation do not exist, but rather that such cases are not the intended focus of this experiment.

5.2 Operationalising directionality: revisited

For the purpose of comparability with the previous experiments, I have once again surveyed the intuitions of native speakers. As previously noted, this survey aims to not only elicit intuitions appropriate to the current investigation, but also to reassess the methods of the previous survey (cf. §3.2.2) and modify them as needed. The methods employed in this survey therefore represent the attempt to balance this need for improvement with the necessity of maintaining comparability with the work undertaken in the earlier chapters.

5.2.1 Motivations

Because Experiment 3 primarily concerns the processing behaviour of potential 'u' pairs, the focus of Survey 2 is on somewhat different patterns of linguistic characteristics, and the effect these characteristics might have on the intuitions of native speakers. But what kinds of intuitions might we expect an underspecified word form to elicit? As discussed throughout §1.3, conversion pairs whose relationship seems to be more symmetrical are often more similar in frequency; have mutually dependent meanings; and have similar ranges of usage both semantically and syntactically. If asymmetries in these attributes (and possibly others) are what gives rise to the relatively strong and consistent speaker intuitions across directional pairs, it would be reasonable to expect these same characteristics to also influence intuitions regarding non-directional pairs. With little to no indication from these patterns of any clear asymmetries, it might therefore be suggested that a putative underspecified form will simply elicit *disagreement* in individual (forced-choice) responses as observed across a group of speakers.

This proposal then raises the question of how and why we might expect such disagreement to manifest. There are at least three primary possibilities. The first of these is that if the lexical entry for a 'u' root does indeed lack a marker of word class, a speaker with such a lexical entry in his or her mental lexicon would then be unsure of how to answer a question like, 'Is this a noun or a verb?' When only

given the two choices of 'Noun' or 'Verb,' they might therefore choose relatively randomly. If many speakers individually make a random selection, it would not be unusual to find that 'Noun' and 'Verb' were each chosen with roughly equal frequency across the group of speakers surveyed – or at least with neither category amassing more than 75% of responses.

Another possibility is that speakers may have felt that a form fell somewhere in between the prototypical 'Noun' and the prototypical 'Verb,' with some characteristics of each.[3] However, the forced-choice design of Survey 1 did not give speakers the option to indicate such an intuition, and their responses may thus have been more or less random in these cases as well.

Finally, there is also a third main possibility which does not involve speaker uncertainty: individual speakers may have been relatively confident in their choice, but may simply have disagreed with other speakers. This inter-speaker disagreement may have been caused by differences in individual linguistic experience, including differences in frequency of use – both their own and that of others around them.[4] Thus, even if a form may lack a consistent 'inherent' specification of word class, individual speakers may each have *different* fully specified entries in their lexicons. In such a scenario, these forms would not strictly be underspecified on the level of the individual, but instead just lack this 'inherent' specification.

It is, of course, entirely possible that disagreement for a particular form might arise from some combination of these; alternatively, each type of disagreement might apply to certain forms, but not others.[5] Unfortunately, the use of forced-choice alone does not allow us to disambiguate between these different situations. The second survey will therefore need to be modified in order to take into account these potential distinctions, particularly in light of the fact that only the former two may be of greatest interest in terms of indicating a underlying lack of word class specification.

[3]Cf. the related discussion on *-ing* forms in Huddleston & Pullum (2002: 77-82) and Bauer et al. (2013: 555).

[4]Cf. Croft (1998) and §6.4.

[5]Cf. §6.4 for further thoughts on this issue.

However, before moving on to a description of this survey and its modifications, it is also necessary to address an issue noted in §4.3.2 above: the limitation of the stimuli to only those forms which were freely allowed to occur with *both* 'TO' and 'A/AN.' While the reasoning behind this requirement remains valid (i.e., the nominal form is less marked in isolation when preceded by the indefinite article as compared to the definite – compare *a smile* vs. *the smile*; cf. Quirk et al. 1972: 154), it is possible that this restriction may have had implications for the types of words which were ultimately tested. For instance, nouns which designate substances (e.g., *butter*) or more abstract concepts (e.g., *dread*) are less likely to be countable and therefore are less likely to be allowed to appear with the indefinite article (Quirk et al. 1985: 247). As it is possible that items from particular meaning groups may elicit particular patterns of speaker intuitions, or may be stored or processed in different ways (cf. §1.3.1), it is preferable to ensure that these meaning groups are also included in the survey.[6]

With these considerations in mind, we now turn to a description of Survey 2, with particular attention paid to the attempts to address the concerns raised in this section.

5.2.2 Survey 2: Method and design

In light of the issues discussed above, several modifications were made to the methods and design of the previous survey. Firstly, the requirement that the nominal form in a pair be freely allowed to occur with *a/an* was lifted, in order to allow for the inclusion of a wider range of meanings, as noted above. The requirements for nominals were therefore expanded to include those forms which may appear following *the*, in addition to those with *a* or *an*.[7]

The second substantive change to the requirements for inclusion in the surveys concerns the relative frequencies of the forms in question. Though the earlier

[6] Cf. also §1.3.1.6 and §6.2.1.2.

[7] However, as noted below, several items which did not fulfill this requirement (e.g., *golf*) were nevertheless inadvertently included in the surveys, though not in the experimental task.

survey was restricted to those pairs which had a particular pattern of relative nominal and verbal frequencies (cf. §3.2.2), in view of the possible relationship between these relative frequencies and apparent (non-)directionality (cf. §1.3.5), it was necessary to include a range of different frequency patterns – particularly given the apparent rarity of forms which are intuitively felt to be less clearly nominal or verbal (see below). Furthermore, the inclusion of a wider range of frequencies was also motivated by the need to facilitate the matching of particular stimulus groups on word frequency (discussed further in §5.3.1.2A).[8] All other formal requirements for inclusion remained the same as in Survey 1.

These criteria resulted in group of 209 unaffixed monosyllabic forms, which were roughly pre-categorised into four groups according to my own intuitions. One of these groups consisted of forms that were judged to be 'Noun Base,' and a second of hypothesised 'Verb Base' forms.[9] The other two groups comprised forms which did not fall into either of the two 'directional' groups. These forms were then further subdivided according to which form was tagged in CELEX as 'M' (monomorphemic; cf. §3.2.2), thus resulting in a preliminary 'uN_B' group for those forms with M-tagged nouns, and a 'uV_B' group for M-tagged verbs.[10] In general, fewer forms seemed to fall into these latter two groups, particularly the uN_B set; however, this latter pattern is likely due to the default tagging in CELEX of zero-related verbs as 'M,' and their nominal counterparts as 'Z.'

These 209 forms were divided into two survey groups (Survey 2.1 and Survey 2.2), with each of the four pre-category groups divided evenly where possible. Within each survey group, words were further evenly divided into two sub-groups, A and B, each of which was assigned one of *two* rating types for different versions of the survey.

These two rating types consisted of either a forced-choice (two options, Noun or Verb), or a 7-point scale (from Noun to Verb or Verb to Noun, counterbal-

[8] Cf. §4.3.1.

[9] While some forms included in the previous survey were also included in Survey 2, forms which were used in the experiments were not.

[10] Cf. §5.3.1.1 and 5.3.1.2A.

anced across survey version). For those items rated using the scale, respondents were also asked to rate how confident they felt about their choice – 'Not at all,' 'Average,' or 'Very.' The reasoning behind using both forced-choice and scalar responses (with confidence ratings) follows from the discussion in §5.2.1 above, and is intended to both allow for the kind(s) of intuitions which underspecified forms might elicit, as well as to help disentangle potentially different types of disagreement from one another. As will be further discussed in §5.2.3, this design may also help to ensure that the responses to proposed 'u' items which are ultimately selected for the experiment were, to a certain extent, consistent.

Thus, using these two rating types, the first version of the survey for each survey group (i.e., 2.1A or 2.2A) asked respondents to rate the words in group A via forced-choice, and the words in group B via the scale. The second version of each survey (e.g., Survey 2.1B and 2.2B) then presented each of these groups with the opposite rating type. Respondents were allowed to respond to only one version of each survey – as Survey 2.1 and 2.2 involved different items, respondents were permitted to fill out one version of each of these if they chose to do so.

Due to the fairly large number of items in each survey (105 in Survey 2.1 and 104 in Survey 2.2), each rating type group was further subdivided into separate survey pages. The forced-choice section was divided into three pages of 12-20 items each. As respondents to pilot versions of the survey commented that the scalar rating section was easier to read with fewer items per page, this section was divided into five pages of 10-11 items each. Each version of the survey thus had a total of eight pages of items. Due to differences in the number of items available from each pre-category group, there were somewhat unequal numbers of each pre-category group among the items on a single page; however, each of the pages had roughly the same number of items from any one pre-category group as the other pages. The particular set of items on a single page was psuedorandomised to avoid placing two forms which were semantically related on the same page, as well as to avoid too many phonologically similar forms on a single page. Each

of the pages was then individually randomised by the survey software, with a different within-page order presented to each participant.

As in the previous survey, respondents were asked to choose whether each item was a noun or a verb. For the scalar responses, they were also asked to mark how confident they were in their choice.[11] The survey was administered online via the SurveyMonkey interface (www.surveymonkey.com). There were 159 respondents in total: 36 for Survey 2.1A, 32 for Survey 2.1B, 30 for Survey 2.2A, and 61 for Survey 2.2B. All respondents were self-reported native speakers of various dialects of English.

5.2.3 Survey 2: Results

Although there were 159 respondents, only 117 of these completed the entire survey. However, data for participants who did not complete the survey was nevertheless initially included, in order to include as many ratings for each form as possible.

Using the comment box at the end of the survey, a number of respondents reported both 'category contagiousness' (i.e., ratings influenced by other nearby items), as well as making judgments based on subjective frequency of use estimates. Confidence ratings were not particularly useful, as respondents primarily provided the same rating for all items (usually 'Average'). These ratings were therefore not included in further analysis. Several responses were clear mistakes – e.g., respondents either ticked 'Noun' or 'Very' (rather than 'Verb') in the scalar ratings, or ticked two scale ratings but no confidence rating. These responses were therefore removed.

Although the vast majority of the respondents gave a wide variety of ratings,

[11] Although the instructions of both this survey and the previous one were deliberately left vague as to what was meant by 'Noun' and 'Verb' in order to avoid biasing towards selecting only person/place/thing meanings for 'Noun,' action/state of being meanings for 'Verb,' in retrospect it is likely that respondents used such definitions anyway, as these are the definitions of these categories which they will have likely learned in school. Nevertheless, it is worth noting that speaker responses did not always correlate with the relative word class prototypicality of a form's meaning (cf. §5.2.3).

several of them primarily (or only) chose a particular point on the scale or one forced-choice category for all or most items. These respondents seemed to be unusual in this respect; however, in order to confirm this intuition, the mean number of times (as a percentage of total number of item ratings) that a respondent provided the same answer for multiple items in the survey was computed, as well as two standard deviations from this mean. These means and standard deviations were calculated separately for each rating type (i.e., forced-choice vs. scale).[12]

For the forced-choice data, several respondents fell outside two standard deviations (Survey 2.1A Mean: 50%; 2SD: 74.4%; Survey 2.1B Mean: 50%; 2SD: 80.4%; Survey 2.2A Mean: 50%; 2SD: 73.0%; Survey 2.2B Mean: 50%; 2SD: 74.6%;). The forced-choice ratings of these respondents were therefore also excluded from further analysis. For the scalar data, the two standard deviations measurement was rather low, with any respondent who provided the same rating for more than ~45% of their scalar responses falling outside of this range. This measurement was judged to be too strict of a cutoff point for exclusion, as it may have introduced a bias against respondents who only used two points on the scale (generally the endpoints, but occasionally more central points as well), and who may have had more categorical intuitions. In order to avoid this, a more conservative (but fairly arbitrary) cutoff point was chosen: if a respondent selected the same rating for more than 60% of their scalar responses, their scalar ratings were excluded from further analysis. The final analyses were conducted on data from 151 different speakers.

Scalar ratings were first normalised by converting them to z-score ratings calculated by respondents. In this way, some of the usual biases in individual participant responses to scalar data – such as avoiding extreme responses (e.g., points 1 and 7), or only using part of the scale – may be minimised (Schütze

[12]These statistics were also calculated separately for each survey, as the different items in each survey group likely had an effect on the overall number of times a particular rating was given.

& Sprouse 2013: 33-34). Each respondent's *z*-score for each form rated by that respondent was calculated by determining the mean and standard deviation across all of the respondent's scalar ratings. The raw 1-7 rating given by the respondent for each word was then subtracted from this mean, and the resulting difference divided by the respondent's standard deviation. As succinctly summarised by Schütze & Sprouse (2013: 43),

> The resulting set of responses (z-scores) represents a *standardized* form of P[articipant]'s responses, as each response is expressed in standard deviation units from P's mean.
>
> (emphasis in original)

Thus, any ratings closer to the mean or middle will have *z*-scores closer to 0. Non-zero scores will then represent how many standard deviations from the mean a particular rating is, with negative scores less than the mean, and positive ones greater.

For each word, *z*-scores were then averaged across participants. In the case of this set of surveys, more negative *z*-scores represent ratings closer to the 'Verb' end of the scale, and more positive scores closer to the 'Noun' end. Forced-choice ratings were calculated as in Survey 1 (cf. §3.2.3), with percentages representing the proportion of respondents (out of the total number of forced-choice ratings for that item) who chose 'Verb' (%Verb) or 'Noun' (%Noun). The results of the survey, with both (mean) scalar and forced-choice ratings, are summarised in Tables 5.1-5.3 below.[13]

As expected, there was a wide range of levels of agreement, with scalar *z* scores ranging from 1.55 (*boat*) to -1.28 (*coo*), and a slightly verb-skewed mean of -0.000464. The distribution of forced-choice ratings was similar, with items from the entire range of 0 (e.g., *dig*) to 100% (e.g., *cup*) 'Noun' responses, and again a slightly verb-skewed mean of 43.8% 'Noun.' Over half of all forms had *z*-scores roughly in the middle, between -0.5 and 0.5. In contrast, only a quarter of

[13]As ratings often varied depending on whether they were scalar or forced-choice, the table is simply organised alphabetically. Higher percentages appear in bold.

Item	*z*-score	%Verb	%Noun	Item	*z*-score	%Verb	%Noun
ache	0.08	**60.71%**	39.29%	*plague*	0.89	4.26%	**95.74%**
aid	-0.12	**74.07%**	25.93%	*plan*	0.42	**57.89%**	42.11%
aim	-0.75	**96.88%**	3.13%	*pledge*	-0.24	**61.70%**	38.30%
ape	1.47	5.26%	**94.74%**	*plot*	0.42	28.57%	**71.43%**
arc	0.90	0%	**100%**	*pulp*	0.88	15.79%	**84.21%**
bait	0.66	22.22%	**77.78%**	*pump*	0.31	**66.67%**	33.33%
belch	-0.71	**87.50%**	12.5%	*purr*	-0.71	**89.47%**	10.53%
bend	-0.40	**80.85%**	19.15%	*quest*	1.19	6.38%	**93.62%**
bet	-0.06	**67.86%**	32.14%	*quip*	-0.29	37.50%	**62.50%**
blame	-0.40	**68.42%**	31.58%	*quote*	-0.31	42.86%	**57.14%**
bleach	0.56	10.71%	**89.29%**	*rage*	0.56	36.17%	**63.83%**
bleat	-0.95	**90.63%**	9.38%	*raid*	0.02	**53.19%**	46.81%
bloom	-0.36	**89.29%**	10.71%	*rain*	0.52	32.14%	**67.86%**
bluff	-0.25	**51.06%**	48.94%	*reign*	-0.24	**60.71%**	39.39%
boat	1.56	0%	**100%**	*ride*	-0.48	**78.95%**	21.05%
boost	-0.34	**77.78%**	22.22%	*rip*	-0.62	**90.63%**	9.38%
brawl	0.11	23.40%	**76.60%**	*roost*	-0.41	**61.70%**	38.30%
bruise	0.96	11.11%	**88.89%**	*rub*	-0.93	**96.43%**	3.57%
bump	-0.10	**53.19%**	46.81%	*scan*	-0.82	**96.30%**	3.70%
burp	-0.41	**92.59%**	7.41%	*scar*	1.12	0%	**100%**
camp	0.087	21.05%	**78.95%**	*scare*	-0.66	**85.71%**	14.29%
catch	-0.94	**91.49%**	8.51%	*scoop*	-0.17	**61.70%**	38.30%
cause	0.16	**52.63%**	47.37%	*scorn*	-0.01	**54.17%**	45.83%
chain	1.13	9.38%	**90.63%**	*scowl*	-0.06	**78.95%**	21.05%
chart	0.92	10.71%	**89.29%**	*scrape*	-0.51	**85.71%**	14.29%
chat	-0.52	**93.75%**	6.25%	*scrawl*	-0.09	**78.72%**	21.28%
cheer	-0.41	**82.98%**	17.02%	*scream*	-0.35	**73.68%**	26.32%
chirp	-0.61	**82.98%**	17.02%	*sense*	0.16	**53.57%**	46.43%
claim	-0.19	**61.70%**	38.30%	*shave*	-0.86	**100%**	0%
clash	-0.19	**68.42%**	31.58%	*shred*	-0.68	**89.47%**	10.53%
clasp	-0.01	**65.63%**	34.38%	*shriek*	-0.25	**73.68%**	26.32%
click	-0.09	**74.07%**	25.93%	*shroud*	0.96	31.58%	**68.42%**
climb	-1.01	**93.62%**	6.38%	*sip*	-0.47	**84.21%**	15.79%
cloud	1.31	2.13%	**97.87%**	*sketch*	-0.02	**64.29%**	35.71%
clump	0.58	12.50%	**87.50%**	*slant*	0.49	31.91%	**68.09%**
coo	-1.28	**91.67%**	8.33%	*sleep*	-0.61	**89.29%**	10.71%
cook	-0.31	**89.29%**	10.71%	*slice*	0.01	41.67%	**58.33%**
cough	-0.33	**82.14%**	17.86%	*slit*	0.45	46.81%	**53.19%**
cramp	0.73	37.50%	**62.50%**	*slog*	-0.44	**85.71%**	14.29%
crash	-0.12	**64.29%**	35.71%	*smell*	-0.10	**59.57%**	40.43%
crease	0.39	28.57%	**71.43%**	*smile*	-0.16	**59.57%**	40.43%
croak	-0.54	**89.36%**	10.64%	*smirk*	-0.11	**75.00%**	25.00%
cup	1.12	0%	100%	*smudge*	0.06	37.50%	**62.50%**
curl	-0.05	**71.43%**	28.57%	*snag*	-0.25	**61.70%**	38.30%
curse	-0.01	**59.57%**	40.43%	*snare*	0.02	**51.06%**	48.94%

Table 5.1: Native speaker word class ratings for Survey 2 (part 1)

Item	*z*-score	%Verb	%Noun	Item	*z*-score	%Verb	%Noun
dawn	0.78	0%	**100%**	*sneak*	-0.96	**100%**	0%
dig	-1.05	**100%**	0%	*sneer*	-0.35	**82.98%**	17.02%
drain	0.21	27.66%	**72.34%**	*sneeze*	-0.33	**82.14%**	17.86%
drape	-0.41	**68.42%**	31.58%	*snip*	-0.82	**94.74%**	5.26%
dread	-0.30	**63.16%**	36.84%	*snore*	-0.94	**92.86%**	7.14%
dream	0.36	50.00%	50.00%	*snow*	0.56	17.86%	**82.14%**
feint	-0.23	**67.86%**	32.14%	*spill*	-0.44	**87.23%**	12.77%
film	0.69	12.50%	**87.50%**	*sponge*	0.92	0%	**100%**
fizz	-0.46	**68.42%**	31.58%	*sprawl*	-0.67	**89.47%**	10.53%
flare	0.45	36.84%	**63.16%**	*spray*	-0.58	**73.68%**	26.32%
foam	0.89	10.71%	**89.29%**	*spy*	0.19	50.00%	50.00%
force	-0.25	**78.13%**	21.88%	*squawk*	-0.51	**71.43%**	28.57%
freeze	-1.17	**93.62%**	6.38%	*squeak*	-0.52	**74.07%**	25.93%
froth	0.17	26.32%	**73.68%**	*squeeze*	-0.92	**100%**	0%
fund	-0.10	50.00%	50.00%	*starch*	0.74	4.17%	**95.85%**
gain	-0.68	**78.95%**	21.05%	*stay*	-0.89	**100%**	0%
gauge	-0.36	**60.71%**	39.29%	*steam*	0.65	17.02%	**82.98%**
gaze	-0.78	**85.19%**	14.81%	*step*	0.19	31.58%	**68.42%**
glimpse	0.26	**63.16%**	36.84%	*stray*	-0.56	**74.47%**	25.53%
glue	0.83	3.70%	**96.30%**	*stream*	1.04	0%	**100%**
golf	1.16	11.11%	**88.89%**	*stretch*	-0.93	**100%**	0%
grasp	-0.39	**84.21%**	15.79%	*string*	1.42	4.26%	**95.74%**
grease	0.60	10.64%	**89.36%**	*style*	0.94	7.14%	**92.86%**
grin	-0.10	**57.89%**	42.11%	*sulk*	-1.07	**97.87%**	2.13%
growl	-0.41	**82.14%**	17.86%	*sun*	1.45	0%	**100%**
guard	-0.01	**55.32%**	44.68%	*surge*	-0.26	**63.16%**	36.84%
guide	0.22	**59.26%**	40.74%	*swap*	-0.81	**94.74%**	5.26%
hate	-0.84	**92.86%**	7.14%	*swig*	-0.38	**63.16%**	36.84%
hoist	-0.91	**93.75%**	6.25%	*talk*	-0.62	**96.43%**	3.57%
hold	-0.60	**94.74%**	5.26%	*tar*	1.23	3.57%	**96.43%**
hoot	-0.08	**71.43%**	28.57%	*taste*	-0.17	**89.47%**	10.53%
host	0.58	21.05%	**78.95%**	*test*	0.51	27.66%	**72.34%**
hug	0.16	40.43%	**59.57%**	*thaw*	-0.97	**100%**	0%
hush	-0.26	**75.00%**	25.00%	*thread*	0.61	12.50%	**87.50%**
inch	0.90	0%	**100%**	*thrill*	0.42	42.86%	**57.14%**
jig	0.33	33.33%	**66.67%**	*throw*	-1.00	**100%**	0%
jolt	-0.03	**53.19%**	46.81%	*thud*	1.22	31.58%	**68.42%**
judge	0.15	**57.89%**	42.11%	*thumb*	1.53	0%	**100%**
kill	-1.00	**100%**	0%	*tint*	0.27	43.75%	**56.25%**
kiss	-0.22	**65.96%**	34.04%	*trade*	-0.10	**77.78%**	22.22%
knight	1.13	3.13%	**96.88%**	*trap*	0.20	23.40%	**76.60%**
latch	0.77	21.43%	**78.57%**	*trick*	-0.07	45.83%	**54.17%**
lease	0.18	37.50%	**62.50%**	*tweak*	-0.98	**95.74%**	4.26%
leer	-0.83	**100%**	0%	*twirl*	-0.87	**94.74%**	5.26%
lock	0.18	42.11%	**57.89%**	*twitch*	-0.55	**84.21%**	15.79%

Table 5.2: Native speaker word class ratings for Survey 2 (part 2)

Item	*z*-score	%Verb	%Noun	Item	*z*-score	%Verb	%Noun
loot	0.18	47.37%	**52.63%**	*urge*	-0.35	**63.83%**	36.17%
lounge	0.20	27.66%	**72.34%**	*view*	0.36	25.53%	**74.47%**
lull	0.18	44.44%	**55.56%**	*wail*	-0.41	**74.47%**	25.53%
map	1.10	0%	**100%**	*wait*	-0.98	**95.83%**	4.17%
mist	1.38	4.26%	**95.74%**	*wheel*	1.39	3.57%	**96.43%**
mix	-0.33	**96.43%**	3.57%	*whine*	-0.65	**100%**	0%
mob	1.05	7.14%	**92.86%**	*whirr*	-0.35	**68.42%**	31.58%
move	-0.87	**97.87%**	2.13%	*win*	-0.82	**96.43%**	3.57%
nap	0.79	34.04%	**65.96%**	*wish*	0.06	**75.00%**	25.00%
need	-0.35	**89.29%**	10.71%	*work*	-0.26	**74.07%**	25.93%
nose	1.44	2.13%	**97.87%**	*wreck*	0.28	40.74%	**59.26%**
note	0.80	14.29%	**85.71%**	*yawn*	-0.40	**85.71%**	14.29%
nudge	-0.62	**100%**	0%	*yelp*	-0.32	**68.42%**	31.58%
paste	0.29	**51.06%**	48.94%	*yoke*	0.91	7.41%	**92.59%**
pile	0.87	5.26%	**94.74%**	–	–	–	–

Table 5.3: Native speaker word class ratings for Survey 2 (part 3)

items elicited forced-choice ratings in which neither 'Noun' nor 'Verb' was chosen more than 65% of the time.[14] Overall, responses were also generally in line with pre-category groupings. Further methods for choosing stimuli from the group of forms in the tables above will be detailed in §5.3.1.2A.

5.3 Experiment 3: Visual delayed priming

As in Experiment 2, this chapter reports on the results of a delayed priming lexical decision task, in an effort to observe effects of deeper morphological processing – at least as compared to masked priming – while simultaneously filtering out the influences of semantic and purely phonological/orthographic relatedness as far as possible. However, given the amount of data lost in the previous experiment (as discussed in §4.2.4 and 4.3.2), it was decided that a visual rather than an auditory presentation mode would be preferable in terms of maximising the amount of useable data. This visual delayed priming design has the added benefit of allowing us to compare processing effects *within the same task* across the different modal-

[14]Cf. §5.3.1.2A.

ities. As noted by Marslen-Wilson et al. (1994: 4; cf. §2.2.1.4), an intramodal task may potentially only reveal lower level effects of a form's *access representation*, rather than its modality-independent lexical representation. Investigating the processing of similar forms in two different modalities may therefore provide some insight into this higher level representation.

Additionally, the use of the same task offers the opportunity to build upon the results of the previous experiment, and to disentangle some of the issues mentioned in §4.2.4 and 4.3. One of the ways in which this will be accomplished is through comparing and contrasting the processing of nouns which seem to belong to directional pairs with that of nouns which appear to be forms of underspecified roots. This focus on nominal targets is motivated by several considerations, the first of which is methodological: by limiting the test targets to forms from the same word class, it will be easier to match stimuli across target groups on a number of parameters of interest. This matching is particularly relevant given the possible influence of unaffixed surface frequency in Experiment 2. Furthermore, under either of the two structurally-based interpretations offered for the results of the previous task ('1-step/2-step' and the 'DP analysis'), if *-ing* forms are used as primes, verb targets should be facilitated regardless of their particular relationship to the noun. The earlier fMRI studies on underlying complexity (Meinzer et al. 2009; Pliatsikas et al. 2014) also support this understanding. Noun targets, on the other hand, seemed to exhibit different behaviour according to whether speakers felt that the form more likely represented a noun or not – though, as suggested in §4.3.1, it is not yet clear what information is truly reflected in either speakers' intuitions or this processing behaviour. Therefore, if the relevant characteristics of nominal targets are appropriately manipulated based on the three primary interpretations of the results of Experiment 2, then we may be able to increase our understanding of not only potential 'u' pairs, but also of what sorts of processing mechanisms and contributing factors may have been at work during the previous experiment.

5.3.1 Method

5.3.1.1 Design

This experiment contained four groups of Conversion items, all of which used monosyllabic nouns as targets. These conditions were: N_BNouns, 'underspecified' N_BNouns (uN_BNouns), V_BNouns, and 'underspecified' uV_BNouns.[15] Due to the difficulty in finding certain types of these items (cf. §5.2.1), there were only 16 targets in each condition, half of which were presented following 'A/AN' and the other half following 'THE.' Each target had a corresponding related disyllabic *-ing* prime and a matched, unrelated *-ing* prime, both of which were stress-initial. Presentation of primes and targets was divided and counterbalanced across two experimental lists, so that there were equal numbers of 'A/AN' and 'THE' targets from each condition, with half of them presented following a related prime, and the other half following an unrelated prime. These targets then appeared with their corresponding prime of the opposite type in the second list. Table 5.4 illustrates the makeup of *each* of these four conditions in each list.

16 noun targets per list per condition

Prime Type	8 with related prime		8 with unrelated prime	
Particle	4 'A/AN'	4 'THE'	4 'A/AN'	4 'THE'

Table 5.4: Makeup of Conversion conditions in each list

All four of the conditions were presented in each list, for a total of 64 real word noun targets (32 'A/AN' and 32 'THE') and 64 real word *-ing* primes.

In order to prevent participants from attaching any special importance to these nouns which might affect their responses, both lists included filler pairs comprised of monosyllabic verb targets (following 'TO') and adjective targets, paired with disyllabic, suffixed primes. In line with the Conversion conditions, there were 64 verb targets and 64 adjective targets. Each verb target was paired with one stress-initial, disyllabic prime composed of a free stem plus the inflectional suffix

[15]For the method used to select words for each of these conditions, see §5.2 and §5.3.1.2A below.

-ed. Half of the verbs were paired with a related *-ed* prime (e.g., *pleaded* – TO PLEAD), while half were paired with an unrelated *-ed* prime (e.g., *traded* – TO SMOKE). The adjective targets were not preceded by a particle. Each target was paired with a stress-initial, disyllabic prime composed of a free stem plus the comparative suffix *-er*. All *-er* primes represented the comparative forms of adjectives, rather than containing the nominalising suffix *-er* (e.g., *walker*). As with the verb fillers, half of the monosyllabic adjective targets were paired with a related *-er* prime (e.g., *cuter* – CUTE) and half with an unrelated *-er* prime (e.g., *richer* – SPRY). Each filler target was only paired with one prime, and thus did not vary in prime-target relatedness across lists. The same 128 filler pairs (64 verb pairs and 64 adjective pairs) were presented in both lists. These filler pairs, along with the pairs from the Conversion conditions, resulted in 192 monosyllabic words and 192 disyllabic words in each list.

To balance out the real word stimuli, 384 nonwords were also constructed, 192 of which were disyllabic and stress-initial, and 192 of which were monosyllabic. The structure of the nonwords was matched to that of the real words (cf. §5.3.1.2C). Half of the nonword targets had related primes, while the other half had unrelated primes. All 384 nonwords were included in both lists, for a total of 768 items in each list. The total proportion of related items in each list was 50%.

Prime-target pairs, both words (including fillers) and nonwords, were arranged so that there were 5-7 items intervening between the prime and the target. No additional stimuli were added in order to contribute intervening items, but instead these items were members of one of the prime-target pairs described above. The order of items in the list was then pseudorandomised according to the following criteria:

(1) No more than five consecutive word or nonword trials were allowed.

(2) No items (other than the related prime) which were related in meaning or began with the same letter as a test target were allowed within the ten trials preceding that target.

Aside from changes in the prime type (Related or Unrelated) of the Conversion conditions, the overall order of items remained the same across the four lists. Each complete list of 768 items was divided into three blocks of 256 items each.

5.3.1.2 Stimuli

(A) Conversion pairs Stimuli for these conditions were chosen based on the proportionate forced-choice ratings and the mean z-score responses across participants. As in Experiment 1 (§3.3.1.2A), items were only considered for the directional categories if more than 75% of respondents agreed with one forced-choice category. Items for the 'u' groups were restricted to those forms which elicited less than 65% agreement. These ratings were then combined with the *z*-scores, so that those forms for which ≥75% of forced-choice responses were 'Verb' *and* their mean *z*-score was <-0.5 were labelled V_B, while those forms with the opposite ratings were labelled N_B. Any items which elicited less than 65% agreement in the forced-choice task, along with a mean *z*-score between -0.5 and 0.5 were labelled as 'u.' This group was then further subdivided according to its CELEX tagged 'base' for the purposes of matching with a corresponding directional category (see Table 5.5 below). As only 16 items were revealed to be uN_B under this method, each of the other categories was also limited to 16 items, chosen on the basis of how well they matched in terms of frequency, length, etc. with an item from their directionality counterpart (see below).

The final 64 target forms were initially assigned to be presented with either 'A/AN' or 'TO' on the basis of their grammaticality with each of the particles (e.g., **a loot*). The acceptability of those forms judged to be grammatical with both particles was then assessed in consultation with several native speakers. Those which sounded the least marked with 'THE' were therefore chosen to be presented

with this particle.

For each *-ing* prime-noun target pair, an unrelated prime ending in *-ing* was also chosen. Each unrelated prime was matched to its corresponding related prime in number of syllables, number of letters, stress pattern and surface frequency (calculated as in the previous experiments; cf. §3.3.1.2A).

As for the related prime-target pairs, due to the different types of frequency patterns found in pairs rated 'Noun' as compared to those rated 'Verb,' it was not possible to ensure that frequencies were matched across all four target groups. Instead, following the suggestion that the surface frequency of the target might have had an influence on the size of the priming effect (cf. §4.3.1), the 'directional' targets in this experiment were matched listwise to those of their corresponding 'u' group primarily on the basis of their surface frequency (e.g., N_BNouns were matched to uN_BNouns, and V_BNouns to uV_BNouns). The groups were also matched in this manner on the dimensions of target length (in number of letters) and lemma frequency; prime length; and the amount of orthographic overlap between the prime and the target. Surface and lemma frequencies were calculated as in Experiment 1 (§3.3.1.2A), as was Prime-Target Overlap (following Rastle et al. 2000: 521-22). Because this experiment compared responses across unrelated groups of targets, the mean number of morphological family members and their frequencies were also calculated for each of the four groups. The size of the morphological family was determined by counting the number of separately tagged lemmas in CELEX which contained the same 'root' as the stem (e.g., for *lock*: *lockable*, *unlock*, *locksmith*, etc.). Noun and Verb lemmas were counted separately, and compounds were also included (e.g., *lockjaw*).[16] Morphological family frequency was then calculated by summing the lemma frequencies of each of these morphological family members.

The mean lengths and frequencies of the targets and primes in this condition, along with the mean number of morphological family members and their combined

[16]An item was considered a compound if its orthographic representation either had no separation between component morphemes (e.g., *lockout*) or contained a hyphen (e.g., *lock-up*).

frequency, are summarised in the table below. The p values reported in the table reflect the probability that a directional group and its non-directional counterpart differ on a particular measure, as analysed by a two-tailed pooled t-test.

Stimulus Characteristic	N_BNoun	uN_BNoun	p	V_BNoun	uV_BNoun	p
Target Letters	4.69	4.63	0.8420	4.56	4.44	0.6818
Target Surface Freq.	15.17	12.58	0.7106	4.12	4.01	0.9368
Target Lemma Freq.	19.81	21.04	0.9128	5.84	5.86	0.9922
Prime-Target Overlap	0.77	0.78	0.7976	0.75	0.73	0.3992
Prime Letters	7.63	7.50	0.6291	7.56	7.25	0.2487
Prime Surface Freq.	1.39	8.00	0.2566	9.06	2.67	**0.026***
Prime Lemma Freq.	4.64	20.30	0.1501	55.38	10.03	**0.0405***
Family frequency	27.23	48.60	0.3305	66.03	17.80	**0.0398***
Family size	7.63	7.56	0.9788	5.56	5.00	0.6622

Table 5.5: Conversion condition stimulus characteristics by target group

Although matching the mean morphological family size of each group was not one of the primary goals, it is useful that they are similar to one another on this measure, as it has been found that this factor may affect recognition (Pylkkänen et al. 2004). However, as mentioned above and elsewhere (cf. §6.2.3), pairs which are strongly rated as 'Verb' tend to occur more frequently in their verbal form. As the primary concern in this task was to match the frequencies of the targets, it was not possible to also match the frequencies of the (verbal) primes across the V_B and uV_B groups, nor, as a result of this, the mean morphological family frequency. However, two points regarding the implications of this difference should be noted. Firstly, the results of Experiment 2 (§4.2.3) suggest that the frequency of the prime did not play a particularly large role in determining the size of the delayed priming effect. Secondly, the difference reported here, with V_BNouns having a more frequent prime and more frequent family members, would lead us to predict a different pattern than that of both our structural predictions (§5.3.2.1) and our

results (§5.3.3). This issue will be addressed in further detail in these sections below (see also §5.3.2.2).

(B) Fillers As noted above, the filler targets were either monosyllabic verbs preceded by 'TO,' or monosyllabic adjectives, chosen so that they were matched listwise as closely as possible to the Conversion items on number of letters and surface frequency. Each of the verb targets was paired with a stress-initial, disyllabic verb ending in the verbal suffix *-ed*, and each of the adjectives was paired with a stress-initial, disyllabic comparative adjective ending in *-er*. Related primes were the past tense forms of the targets for verbs (e.g., *roasted* – TO ROAST) and the comparative form for adjectives (e.g., *fresher* – FRESH). Unrelated primes in both groups were neither orthographically nor semantically related to their targets. Because both the *-ed* and *-er* suffixes are one letter shorter than *-ing*, the filler primes were systematically shorter in length than the primes in the Conversion condition; however, they were similar in surface frequency. These shorter suffixes, along with the fact that targets ending with the grapheme *-e* typically preserve this character when suffixed in *-ed* or *-er* (e.g., *shade* vs. *shaded*; *cute* vs. *cuter*), as opposed to forms suffixed with *-ing* (e.g. *paste* vs. *pasting*), led to an overall greater degree of prime-target overlap among related fillers (cf. §5.3.1.3). The table below summarises the mean lengths and frequencies of the filler primes and targets, along with the mean degree of orthographic overlap for the related pairs (half of the total number of filler pairs).

Stimulus Characteristic	Verbs	Adjectives
Target Letters	4.67	4.53
Target Surface Freq.	9.12	17.53
Target Lemma Freq.	30.59	19.10
Prime-Target Overlap	0.85	0.86
Prime Letters	6.55	6.25
Prime Surface Freq.	5.43	4.96
Prime Lemma Freq.	13.44	91.52

Table 5.6: Filler characteristics

(C) Nonwords The 192 monosyllabic nonword targets were either taken from the previous experiments or were created by modifying items produced by the ARC Nonword Database (Rastle et al. 2002) so that they were orthographically and phonologically legal and pronounceable according to the rules of English. To mirror the words in the experiment, 32 of these nonwords were preceded by 'A/AN,' 32 were preceded by 'THE,' 64 were preceded by 'TO,' and 64 were presented in isolation like the adjectives. These items were matched listwise to the words in number of letters (cf. §5.3.1.3).

Each of the monosyllabic nonwords was paired with a stress-initial, disyllabic nonword. As there was some concern about the level of difficulty induced by the inclusion in the previous task of nonwords with real stems and real suffixes (§4.3.2), the disyllabic nonwords in Experiment 3 were instead composed of a nonword stem and an existing suffix (e.g., **gorbing*), and were matched listwise to the prime words in number of letters. Like the disyllabic words, 64 of these suffixed nonword ended in *-ing* and were paired with the 'noun' nonwords preceded by 'A/AN' or 'THE', while the 64 nonwords ending in *-ed* were paired with the 'verb' nonwords preceded by 'TO.' Finally, 64 disyllabic nonwords were suffixed with *-er*, and were paired with the isolated nonword stems. Half of each of these three sets of 64 prime-target pairs consisted of related primes and targets, in which the disyllabic prime was a suffixed form of the monosyllabic target (e.g., **nooping* – *A NOOP; **bounted* – *TO BOUNT; **crumer* – CRUME). For the other half of the nonword pairs, the primes were orthographically and phonologically unrelated to their targets.

5.3.1.3 Summary of stimulus characteristics

Table 5.7 summarises the primary characteristics of the items included in this experiment.[17]

[17]Note that, for the fillers and nonwords, *Prime-Target Overlap* only concerns the related half of the total number of prime-target pairs in the experiment.

Stimulus Characteristic	Conversion	Verbs	Adjectives	Words	Nonwords
Target Letters	4.58	4.67	4.53	4.59	4.57
Target Surface Freq.	8.98	9.12	17.53	11.87	–
Target Lemma Freq.	13.14	30.59	19.10	20.94	–
Prime-Target Overlap	0.76	0.85	0.86	0.80	0.83
Prime Letters	7.48	6.55	6.25	6.76	6.87
Prime Surface Freq.	5.28	5.43	4.96	5.22	–
Prime Lemma Freq.	22.59	13.44	91.52	42.52	–

Table 5.7: Summary of stimulus characteristics by condition

5.3.1.4 Participants and procedure

Thirty-two participants between the ages of 18 and 72 (20 female; mean age: 24.7) participated in the experiment. Participants were native speakers of any variety of English and were recruited through mailing lists at the University of Oxford. Participants gave signed consent of their participation and were compensated £10.00 for their time.

Sixteen participants were assigned to each of the two experimental lists. Participants were instructed that the task would begin with a blank screen, followed by a series of letters appearing. They were instructed to press 'YES' if the letters formed a word in English, and 'NO' if they did not.

Each list of 768 trials was divided into three blocks of 256 trials each. Each trial began with a short tone of 200 ms and a 300 ms pause, followed by a 456.3 ms auditory trigger. This tone and auditory trigger were played on a channel only audible to the computer, in order to trigger the reaction time measurements. Participants were not aware of these sounds, and the screen remained blank. The stimulus was then presented in lower case for 500 ms. This was followed by a blank screen for 1500 ms, until the next trial began. Reaction times were measured from stimulus onset and timed out after 1600 ms. All text was presented in Helvetica font, size 36, in white on a black background.

Participants were tested individually or in groups in a quiet room, and were

seated approximately two feet from the screen. Reaction times were measured using a serial response box with the 'YES' button controlled by the participant's dominant hand. Participants were instructed to hold the box in their hands for the duration of the experiment and press the buttons with their thumbs. Before beginning the experiment, participants were given 10 practice trials which did not share any stimuli with the main experiment, but contained structurally similar words and nonwords. The experiment itself took approximately 40 minutes, and was divided into three blocks of approximately 13 minutes each. Participants were instructed to respond to every stimulus item, and were given a short break between blocks.

The experiment was run using XMOD data gathering software (v. 1.1; Reetz & Kleinmann 2003) on an Apple Macintosh desktop running OS X.

5.3.2 Predictions

Although this experiment only uses nouns as the relevant test targets, and additionally presents the stimuli in the visual domain, the use of the delayed priming paradigm in this task should be of greater relevance to its comparability with the previous experiment. The predictions described below therefore take into account the primary interpretation I have offered for the results of Experiment 2, as well as the contrasting predictions which might be made on the basis of the alternative accounts described in §4.3.1. These analyses, and their relationship to the possibilities regarding the behaviour of the 'u' conversion pairs, are laid out in greater detail below.

5.3.2.1 Morphological complexity

This section outlines the predictions that might be made by an account that assumes that the pattern of results in Experiment 2 is due to differences in the underlying morphological structure of the primes, in combination with differences in the particular morphological relationship they have with their corresponding

targets. Both the primary interpretation offered in §4.2.4 and the alternative discussed in §4.3.1 share this assumption; however, they differ in terms of which forms they consider to have additional layers of morphological structure. In this experiment, this difference leads to contrasting sets of predictions. I will discuss each of these in turn.

Firstly, unlike Experiment 2, the current task employs only nominal forms as targets. According to the theoretical model suggested in §1.5, it is the sentential environment in which an underspecified root is placed which functions as the marker of word class (cf. Farrell 2001). Under this model, then, all four types of noun should be the same number of 'steps' away from their *-ing* primes; however, these steps will differ according to whether they involve a fully specified form:

Condition	Relationship	# Steps
N_BNoun	*greasing* ← *(to) grease*$_V$ ← *the grease*$_N$	2
uN_BNoun	*guarding* ← $\sqrt{\text{GUARD}}$ → *a guard*	2
V_BNoun	*killing* ← *(to) kill*$_V$ → *a kill*$_N$	2
uV_BNoun	*hugging* ← $\sqrt{\text{HUG}}$ → *a hug*	2

Table 5.8: Morphological steps from prime to target

The description in the table above assumes that when the suffix is removed from the *-ing* prime of a 'u' item, what remains is not a verbal stem but a bare root, without any specification for word class.[18] This root is then placed in the nominal environment of what is essentially either a definite or indefinite DP, without fully 'becoming' a noun. Thus, on this account, directional pairs and their 'u' counterparts are matched on the dimension of morphological 'steps' from the prime to the target, with each prime-target pair being two steps apart. As noted in §5.3, it is important that there are minimally two intervening steps: since a

[18]It will of course be noted that this is manifestly *not* the assumption within a number of DM-based approaches, where it would be argued that the *-ing* form results from the root minimally merging with little *v*, before adding the morpheme which is realised by the suffix. The noun, on the other hand, would be created by either placing the root directly in a DP environment, or by first merging it with little *n* before becoming the complement of D (Harley & Noyer 1999; Arad 2003). Such root-based models would thus make the morphological 'distance' between the noun and the verb *greater* in apparently 'root-derived' pairs (i.e., 3 steps), as compared to directional 'word-derived' ones. However, since this kind of model would seem to make similar predictions to those based on the primes' lack of an underlying little *n* (described below), it will not be explored in further detail.

target that is only one step from its prime should, *ceteris paribus*, be facilitated regardless, it would be more difficult to discern whether there are any effects of the underlying structure of the prime.

In fact, it is this underlying structure which is more important for our purposes, as it appears to have been the more influential factor in Experiment 2. Therefore, the primary question to ask is whether and how the primes in the four Conversion groups differ in the complexity of their morphological structure. Based on the interpretation of the data I have offered, and the hypothesis regarding underspecified 'u' items, the primes in the above-mentioned target groups should be structured roughly as follows:

(5.1) a. N_B *greasing*: [[[*grease*$_N$]$_V$]*ing*]

b. uN_B *guarding*: [[*guard*]*ing*]

c. V_B *killing*: [[*kill*$_V$]*ing*]

d. uV_B *hugging*: [[*hug(g)*]*ing*]

Of the four groups, it is only the directional N_B primes which are hypothesised to have an intervening layer of structure: they contain, within the verb, an underlying noun. The other three types of prime, whether formed from a verb or directly from the root, nevertheless do not contain this additional level of complexity.

The implications of this proposed structure for the different types of *-ing* form are fairly straightforward, given the previous set of results. The greater complexity of the N_B primes – along with the fact that two steps of morphological decomposition are necessary to reach the underlying noun – should mitigate the amount of facilitation for targets in the N_B group, just as it appears to have done in Experiment 2. In contrast, V_B primes, as well as those of both uV_B and uN_B, should significantly facilitate responses to their nominal targets without difficulty, since their *-ing* forms are more easily analysable. Thus, their processing should not attenuate their facilitatory priming effects.

Recall, however, the alternative possibility advanced in §4.3.1, which differs from Example 5.1 in its assumptions of how the primes in each Conversion group are structured. Instead, it is suggested that the lack of a significant priming effect for the N_BNoun group in Experiment 2 is due to the fact that N_B *-ing* forms do *not* contain an underlying noun, but are instead formed by directly merging an underspecified root with a verbal head. In fact, it is argued that the nominal form itself does not contain a marker of word class as such (e.g., little *n*), but is only nominal by virtue of its appearance in a DP environment (Harley 1999; Harley & Noyer 1999; Alexiadou 2001). Thus, there cannot be 'denominal verbs' in the sense of Arad (2003), since there is no specifically 'noun' head upon which to build a word-derived verbal structure. V_BNouns, on the other hand, are not limited to being root-derived, as they may be derived from verbs by placing the verb (with its little *v* head) into a DP (cf. Alexiadou 2001). If this is indeed the case, then both the V_B primes and their corresponding V_BNouns potentially contain an underlying little *v*, thus leading to the facilitation of these nouns upon prior presentation of the related primes which share this feature.

According to this account, the N_B and V_B primes in Experiment 3 are structured in the same way as their counterparts in Experiment 2. Furthermore, the 'u' group primes, if they are not word-derived, must also then be derived from a root merged with little *v*. This results in identical structures for all four types of prime:

(5.2) a. N_B *greasing*: $[[[grease]_v]ing]$

b. uN_B *guarding*: $[[[guard]_v]ing]$

c. V_B *killing*: $[[[kill]_v]ing]$

d. uV_B *hugging*: $[[[hug(g)]_v]ing]$

Where the distinction between the stimulus groups becomes relevant is thus actually in the underlying structure of the targets. As with the primes, the N_B and V_B target nouns should have the same structure they are suggested to have

in Experiment 2.[19] The 'u' targets, like the N_BNouns, should be derived directly from the root:

(5.3) a. N_B *the grease*: [*the* [*grease*] $_{DP}$]

b. uN_B *a guard*: [*a* [*guard*] $_{DP}$]

c. V_B *a kill*: [*a* [[*kill*]$_v$] $_{DP}$]

d. uV_B *a hug*: [*a* [*hug*] $_{DP}$]

Thus, the only targets that contain an underlying verbal element should be the V_BNouns. As it is the presence of this little *v* in both the *-ing* primes and these targets which may have produced the facilitation in the earlier task, this account predicts a significant priming effect *only* for V_BNouns. As the other target groups do not contain this verbal element, it cannot be repeatedly activated, and the amount of facilitation they receive should therefore be much less.

Before moving on, it is worth considering the possible ways that the various frequency characteristics of the primes and the targets might interact with the above proposals (cf. §5.3.2.2). Given the apparent lack of a prime frequency effect in Experiment 2, we would not expect such an effect to appear here; nevertheless, should prime frequency influence facilitation, it would be predicted to favour responses to uN_BNouns over the directional N_B group, but V_BNouns over their non-directional counterparts. As for target frequency, responses to directional targets should be similar to those of their corresponding 'u' group. However, the degree of facilitation may be greater for the lower (surface and lemma) frequency targets of both types of V_B items. These considerations apply equally to both of the approaches which argue for differences in underlying complexity.

Although the patterns outlined above are not the only conceivable possibilities for how the word-internal structure of the stimuli might condition the processes of recognition, should we find that the results are aligned with one or the other set of

[19] In contrast to the representations in Example 5.1, the 'V' subscripts in Example 5.2 appear *outside* the root layer, but within the *-ing* layer. This is intended to reflect the DM approach upon which this particular proposal is based, wherein all words are composed of underspecified roots merged with some type of functional head (for verbs, minimally little *v*).

predictions, this will support the respective hypotheses regarding the structural differences and the variation in the relationships which hold between different types of conversion pairs.

5.3.2.2 Target surface frequency

The predictions based on the surface frequency of the target nouns are quite straightforward. Recall that, if this particular frequency measure was indeed responsible for the pattern observed in Experiment 2, then the size of the priming effect would appear to be inversely correlated with target surface frequency – in other words, a higher surface frequency should lead to less facilitation (cf. §4.3.1).

If this is the case, then how might this consideration apply to the current experiment? Table 5.9 reviews the frequencies of the targets given in Table 5.5 above, with additional data regarding the *log* surface frequencies. As before, p represents the probability that the two groups differ in frequency, as analysed by a two-tailed pooled t-test.

Group	Frequency	*log* Frequency
N_BNouns	15.17	0.983
uN_BNouns	12.58	0.76
p	0.7106	0.2024
V_BNouns	4.12	0.38
uV_BNouns	4.01	0.49
p	0.9368	0.4401

Table 5.9: Conversion condition target surface frequencies

As the two groups of targets within a base type are matched in surface frequency, a frequency-based account would predict that the priming effect for a group of directional targets should be comparable to that of its matched, non-directional counterpart. Additionally, since the targets in the N_B conditions are far more frequent, we might expect them to be facilitated to a lesser degree overall than the lower frequency targets in the V_B conditions.

Finally, although neither target lemma frequency nor prime surface frequency appeared to exert a strong influence in Experiment 2, it may be useful to note

what effect these factors might have in Experiment 3, in order to determine whether they might be interacting with other factors like those in §5.3.2.1. As the lemma frequencies of the targets are in the same pattern as the surface frequencies (cf. Table 5.5), any effect of this factor should simply mirror the pattern described above. Prime frequency, on the other hand, is one of the only measures on which any two groups within a base type significantly differ, with primes in the V_BNoun group having a much higher frequency of occurrence than the related -*ing* forms of uV_BNouns. Although unlikely based on the results of the previous task, any effect of this difference would be predicted to increase the facilitation of the directional V_BNouns and the non-directional uN_BNouns (cf. Giraudo & Grainger 2000, §2.3.2.1).

Whether or not these additional measures have an effect on the degree of facilitation, the relatively simple pattern of target surface frequencies in this task will nevertheless help us to discern whether or not a target's frequency on its own might be more important in conditioning priming effects as compared to the other lexical characteristics which are the primary objects of the current investigation.

5.3.3 Results

Results were cleaned and analysed using the JMP (10.0) statistical package. As compared to Experiment 2 (§4.2.3), responses were generally quicker and more accurate. After cleaning the results as reported below (but before removing Conversion targets with high error rates), the mean correct response time overall was 603.4 ms, and the mean error rate was 6.39%.

The data were first cleaned by removing individual data points for which the subject responded before the stimulus began or after the trial timed out (0.60% of the data), of which 33.8% were fillers and 50% were nonwords. These points were treated as missing and were not included in any further analyses.

Three subjects were also excluded, two from the first list and one from the second. One subject from the first list was excluded due to to an overall error

rate greater than two standard deviations from the group mean (Mean: 6.7%; 2StdDev: 17.8%; excluded subject: 25%). The other two subjects (one from each list) were removed due to a mean correct response time greater than two standard deviations from the group mean (Mean: 616.4 ms; 2StdDev: 811.2 ms).[20]

Only the data from the four test conditions (N_BNouns, uN_BNouns, V_BNouns, and uV_BNouns) were submitted to further analysis. Five additional targets (2 from the uV_BNouns and 1 from each of the other three groups) had an overall error rate greater than two standard deviations from the mean (Mean: 4.7%; 2StdDev: 16.5%). These items were removed (7.9% of remaining conversion target responses). Furthermore, responses to targets which followed missing or incorrect responses to their related primes were also removed (4.8% of remaining target responses).

Finally, for the reaction time analysis, the standard deviation was calculated for correct responses, and individual data points more than two standard deviations from the mean target RT were excluded from the analysis (Mean: 570.4 ms; 2StdDev: 838.7; 4.2% of remaining responses).[21] Mean correct reaction times in milliseconds (from stimulus onset) and error rates (percentages in parentheses) are summarised in Table 5.10.

(A) Reaction times Reaction time data for correct responses were analysed by a three-factor linear mixed effects model, with Subjects and Items as random factors. The fixed factors were Prime Type (Related vs. Unrelated), Base Type (N_B vs. V_B) and Directionality (Directional vs. Non-directional). The surface frequencies of the unaffixed forms and the residualised family frequencies were included as covariates, with family frequency residualised by the

[20]It will be noted that this cutoff point is still very fast. The analyses below were therefore run both with and without these subjects; as the pattern remained the same, I report only the results obtained with these participants excluded, for the sake of consistency with the previous experiments.

[21]As with the excluded subjects, there was some concern that this cutoff point may be too stringent; the analyses were therefore run both with and without these outliers. There was no difference in the pattern of priming, and the results are reported with these points excluded, as in previous experiments.

same method as the lemma frequency covariates in Experiments 1 (§3.3.3.1) and 2 (§4.2.3.1).[22]

The adjusted R^2 for this model was .441. There was a significant main effect of Prime Type [$F(1, 1428) = 18.55$, $p<.0001$]. Participants responded, on average, 17.4 ms faster to conversion pair targets when they were preceded by their related *-ing* prime than when preceded by an unrelated control.

However, the difference appears to be primarily due to the items in the Non-directional groups, as there was a significant interaction between Prime Type and Directionality [$F(1, 1427) = 7.41$, $p=.0066$]. When taken together, responses to uN_BNouns and uV_BNouns were 28.4 ms faster when a related *-ing* prime appeared earlier in the list, as compared to an unrelated prime [$t(1427) = 4.92$, $p<.0001$]. Responses to N_BNouns and V_BNouns, on the other hand, hardly changed at all, with only a 6.4 ms difference between the related and unrelated prime conditions [$t(1427) = 1.13$, $p=.2569$].

Planned comparisons of the priming effects in each of the four individual groups seemed to confirm this pattern, with only the 'u' groups showing significant facilitation [N_BNouns: 6.2 ms, $t(1427) = 0.7685$, $p=.4423$; uN_BNouns: 35.6 ms, $t(1427) = 4.43$, $p<.0001$; V_BNouns: 6.7 ms, $t(1427) = 0.8366$, $p=.4029$; uV_BNouns: 21.2 ms, $t(1427) = 2.56$, $p=.0107$]. However, this difference in the level of priming for the two groups within a Base Type was stronger for the N_B groups than for the V_B groups, only reaching significance in the former [N_B vs. uN_B: $t(1427) = 2.59$, $p=.0097$; V_B vs. uV_B: $t(1427) = 1.27$, $p=.2055$)].

Finally, responses overall significantly covaried with the surface frequency of the unaffixed targets [$F(1, 48.36) = 14.90$, $p=.0003$], though not with morphological family frequency once the effect of surface frequency was partialled out [$F(1, 50.01) = 0.7057$, $p=.4049$]. This effect is not entirely unexpected, given that the

[22]The reasoning behind using morphological family frequency, rather than lemma frequency as before, is that groups within a Base Type in the current experiment were closely matched in lemma frequency. In contrast, however, they differed in the overall frequency of their morphological family members – even to a significant degree in the case of the V_B groups. Family frequency was thus judged to be a more useful measurement for inclusion as a covariate in this analysis.

surface frequencies of the targets were only matched within a Base Type. No other main or interaction effects approached significance.

(B) Error rates The error rate data were analysed using a binomial generalised linear model (GLM), which included the same fixed effects and frequency covariates as the reaction times.[23] The analysis revealed a main effect of Prime Type [$\chi^2 = 6.00$, p=.0143]. Participants made 2.3% fewer errors when targets were preceded by their related -*ing* prime. The main effect of Directionality was also marginally significant [$\chi^2 = 3.80$, p=.0512], with participants responding more accurately to Directional targets overall (Directional: 2.2%; Non-directional: 3.9%). Planned comparisons of the error rates in individual stimulus groups revealed a significant facilitatory effect for uN_BNouns only [$\chi^2 = 4.42$, p=.0355], though V_BNouns also showed a marginal increase in accuracy [$\chi^2 = 2.73$, p=.0985]. No other main or interaction effects approached significance.[24]

Target	Unrelated	Related	Priming Effect	Diff. in Effect
N_BNoun	556.0 (1.8%)	549.9 (1.1%)	6.2 (0.7%)	
				29.4* (3.3%)
uN_BNoun	572.6 (6.0%)	537.0 (2.0%)	35.6** (4.0%*)	
V_BNoun	560.8 (4.1%)	554.2 (1.5%)	6.7 (2.6%)	
				14.5 (-0.8%)
uV_BNoun	564.6 (4.5%)	543.3 (2.7%)	21.2* (1.8%)	
Overall	563.5 (4.1%)	546.1 (1.8%)	17.4** (2.3%**)	

Table 5.10: Results of Conversion conditions (Experiment 3)

The general pattern of results in this experiment is illustrated in Figure 5.1. Figure 5.2 represents the size of the priming effect in each condition, calculated by subtracting the mean RT for targets following related primes from the mean RT following unrelated primes.[25]

[23] Like the analyses in earlier chapters, the GLM does not include Subjects or Items as random factors. All error rate percentages reported are the results of a contingency analysis that included neither random factors nor frequency covariates.

[24] As in the previous experiments, * = significant at p<.05, ** = significant at p<.01.

[25] As in the table, * = significant at p <.05, ** = significant at p<.01.

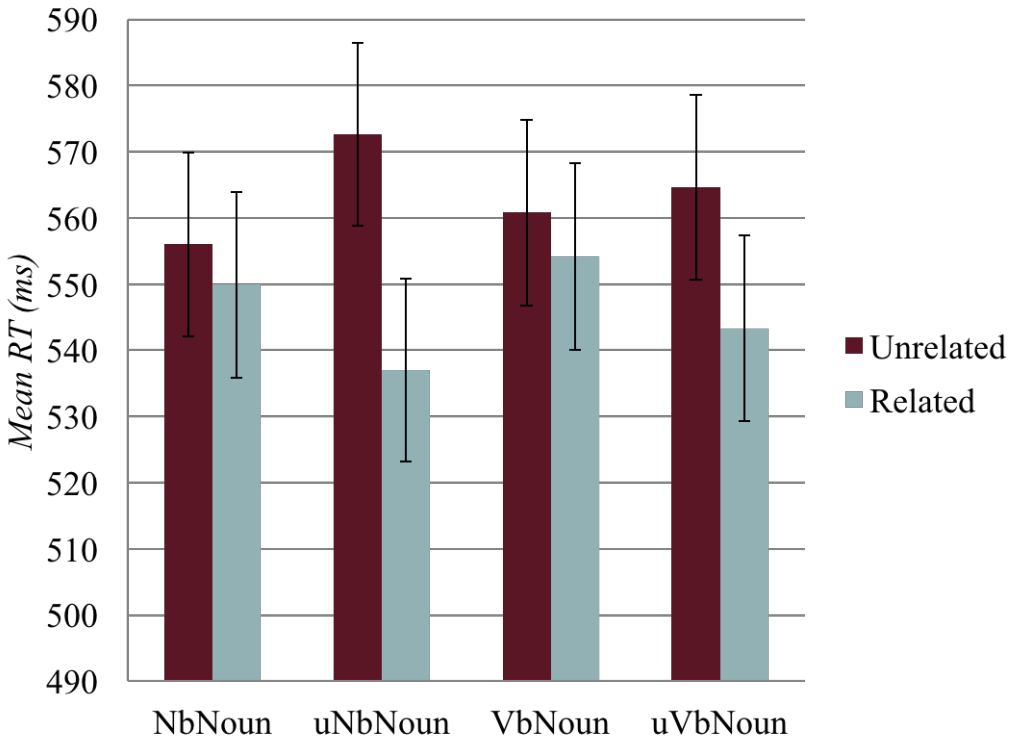


Figure 5.1: Mean RT and standard error (in ms) for all conditions (Experiment 3)

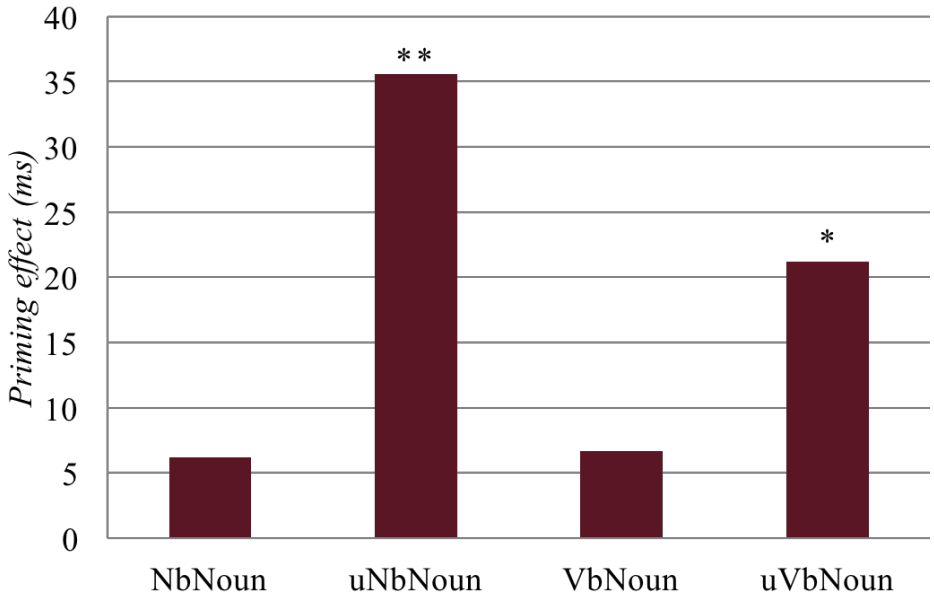


Figure 5.2: Mean priming effect (in ms) for all conditions (Experiment 3)

5.3.4 Discussion

As indicated above, Experiment 3 revealed a robust pattern of results which persisted regardless of the data pre-processing methods employed. Although responses were generally quick and accurate, we find significant facilitation of correct reactions to 'u' targets following prior presentation of a related -*ing* prime. In contrast, responses to N_BNouns and V_BNouns were *not* significantly affected by whether the -*ing* form which preceded them was related or not.

This strong overall pattern raises a number of interesting questions. To begin with, this pattern does not seem to be in line with any of the sets of predictions outlined in §5.3.2. For instance, if the degree of facilitation received by a target is primarily due to its surface (or lemma) frequency, we would have expected the two 'u' groups to be primed to the *same* extent as their frequency-matched directional counterparts, rather than exhibiting significantly different effects. With respect to the proposal based on the presence of little v and absence of little n, it was hypothesised that those nominal forms which do not seem to be derived from the verb – N_BNouns, uN_BNouns, and uV_BNouns – should not contain the little v head which is present in the -*ing* prime. Lacking this shared element, these groups were predicted to show no facilitation, in contrast to the verb-derived V_BNouns. However, the results clearly do not fall into this pattern either. Finally, it was suggested under the '1-step/2-step morphological complexity' account that any and *only* those noun targets whose -*ing* primes were underlyingly derived from the noun (i.e., only N_BNouns) would fail to receive a significant priming effect. This was argued to follow from the combination of the greater morphological complexity of such primes with the morphological 'distance' between the derived prime and the nominal target. This set of predictions was also not borne out in Experiment 3.

In addition to the fact that this general pattern was therefore somewhat unexpected, there are also a number of smaller patterns of interest among the data from this task. For instance, although there was a significant difference in the

degree of priming for the 'u' targets as compared to the directional targets overall, when the priming of each 'u' group was directly compared to that of its non-'u' counterpart, only the difference between the two N_B groups emerged as statistically significant. Another point concerns the fact that baseline responses to the uN_BNouns seem to be slower than those to the directional N_BNouns.

How should we interpret such effects? Despite the implication in the preceding paragraph, they need not all be indicative of the same underlying issues. However, if we first reconsider the results of this experiment on their own terms, we may be able to reach an interpretation which may account for these sub-effects, as well as the overall similarities and differences found across the two delayed priming tasks. Under the hypothesis advanced for 'u' pairs in example 1.64 – which argues that the different forms of a 'u' item are inflectional variants of a single root – there is a crucial difference between the relationships which obtain between variants of 'u' items and those of nominal and verbal forms related by morphological conversion: the distinction between inflection and derivation (cf. §2.3.1). Importantly, it has also been suggested that this difference may have implications for the results of priming studies. If, as proposed, the primes and targets in the 'u' groups are inflectionally related, and those in the non-'u' groups involve a *derivational* relationship, we might then expect facilitation between inflected forms which share a single lexical entry; lack of facilitation, on the other hand, might be predicted if the prime and target belong to two separate lexical entries. It may therefore be possible that the results revealed here, which fit this pattern precisely, are best understood as a reflection of these different relationship types.

However, as noted, there is a curious difference in the unprimed RTs across the four conditions, with the uN_BNouns eliciting the slowest responses, and the N_BNouns the fastest. These two conditions also exhibit the largest and smallest priming effects, respectively. It might therefore be suggested that the difference in priming between these two groups is simply a matter of these baseline differences. Furthermore, the emergence of target surface frequency as a significant factor in

the analysis would at first glance seem to suggest that these baseline RTs were influenced by this measure of frequency. Neither of these explanations is completely convincing, however. To begin with, the baseline RTs to the uV$_B$Nouns are closer to those of the N$_B$Nouns, and yet significant facilitation was observed in this group. As for surface frequency, although it may have had a significant influence on responses, recall that the two N$_B$ groups were actually matched on this measure. As noted in §5.3.3, it is more likely that this effect stems from the much larger differences between the N$_B$ groups and the V$_B$ groups. Thus, it may be suggested that this small difference in the baseline responses is not likely to be the cause of the much larger differences in priming.

If we therefore accept the general pattern of results at face value, and interpret them in terms of inflection vs. derivation, a question nevertheless remains: why were V$_B$Nouns significantly facilitated in Experiment 2, under ostensibly the same relatedness conditions? A possible answer may be found in the fact that the auditory Experiment 2 differed from the visual task in terms of its difficulty. In general, the earlier task was more difficult, and mean correct word response times were longer overall (Experiment 2: 933.2 ms; Experiment 3: 616.4 ms). This longer overall processing time – which likely resulted from the combined influence of the real-stem-real-suffix nonwords and the auditory presentation – may have also allowed for deeper processing of the V$_B$Nouns in Experiment 2 as compared to the visual task, with its more quickly identified orthographic forms. Thus, it might be suggested that the V$_B$Noun targets in the visual task were not able to be decomposed into their verbal bases, and therefore failed to receive significant facilitation from the *-ing* forms; the longer auditory experiment, in contrast, may have provided ample opportunity for this decomposition to occur, thus leading to subsequent speeding of target responses upon presentation of the verbal *-ing*.[26]

Interestingly, such an interpretation also seems to be in line with several other

[26]I am grateful to Linda Wheeldon for this suggestion.

patterns found across both experiments. For example, the slightly smaller difference between the two V_B groups in terms of their level of priming would suggest that the V_BNouns do not suffer as much (relative to the matched uV_BNouns) from being *derivationally* related to its prime, as compared to the N_BNouns. While the N_BNouns are equally as 'distant' from their primes as their V_B counterparts, the primes of the former have of course been proposed to be more underlyingly complex. Furthermore, the slightly larger (though non-significant) priming effect found for these N_BNouns in the auditory experiment might also be due to the increase in processing time, as this may have allowed more time for any activation from the prime to begin spreading to the noun.

Although the explanation I have offered above may begin to account for many of the results observed in the current investigation, there are additional considerations which might lead us to a somewhat different interpretation. In particular, the various differences in design, method, and stimuli between the two delayed priming tasks make it more difficult to directly compare and interpret their results. Firstly, although the real-stem-real-suffix nonwords used in Experiment 2 were avoided in Experiment 3 due to their potential contribution to data loss, the analysis in Taft (2004) suggests that such nonwords may crucially affect the way in which morphologically-complex words are recognised. However, while Taft claims that this effect is manifested through an increase in sensitivity to a 'recombination stage,' the discussion in §4.2.4 argues that this is unlikely. As noted previously, not only were the nominal forms of the V_B group much less frequent than their verbal partners, but they also were incompatible with the verbal *-ing* suffix. If the recombination stage had been of greater importance in Experiment 2, one would predict that facilitation of this low-frequency, category-clashing nominal form would have been minimal.[27] At any rate, the removal of these special nonwords (as in Experiment 3) would have been predicted to reveal *greater* comparative facilitation, due to there being less of a 'noun-blocking' in-

[27] Cf. §4.2.2.2.

fluence from the recombination of the stem with *-ing*. In fact, the results display the opposite pattern, with a larger priming effect for V_BNouns in the presence of real-stem-real-suffix nonwords. Indirectly, this seems to provide further support for the idea that these nonwords did not simply induce left-to-right competition in Experiment 2, as might be suggested by Taft (2004) – though they may have affected processing times more generally, as proposed above.

A further issue concerns the differences in the kinds of nominal forms included in the tasks – more specifically, the fact that Experiment 3 included targets preceded by either 'A/AN' or 'THE', while Experiment 2 was limited to those items which could be used with the indefinite article. This inclusion in the third experiment allowed for a wider range of meanings, and increased the chances of finding a similarly wide range of speaker intuitions. However, it is possible that this may have had unintentional consequences for the experimental results, through the introduction of a potentially interesting pattern. Consider, for instance, the form *smoke*. When used as a mass noun and preceded by *the*, it refers to a visible substance, e.g., *The smoke was blinding.* This form may also be used with the indefinite article, but with a different meaning, e.g., *I went for a smoke.* In the latter case, it seems to roughly designate an event of *smoking.* Thus, like *a walk* in *I went for a walk*, the indefinite noun $smoke_N$ seems to make more direct reference to its corresponding verb than does the definite use – in other words, the definite and indefinite nouns may in fact differ in their relationship to the verb.

Following this argument to its conclusion, a systematic difference of this sort would lead us to suggest that while the count V_BNouns in Experiment 2 may have indeed all been deverbal, the same may not be true for the later group of V_BNouns preceded by 'THE'.[28] We might therefore expect that the lesser degree of priming for these nouns in Experiment 3 was thus due to a lack of facilitation for these non-derived definite forms. However, a closer examination of the data for this task does not seem to confirm this prediction. Although further subdivision of

[28]Note that an effect of a closer semantic relationship *on its own* would not be expected to affect facilitation in a delayed priming task (§2.2.2.1).

the results according to determiner type leaves too few data points for statistical analysis, there does not seem to be much difference between the 'A' and 'THE' forms of V_BNouns in terms of facilitation – 'THE' forms show an 10.5 ms priming effect, and 'A' forms show even less, at 3.0 ms. Nevertheless, given the small number of data points, it is still possible that this pattern of meaning relatedness may be revealed to be influential after further testing. It therefore should be kept in mind in future research on CONVERSION.

To summarise, I have argued in this section that the combined results of Experiments 2 and 3 support an analysis of conversion items in terms of both morphological complexity and the sharing of a lexical entry, and that these results are unlikely to have arisen solely from the particularities of the individual experimental designs. However, it must still be acknowledged that the different implementations of the two tasks mean that we cannot unequivocally interpret the results in a unified way. Additionally, it is likely that there are other factors – both linguistic and more cognitive – which might turn out to play an important role. These issues and their potential implications for a more complete understanding of CONVERSION will be discussed further in both §6.3 and 6.4.

5.4 Conclusion

The survey and experiment reported in this chapter have offered further insight into not only the behaviour of potential cases of word class underspecification, but also additional information about how we might best understand the patterns found in more asymmetrical conversion pairs. Through the refinement and expansion of the survey methods, a much wider range of patterns of speaker judgments was revealed. These changes also made it possible to distinguish between different patterns of responses which in the previous survey all manifested as simply surface disagreement across speakers' category judgments.

As regards the visual delayed priming task, although the results were not entirely as predicted, it has nevertheless been possible to interpret them in light

of the similarities and differences between this task and the previous auditory experiment. That said, further exploration of how these sets of results relate to one another, as well as to the two surveys, is still required in order to fully unite the investigations conducted here with earlier research both on morphological processing and our theoretical understanding of CONVERSION. In particular, the results have begun to raise numerous questions regarding what sorts of information speakers are utilising in making both their offline and online responses. The following chapter will therefore delve deeper into these issues, and readdress many of the topics which have been introduced thus far.

Chapter 6

Implications for an understanding of conversion, underspecification, and morphological processing

6.1 Introduction

I will now attempt to weave together the various threads of discussion we have been pursuing, with the aim of contributing to a deeper understanding of the synchronic status of conversion pairs in the mental lexicon. I will first re-examine some of the theoretical criteria which have been proposed in the literature to reflect the underlying structure of the words in conversion pairs (§6.2). This will be accompanied by a discussion of how useful these criteria are as a means of indicating whether speakers will perceive a particular form as more basic – and, conversely, how these characteristics might be reflected by speakers' judgments and behaviour during word recognition. The subsequent section (§6.3) will then attempt to integrate the results of the experiments carried out in this study, and, within this context, will revisit some of the questions raised in Chapter 2,

particularly as regards the factors which may affect morphological processing. Following that, in §6.4 I will take into account the discussion in the previous two sections, and offer some suggestions for how the subset of conversion items dealt with in this thesis might be modelled theoretically – though, of course, much work remains to be done in order to develop this model fully. Finally, in §6.5, I will offer some additional suggestions for further research on these issues, both theoretical and experimental.

6.2 Basicness, complexity, and linguistic patterns reconsidered

As the title suggests, the discussion presented in this section will probe more deeply into both the survey data in light of the experimental results, and will explore how speakers' behaviour might be connected to some of the linguistic characteristics of the conversion pairs used in the present study. The primary goals of this endeavour are (1) to provide an indication of the importance of these characteristics for the synchronic cognitive representation of conversion pairs; and (2) to further investigate what types of information speakers may have drawn from in making their responses. It is hoped that this analysis will contribute useful information for further studies on CONVERSION, both in terms of eliciting speaker intuitions, as well as in choosing stimuli for experimental research, in particular as regards individual aspects of the behaviour of conversion pairs.

However, both the breadth and depth of this examination are limited to a certain extent by other considerations. Firstly, a full exploration of each of the patterns found in conversion pairs, and to what degree they suggest differences in directionality, complexity, or lexical organisation, would clearly require an extensive and careful analysis of the ways in which this information is expressed elsewhere in the language. Such an analysis is outside the scope of this study, and although investigations of this sort have been conducted (e.g., Balteiro 2007),

these have had different theoretical questions in mind. Secondly, the methods employed in selecting pairs for inclusion in the surveys and experiments have been primarily concerned with issues relevant to their use in the priming tasks, such as frequency, length, familiarity, acceptability when preceded by a particle, etc. As such, the words ultimately chosen for testing should not necessarily be considered a representative sample of the entire phenomenon.

Given these limitations, I have opted to briefly examine a selection of the types of patterns discussed in §1.3, along with their potential relationship to speakers' behaviour with regard to the three relatively distinct experimental groups of forms: N_B, V_B, and 'u.' In view of this restriction and the others noted above, the analyses presented here should thus be taken as merely preliminary insights into the complex nature of how conversion pairs might be represented and organised in the grammar. Further research will be needed in order to explore these patterns fully, in a manner which takes into account their relationship to other aspects of the grammar as whole.

6.2.1 Semantic patterns

I will begin the reconsideration of the linguistic behaviour of CONVERSION with a look at some of the patterns of meaning and meaning relatedness found amongst the pairs from the experiments. As suggested in §1.3.1, it is not a straightforward task to determine precisely what these patterns are in a relatively objective and replicable way. Nevertheless, I attempt in the following two sections to address these patterns as systematically as possible, while indicating where I have encountered difficulties in applying the particular methods chosen.

The primary focus in this discussion of semantic patterns will be on semantic dependency/complexity (§6.2.1.1) and word class prototypicality by way of concreteness (§6.2.1.2). Although additional patterns (such as regularity and transparency or range and restrictions) have been noted, these will not be dealt with further in this study for three reasons. Firstly, the restriction of the words

included in the surveys and experiments to the more canonical pairs means that the majority of the pairs investigated will be relatively semantically regular/transparent, and will not include highly semantically-restricted forms. Secondly, within this group of more canonical cases, those forms which are the most transparently related (i.e., 'u' forms) are the ones which display symmetrical meaning dependencies, and should therefore be revealed in the analysis below (§6.2.1.1). Finally, as regards semantic range and restrictions, there does not seem to be a clear way to evaluate this pattern which does not rely almost wholly on intuition. It might be suggested that one could ascertain the number of senses for each form in a pair, but this does not necessarily provide an indication of semantic range/restrictedness, as it is possible to have many very specific senses as well as few very general ones (and vice-versa). Despite these issues, the general impressions suggested by these patterns will still be kept in mind in the development of the model of CONVERSION in §6.4 below.

6.2.1.1 Semantic dependency and complexity

For a first look at the patterns of semantic dependency and complexity among the pairs of words tested, I used the definitions provided by the Oxford Advanced Learner's Dictionary (OALD; Hornby & Turnbull 2010), a resource which draws on native speaker data from the Oxford English Corpus (OEC 2007). This dictionary was selected for its focus on words and senses 'chosen on the basis of their **frequency** and **usefulness** for learners of English' (emphasis in original; OALD Online 'How To'). It is therefore likely to be reasonably representative of the types of meanings that will be part of the common usage of native speakers. Its inclusion of only the most frequent words and senses may be particularly useful for the analysis of the survey results, as it seems likely that speakers would generally have drawn upon the most frequently occurring sense(s) of each form in making their category judgments.

Of course, as noted by Balteiro (2007: 112), dictionaries 'are not always useful

and clear' as a means of helping to establish semantic dependency. Because the true purpose of a dictionary is to explain the meanings of unfamiliar words, it is rare to find that one form (or a sense of this form) is explicitly defined in terms of its corresponding conversion pair partner – i.e., with direct use of the other form, as in example 6.1:

(6.1) *bite*$_{\mathrm{V}}$: 'to use your teeth to cut into or through something'
bite$_{\mathrm{N}}$: 'an act of *biting*'

(from the OALD)[1]

Defining *bite*$_{\mathrm{N}}$ as 'an act of *biting*' is not likely to be particularly useful to someone who does not know the meaning of *bite*$_{\mathrm{N}}$, given the phonological and semantic similarities between the noun and the verb. As a result, this type of pattern is relatively uncommon in the OALD, and therefore could not be used as the sole criterion for establishing semantic dependency. Instead, in order to assess the issue in a way which more closely reflects the meaning relationships in these pairs, three different types of relatedness were judged to exhibit semantic dependency:

(6.2) *An individual sense is semantically dependent if*:

a. its definition explicitly includes the corresponding pair partner (see example 6.1 above)

b. its definition contains a direct paraphrase of the definition of one of the senses of the corresponding pair partner (see example 6.3)

c. its definition contains several of the main lexical words found in the definition of one of the senses of the corresponding pair partner (see example 6.4)

It should be mentioned that the classification of the latter two types – particularly 6.2c – as *semantically dependent* is in fact somewhat intuitively applied,

[1]Unless otherwise noted, all definitions in this section are taken from the online edition of the OALD.

although every effort was made to base these classifications on the actual definitions provided. Some examples of these two types are given below, with the nominal senses in these cases being dependent on their corresponding verbs.

(6.3) *Direct paraphrase (6.2b)*:

chase$_{\text{V}}$: 'to run, drive, etc. after somebody/something in order to catch them'

chase$_{\text{N}}$: 'an act of running or driving after somebody/something in order to catch them'

(6.4) *Shared lexical words (6.2c)*:

mask$_{\text{V}}$: 'to hide a feeling, smell, fact, etc. so that it cannot be easily seen or noticed'

mask$_{\text{N}}$: 'a manner or expression that hides your true character or feelings'

However, the criteria in 6.2b and c as they are written are not completely sufficient to distinguish the *dependent* senses in examples like these from the *non-dependent* senses. Thus, the sense of *chase*$_{\text{V}}$ in 6.3 might be argued to contain a direct paraphrase of (part of) the definition of *chase*$_{\text{N}}$; furthermore, *mask*$_{\text{V}}$ by definition shares several of its lexical words with the sense of *mask*$_{\text{N}}$ in 6.4. Like *bite*$_{\text{N}}$, however, each of the nominal meanings here seems to be more semantically – though perhaps not conceptually – *complex* than the meaning of its corresponding verb. Although §1.3.1.5 points out some of the difficulties in determining relative semantic complexity, some cases (e.g., *bite*$_{\text{N}}$) are nevertheless fairly straightforward, and even more so because of the reliance here on definitions provided by a single fixed source (the OALD) rather than on intuitive paraphrases or analogies. Essentially, a sense was considered to be more semantically complex if its meaning completely subsumed the meaning of one of the senses of its pair partner while also including additional elements – such as 'an act of...' in examples 6.1 and 6.3, or 'a manner or expression that...' in example 6.4. Thus, the nominal senses in the examples above are not only semantically *dependent* on their verbal senses; they also display greater semantic *complexity*.

Given that the classification of these meanings as dependent is based in part on their greater semantic complexity, a question might be raised as to why a difference in complexity was not simply incorporated into the criteria for the determination of dependency. As discussed in §1.3.1.3, however, some conversion pairs seem to be in a relationship of mutual semantic dependency, in which neither of the meanings is necessarily more complex than the other:

(6.5) *Mutual direct paraphrases*:

grin$_{\text{V}}$: 'to smile widely'

grin$_{\text{N}}$: 'a wide smile'

Although the meanings in example 6.5 are clearly related, there is no obvious indication that one sense has any more semantic content than the other. In such cases, *both* senses were considered to be semantically dependent. Thus, for relationships like that between the nominal and verbal uses of *grin*, dependency was treated as separable from complexity – in contrast to cases such as *bite, chase*, and *mask* above. While this may initially appear to be inconsistent, the greater complexity of one of the senses in the latter pairs argues against the labelling of the less complex sense as semantically dependent, since it does not in fact refer to the *entire* meaning of the more complex sense. For this reason, these less complex senses were tagged as 'Independent,' although they of course share elements of meaning with their pair partners.

It will be gathered from the preceding discussion that the relationships of semantic dependency and complexity in the pairs under consideration have been determined on a *sense-by-sense* basis. The motivations for this method were two-fold. Firstly, the use of dictionary entries – which generally include multiple, separately defined senses – required it. Although one might suggest limiting the analysis to only the most dominant meanings, in practice the determination of which meaning is dominant may be quite a complex task – one which is outside the scope of this project. Secondly, as mentioned in §1.3.1.3, there are a number of cases in which meanings of different senses within a conversion pair seem to

indicate contrasting directions of semantic dependency or complexity (Marchand 1964; Balteiro 2007; Plank 2010). If all of these senses are in common usage, there is no clear reason – at least for the purposes of the present study – why one pattern should be judged to have precedence over the other. Even if the senses differ in their relative dominance, speakers may nevertheless draw upon less dominant senses during both the surveys and online processing, especially when the word form lacks a supporting context.[2]

However, despite having therefore implemented this sense-by-sense method, it was afterwards ultimately necessary to collapse across these individual senses in determining the relative dependency/complexity of the nominal and verbal uses, in order to be able to usefully compare these patterns with speakers' responses. Many cases did not pose any difficulty in this respect, as only the nominal *or* verbal senses were dependent, or else all senses were mutually dependent across the different forms. In other cases, a somewhat intuitive judgment was eventually required, though this judgment was based as far as possible on the *number* of senses which indicated a particular direction. While this may seem counter-intuitive based on the preceding discussion (see especially Plank 2010), there is experimental evidence to suggest that lexical forms which have multiple *related* senses may be treated together as part of a single lexical entry. It is true that *within* this single entry, distinct senses may indeed also be stored and represented in a relatively independent fashion, thus inhibiting one another when the context requires selection of one particular sense (Klein & Murphy 2001; Pylkkänen et al. 2006; Rabagliati et al. 2011). However, additional MEG data also reveals facilitation between these different related senses during the earlier stages of the selection process (Pylkkänen et al. 2006). Furthermore, when polysemous forms are presented without a biasing context, as in lexical decision, the different senses in fact seem to reinforce one another, leading to faster recognition of polysemous forms in general (Rodd et al. 2002; Klepousniotou & Baum 2007). When com-

[2]Cf. Teddiman (2012).

bined with the fact that speakers were only given a single, non-contextualised word form in both the surveys and the experiments (barring the word class particles in the lexical decision tasks), it therefore seems that treating these related senses *together* in the end is likely to better reflect the kinds of information used by speakers in making their choices.

Thus, for this analysis, each item was tagged according to which form would be the base, given the patterns of semantic dependency and complexity indicated by the definitions in the OALD. Those whose nominal and verbal uses were mutually dependent were tagged as 'Other.' For three forms (one in Experiments 1 and 2 and two in Experiment 3), the meaning patterns did not meet any of the criteria in example 6.2, with all senses of one form defined independently of all senses of the other. These items (*flock*, *plague*, and *lull*) were tagged as 'Independent,' and were excluded from the statistical analyses in this section.

This tagging based on patterns of semantic dependency (the *Dependency Base*) was then compared with the forced-choice survey responses in the form of the *Experimental Nominal Weight* (ENW). This latter measurement was calculated following Teddiman (2012: 242; see §2.3.2.3), and it was computed by dividing the number of respondents who chose 'Noun' for a particular word by the total number of survey responses to that word – equivalent to the '%Noun' as reported in §3.2.3 and 5.2.3. For the scalar responses, the relationship of the Dependency Base to the ratings in Survey 2 was investigated by comparing the former to the mean$z$-score for each word, as calculated in §5.2.3. Higher positive z-scores indicate the 'Noun' end of the scale, and increasingly negative numbers indicate the 'Verb' end.

The survey results for the words from Experiments 1 and 2 were therefore submitted to statistical analyses which tested the relationship between each form's Dependency Base tagging and its ENW. An analysis of variance revealed that a form's tagging on the basis of semantic dependency was a significant predictor of survey responses [$F(2,36) = 5.97$, $p=.0058$]. The mean ENW for each Dependency

Base group is summarised in the table below.

Dependency Base	Mean ENW
Noun	0.67
Other	0.35
Verb	0.27

Table 6.1: Mean ENWs by Dependency Base, Survey 1 (Experiments 1 and 2)

A Tukey HSD test revealed that the Noun and Verb groups significantly differed from one another in their mean ENWs [p=.0049]; the 'Other' group, in contrast, did not differ from either of former groups [from Verb: p=.9254; from Noun: p=.3184]. Table 6.2 illustrates how the Dependency Base tags were distributed with regards to the ultimate division of these forms into the experimental N_B and V_B groups.

Dependency Base	N_B	V_B
Noun	15	6
Other	1	2
Verb	3	12

Table 6.2: Dependency Base by experiment group (Experiments 1 and 2)

Although there are not enough data points to conduct a statistical test here, it is clear that the base as established by semantic dependency corresponds closely to speakers' responses, as well as to the division of these forms into experimental groups.

Moving on to the items used in Experiment 3, we again find that semantic dependency is a significant predictor of ENW [$F(2,59) = 4.85$, p=.0112]. Higher proportions of respondents selected 'Noun' in the forced-choice portion of the survey for those items which the OALD definitions suggested to have base nouns, though the mean ENWs were slightly more skewed toward 'Verb' responses generally. Concerning the scalar responses, the Dependency Base of an item was also a significant predictor of these ratings [$F(2,59) = 4.05$, p=.0225], with a mean rating for the 'Other' group just above the cutoff rating point for 'u' forms in Experiment 3.[3]

[3]Cf. §5.3.1.2A.

Dependency Base	Mean ENW	Mean *z*-score
Noun	0.60	0.21
Other	0.47	0.08
Verb	0.32	-0.28

Table 6.3: Mean ENWs and *z*-scores by Dependency Base, Survey 2 (Experiment 3)

Tukey HSD tests revealed significant differences between both the ENWs and mean *z*-scores of the Noun and Verb Dependency Base groups [ENW: p=.0081; *z*--score: .0177], but not between the 'Other' group and either of the other categories [ENW from Verb: p=.3498; ENW from Noun: p=.3241; *z*--score from Verb: p=.1818; *z*-score from Noun: p=.7341]. The distribution of the tags based on semantic dependency with respect to the experiment groups is shown in Table 6.4.

Dependency Base	N_B	uN_B	uV_B	V_B
Noun	10	6	7	4
Other	4	4	4	4
Verb	1	6	4	8

Table 6.4: Dependency Base by experiment group (Experiment 3)

Interestingly, aside from the N_B forms, the items in each experiment group are roughly evenly spread across the different types of semantic dependency. Although there is not enough data here to investigate further, it is possible that this is connected to the different types of meaning patterns which seem to obtain in N_B pairs as opposed to the other types (cf. §6.4). Nevertheless, the strong correlations between both types of speaker ratings with the base as determined by patterns of semantic dependence suggests that speakers' perception of these patterns of meaning still will have indirectly affected what kinds of noun-verb relationships were reflected in each experiment group in the visual delayed priming task.

Overall, the robust results described above – revealed even through this coarse preliminary analysis based on dictionary definitions – suggest that patterns of

semantic dependency between the nominal and verbal forms in a conversion pair are indeed one of the types of information speakers use in assessing whether a form is nominal or verbal, as well as in processing a form during recognition. These patterns most clearly reveal the asymmetries among conversion pairs; however, there are also obvious cases of mutual dependency of meaning, which tend to elicit intuitions that lie somewhere between the categories of 'Noun' and 'Verb.' However, as both the discussion and the results suggest, an issue still remains in that the boundaries between the more balanced pairs and those which tend towards asymmetry do not always seem to be clearly marked. In particular, the patterns which differentiate between 'u' items and V_B items seem to be less distinct. I will return to this point below. However. it is clear that further investigation of the patterns of semantic dependency among pairs potentially involved in CONVERSION may need to take a more fine-grained approach – one which takes into account both the *range* of dependency relationships among these items, as well as the need for a detailed and systematic analysis of the semantics of these forms and their relationship to the grammar as a whole.

6.2.1.2 Concreteness and word class prototypicality

As noted in §1.3.1.6, the issue of whether a word has a meaning which is a more or less prototypical example of the meanings associated with a particular word class is complex.[4] Nevertheless, according to e.g., Croft, there are also certain pairings of meaning and function which are more prototypical or 'unmarked' than others, such as the use of words with OBJECT meanings in a referential (i.e., nominal) function. However, as previously noted, the usefulness of relative prototypicality as a means of predicting speaker behaviour may be limited in certain crucial ways, particularly as concerns the generally action-oriented verbal uses of conversion items.

In view of this latter point, I have chosen to focus on how prototypically

[4]Cf. §1.2.2.

'noun-y' a given form is, through the use of concreteness ratings. These ratings are intended to 'evaluate the degree to which the concept denoted by a word refers to a perceptible entity' (Brysbaert et al. 2014: 904). Although this definition may also include perceptible actions (e.g., *jump*), we might expect that in practice, speakers are more likely to rate a word which may refer to an object as something which can be 'experience[d] directly' (Brysbaert et al. 2014: 906). Thus, it is suggested that concreteness ratings may be correlated with the degree of 'nouniness' of a form, as judged by the respondents of the surveys in this study.

The use of concreteness as a measure of word class prototypicality has a number of benefits. Firstly, unlike several of the other characteristics discussed in §1.3.1, it is relatively quantifiable, and there are several databases which contain numerical ratings of concreteness which have been gathered from native speakers. A further benefit of this measurement, however, is that the relative concreteness of a word has been shown to affect responses in lexical decision, apparently eliciting faster responses for more concrete words (James 1975; Schwanenflugel 1991) – though the issue of precisely what information is reflected by this effect is not uncomplicated (Schwanenflugel et al. 1988; Barber et al. 2013). Still, this effect suggests that concreteness ratings may provide a useful additional perspective on both speakers' judgments of basicness and participants' performance in the experimental tasks.

For the analysis of this factor, I have chosen to use the database of Brysbaert et al. (2014), as it is both recent as well as one of the most exhaustive, containing nearly 40,000 lemmas. The concreteness ratings were gathered by asking participants to rate, on a 5-point scale, how much the concept which a word referred to was something one could 'experience directly through one of the five senses' (Brysbaert et al. 2014: 906). It was emphasised in the instructions that this included any actions which one could also perceive through the senses. These responses were normalised and averaged to give a mean concreteness rating for each word form in the survey, with 5 indicating 'Concrete,' and 1 indicating 'Ab-

stract.' Nominal and verbal forms in conversion pairs were not rated separately; however, this will serve to make the concreteness ratings more comparable to the conditions of the basicness surveys, as these too only presented one form for each conversion pair. As above, the mean concreteness ratings for each form included in the experiments were compared to the ENWs from both sets of forced-choice data, as well as to the mean *z*-scores from Survey 2.

Following Teddiman (2012: 242), the ENWs from the first survey were compared to the concreteness ratings using a Spearman correlation. The responses were significantly correlated with ratings of concreteness [$r_s = .7160$, $n = 40$, $p<.0001$; Figure 6.1].

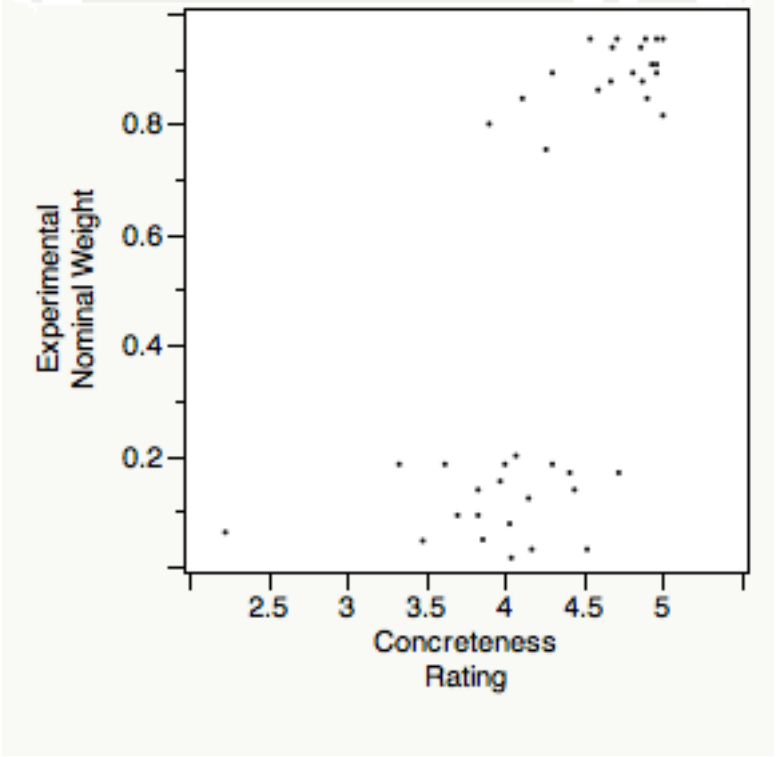


Figure 6.1: Mean concreteness as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2)

As shown in Figure 6.1, most of these words had relatively high concreteness ratings, with the majority rated 3.5 or higher. Nevertheless, there was a distinct tendency for those forms which were judged to have more concrete meanings to also be assigned to the 'Noun' category. Indeed, a comparison of the two sets which eventually formed the N_B and V_B experiment groups also revealed a

significant difference in their average concreteness [t(38) = -5.47, p<.0001], with N_B words having a higher mean concreteness of 4.70, and V_B words a lower mean of 3.94.

Turning now to the forms from Experiment 3, we find again that there is a slightly weaker, but still significant correlation between how often a word was marked as a 'Noun' in the forced-choice responses, and the mean concreteness rating of the word [r_s = .416, n = 64, p=.0006; Figure 6.2]. The scalar ratings were also in line with this pattern [r_s = .441, n = 64, p=.0003; Figure 6.3].

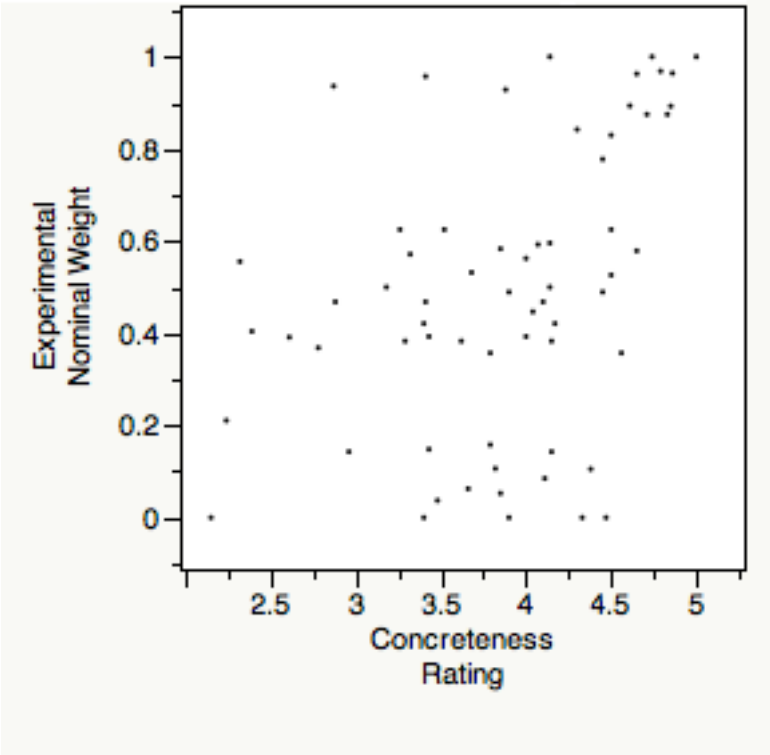


Figure 6.2: Mean concreteness as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3)

As with the previous experiment groups, for words with higher concreteness ratings, respondents to the basicness surveys were more likely to choose 'Noun' in the forced-choice task, or to choose points closer to the (positive) 'Noun' end of the scale. Furthermore, the items from the N_B group were found to have a significantly higher level of mean concreteness [Mean: 4.41] than the other three groups, which did not differ from one another [uN_B: 3.82; uV_B: 3.56; V_B: 3.63; Tukey HSD: p=.0013]. This difference may account to some extent for the faster

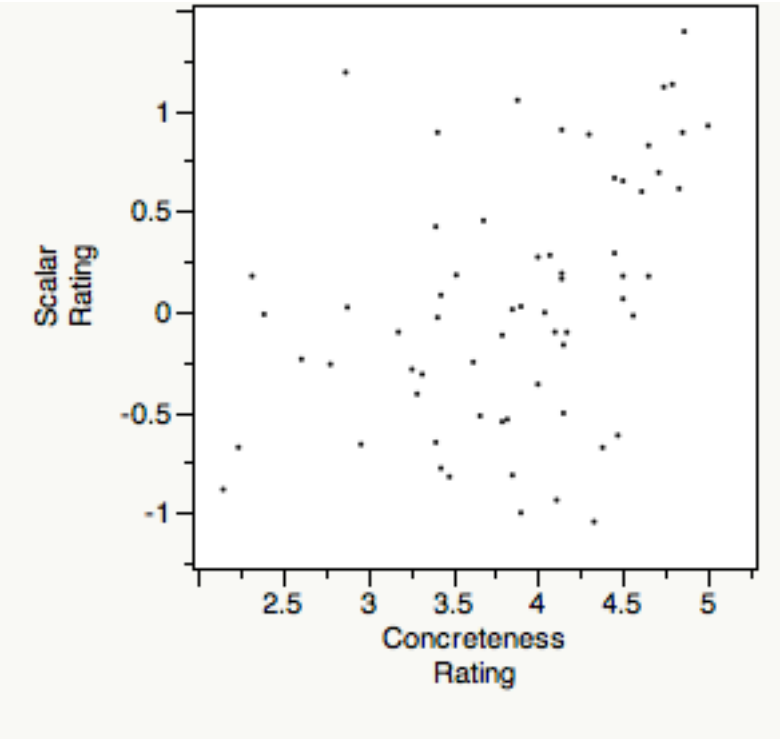


Figure 6.3: Mean concreteness as compared to mean *z*-scores, Survey 2 (Experiment 3)

unprimed lexical decision responses to N_BNouns in the visual delayed priming task.[5]

It is true that the pattern described is not without exceptions, as the scatterplots above demonstrate. On the one hand, there does indeed seem to be a connection between the relative concreteness of a word's meaning and how 'noun-like' it is judged to be. However, the difference between strongly 'verb-like' words and more intermediate ones in terms of their degree of concreteness is not as clear. It is possible that this latter issue is the result of the use of concreteness in the first place, as even those verbal meanings which can very clearly be experienced via the senses may still not be felt to be as firmly concrete as meanings which concern real-world objects. Consequently, we may be unable to determine the relative prototypicality of the verb forms in these pairs through a measurement of concreteness. However, as suggested in §1.3.1.6, determining the prototypicality

[5]Cf. §5.3.3.

of these verbs may in itself not be particularly revealing in terms of understanding speakers' treatment of these forms, or how they should best be analysed. Indeed, many items judged to be basically nouns (e.g., *spoon*) nevertheless have action-oriented verbal meanings, as do a number of forms which speakers categorised as falling in the area between 'Noun' and 'Verb' (e.g., *hug*). Given that the experimental results also appear to be in line with these judgments, it seems that the relative prototypicality of a verb is not as closely tied to speakers' cognitive representation of conversion pairs. If it were, this would seem to predict a far larger number of apparent V_B items than have actually been encountered in this investigation.

Despite these limitations, the correlation of relative concreteness with perceived 'nouniness' suggests that word class prototypicality – or specifically *nominal* prototypicality – may be an additional type of information which influences speakers' assessment of the word class of a form when it is presented in isolation. However, as it seems to have only a limited ability to help discern patterns of (non-) directionality in many conversion pairs, its use as a predictive criterion should be regarded as merely supplementary evidence for those pairs which are likely to be denominal.

6.2.2 Inflectional irregularity

Although inflectional irregularity did not play a primary role in the selection of conversion items for this study (for the reasons outlined in §3.2.1), it is still worth briefly noting the distribution of irregularly-inflected forms in the data, as well as its correlation with speakers' behaviour. As mentioned in §1.4.1.1A and further in §1.4.3.1, Kiparsky (1982, 1983; cf. Kim et al. 1991) argues that irregular verbs which are members of conversion pairs should be regarded as non-derived, due to the fact that such irregular marking is limited to Level 1. Furthermore, I have also argued in §1.5.1 that irregular forms should not belong to 'u' pairs, as these pairs do not have separate entries which can be marked for irregularity.

While there are only a few irregular verbs in the experimental groups tested here (3 out of 40 items in the first group; 2 out of 64 in the second), participants' responses in these cases (listed in Table 6.5 below) seem to roughly confirm the above assertions, and are indicative of the type of pattern which might be found with a greater number of data points.

Word	Survey	Exp. Nominal Weight	Scalar Rating
bite	1	.1385	–
dive	1	.0769	–
sting	1	.1692	–
catch	2	.0851	-0.9382
dig	2	0	-1.046

Table 6.5: Irregular verbs in Experiments 1-3

It should be noted that one of these verbs (*dive*) is found with both regular (*dived*) and irregular variants (*dove*). Still, within this small sample, we find that all of these words were classified as verbs at least 83% of the time in the forced-choice task, and two of them were at the 'Verb' end of the scalar ratings. None approached the requirements for classification as a N_B form. Although this data is sparse, it seems to generally be aligned with the claims made in Chapter 1. Future research on directional and root-derived conversion pairs may therefore benefit from directly testing the processing of a larger group of irregularly-inflected forms.

6.2.3 Frequency patterns

Among the most noted attributes of conversion pairs are the systematic frequency differences found between the uses in a pair. As discussed in §1.3.5, these differences in frequency often seem to be in line with other differences between pair members, such as asymmetrical semantic relationships. Additionally, according to the study by Teddiman (2012), these frequency patterns are also strongly correlated with how often speakers rate a conversion form as a noun or 'noun-like' rather than as a verb.

The results in the current study are no exception. As described in §6.2.1.1,

the survey responses were measured using the Experimental Nominal Weight (Teddiman 2012: 242) and the mean *z*-scores. For the frequencies, two different measurements were calculated. In Teddiman's study, the relative nominal and verbal frequencies were assessed using the *CELEX Nominal Weight* (CNW), which divided the frequency of the noun by the total frequency (noun + verb) of the word (Teddiman 2012: 241). However, it is not made clear whether the frequencies referred to are those of the bare nominal and verbal stems (i.e., surface frequency), or the noun and verb lemmas as a whole. I have therefore calculated and tested both.

For the forced-choice responses of the first group of words, the lemma and surface CNWs were separately compared to the ENWs using Spearman correlations (Teddiman 2012: 242). Forced-choice responses were highly correlated with relative lemma frequencies [$r_s = .888$, $n = 40$, p<.0001; Figure 6.4]. A similar pattern was found for the relative frequencies of the unaffixed forms [$r_s = .800$, $n = 40$, p<.0001; Figure 6.5].

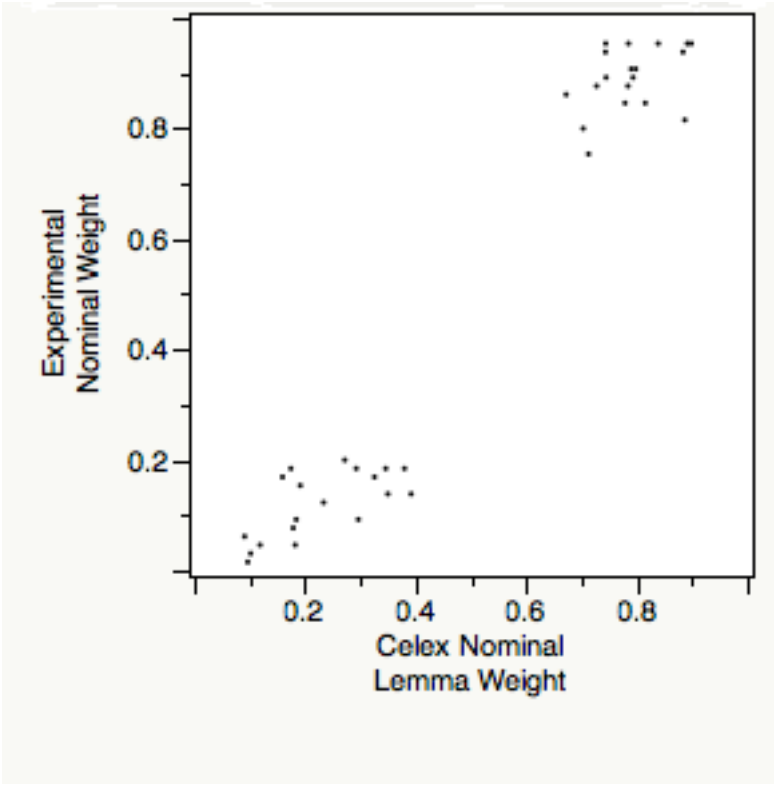


Figure 6.4: Relative nominal lemma frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2)

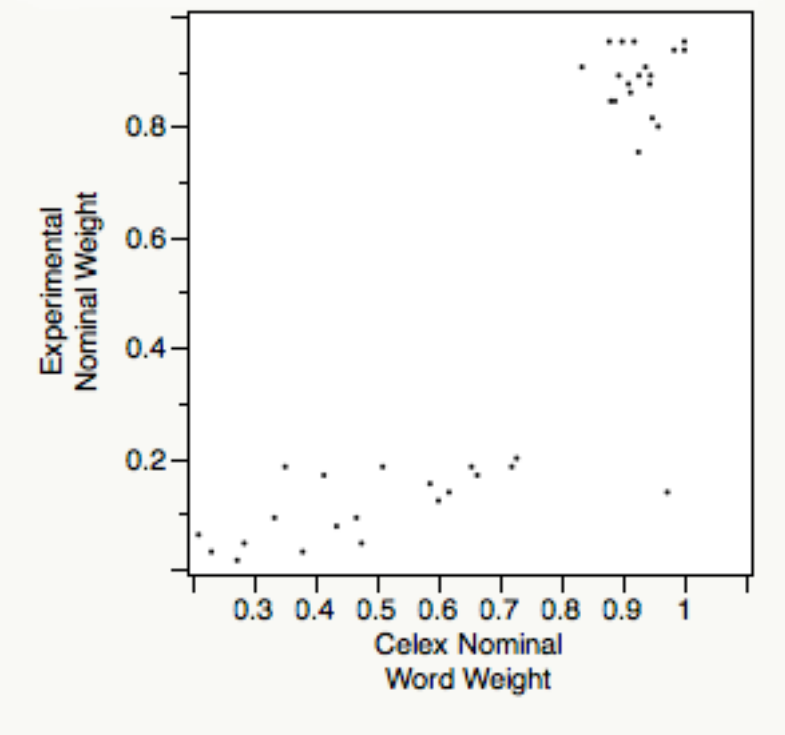


Figure 6.5: Relative nominal surface frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 1 (Experiments 1 and 2)

Following Teddiman (2012: 242-43), linear regressions were also conducted on the data, with the CNWs and what Teddiman refers to as the 'the total *CELEX Word Frequency*' as predictors of the Experimental Nominal Weight. As with the other frequency measures, the total CELEX Word Frequency was calculated on the basis of both lemma and stem surface frequencies. For the lemma frequency regression, the adjusted R^2 for the model was 0.945. CELEX Nominal Lemma Weight was again found to be a significant predictor of forced-choice responses [p<.0001]; however, the total CELEX Lemma Frequency was not [p=.6691]. For surface word frequency, the adjusted R^2 was 0.756, and surface CNW was a significant predictor [p<.0001]. As with total CELEX Lemma Frequency, total CELEX Word Frequency was not a significant factor [p=.2621]. The results from the first set of forms clearly demonstrate that a greater relative frequency of occurrence in nominal contexts is highly predictive of a 'Noun' response in a forced-choice task.

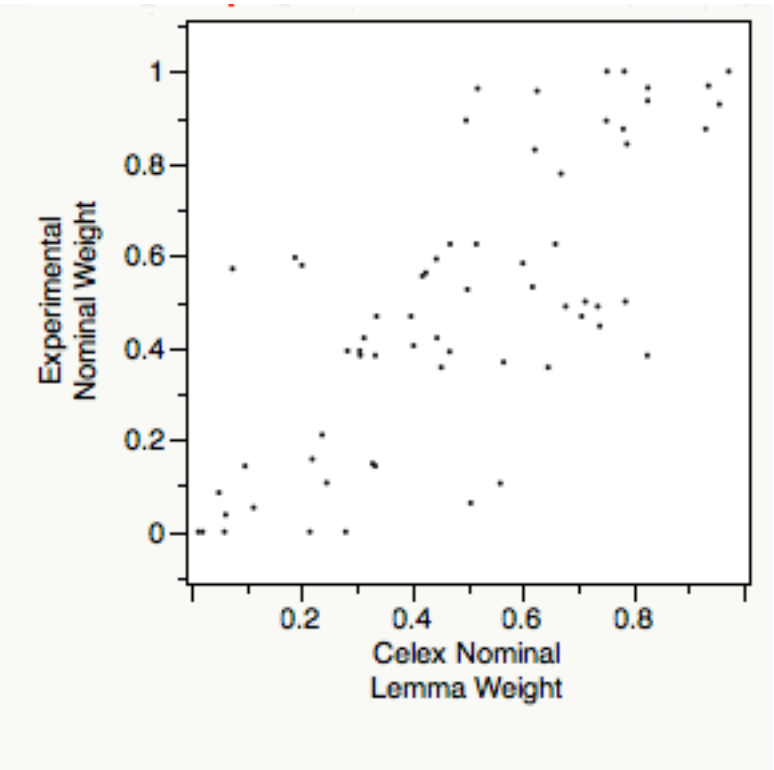


Figure 6.6: Relative nominal lemma frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3)

The forced-choice responses to the forms from Experiment 3 confirmed this pattern. Strong correlations emerged for both relative lemma frequencies [$r_s = .705$, $n = 64$, p<.0001; Figure 6.6] and relative surface stem frequencies [$r_s = .711$, $n = 64$, p<.0001; Figure 6.7].

Linear regressions revealed that only lemma CNW was a significant predictor of responses [adjusted $R^2 = 0.542$, lemma CNW: $p<.0001$, total lemma frequency: p=.6294]. Surface word CNW and the combined surface frequency of the noun and verb stems showed a similar pattern [adjusted $R^2 = 0.460$, Word CNW: $p<.0001$, total word frequency: p= .6628].

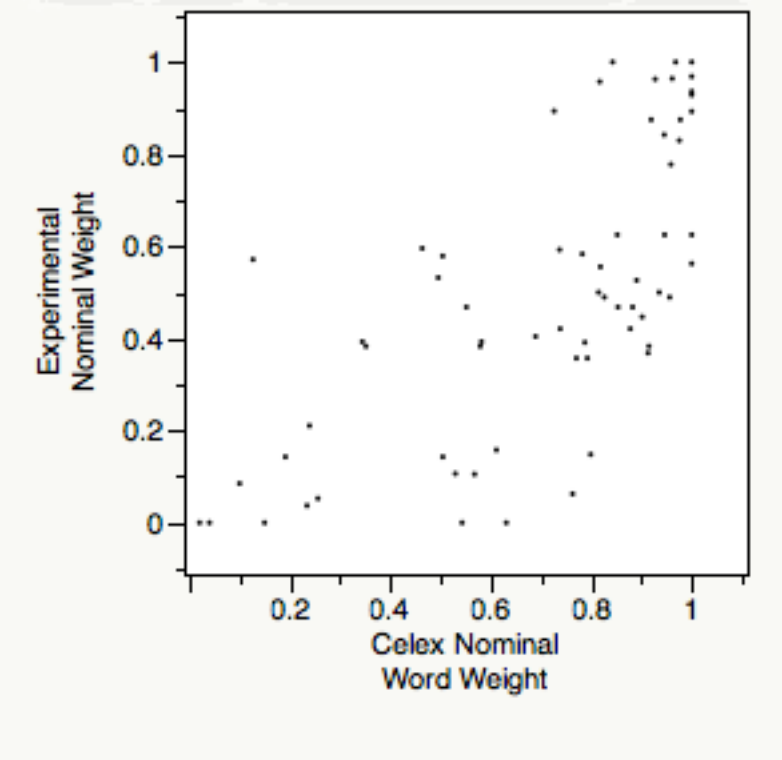


Figure 6.7: Relative nominal surface frequency as compared to percentage of 'Noun' responses in forced-choice, Survey 2 (Experiment 3)

The scalar rating data were in line with these tendencies. Mean ratings were significantly correlated with both lemma CNWs [$r_s = .764$, $n = 64$, $p<.0001$; Figure 6.8] and CELEX Nominal Word Weight [$r_s = .731$, $n = 64$, $p<.0001$; Figure 6.9].

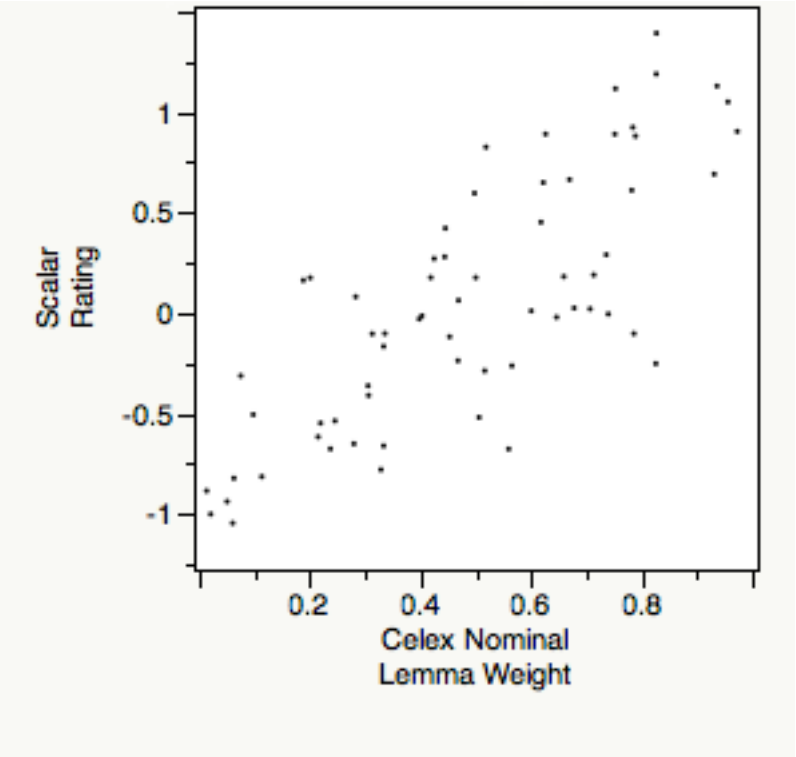


Figure 6.8: Relative nominal lemma frequency as compared to mean scalar responses (Survey 2)

In general, the responses to the second group of forms seem to vary more widely. Given the general correlation with frequency, however, it seems likely that this difference is connected to the larger variety of frequency relationships among the pairs in the later survey (§5.2.2), as compared to the more controlled frequency patterns in Survey 1 (§3.2.2).

Although the relationship is not completely categorical, the data presented here clearly mirrors that of Teddiman (2012). Across both surveys, the frequency of the nominal form – relative to that of the verbal form and the combined frequency of both uses – is associated with larger numbers of respondents selecting 'Noun' in a forced-choice task, as well as with a greater number of scalar responses situated nearer the 'Noun' end of the scale. As Teddiman (2012) argues, these

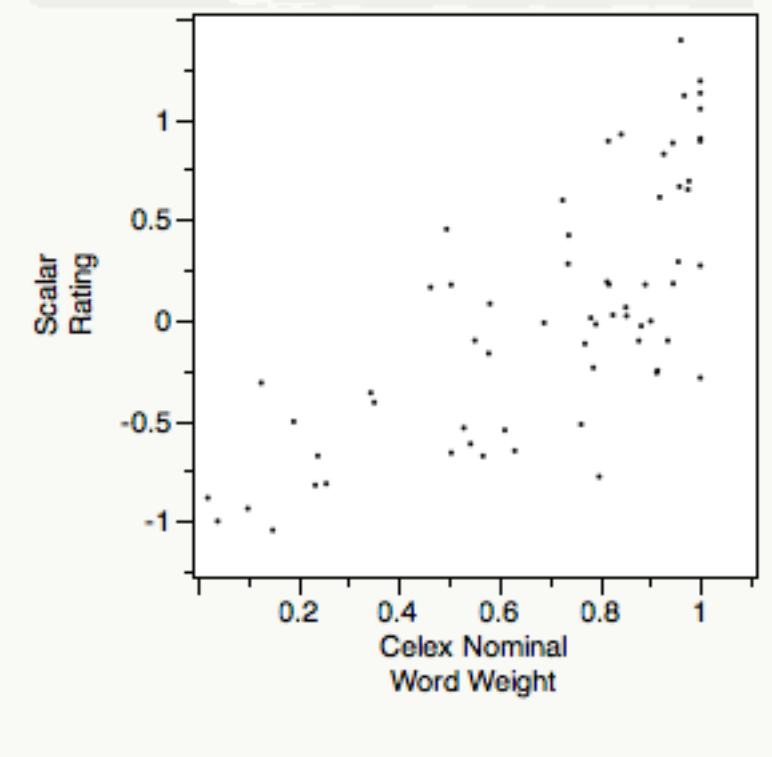


Figure 6.9: Relative nominal surface frequency as compared to mean scalar responses (Survey 2)

patterns suggest firstly that there is some degree of reliability in CELEX frequencies, and that corpora like CELEX 'are able to act as imperfect "stand-ins"' for speakers' linguistic experience. More importantly for our purposes, it also suggests that speakers' perceptions of the word class of a form may be influenced by the distributional patterns which they have previously encountered. It is worth recalling, however, that the strong correlations reported here do not necessarily indicate a direction of causation – that is, as noted in §1.3.6, we cannot discern whether it is frequency which influences basicness intuitions, or whether basicness, or some aspect of it, influences frequency of use.[6] That said, based on the data presented above and the results of the experiments, I am inclined to believe that the relationship is one of mutual reinforcement.[7]

[6]Cf. Plank et al. (2011: 61).

[7]For further discussion of the additional frequency-related measure of *transition probability*, see §6.3 below.

6.2.4 Interim conclusion

The results of the brief set of analyses described above are indicative of the fundamental usefulness of criteria based on particular patterns of linguistic characteristics, most clearly in terms of their ability to predict speaker behaviour, as well as potentially reflecting internal cognitive representations. Furthermore, they also confirm the robustness of the survey methods employed in this study for the assessment of speakers' intuitions of symmetrical and asymmetrical relationships between the forms in conversion pairs. The observed correlations suggest that speakers are sensitive to a variety of different types of knowledge about a lexical form and its relationship to other forms, and are able to draw upon this knowledge in making decisions regarding not only the lexical status of a form (i.e., during lexical decision), but also regarding grammatical features such as word class. Nevertheless, as I will discuss further in §6.4, it is likely that while the strongest tendencies will hold across different populations of speakers, the speaker-perceived boundaries between different types of relationship will also be dependent to some extent on not only the forms in question, but also the extralinguistic characteristics of the respondents, such as education level, dialect, age, etc. Additionally, there are particular patterns across certain groups of conversion pairs which may make the boundaries between them particularly difficult to discern. However, these issues only serve to reinforce the necessity of eliciting judgments from *multiple* speakers in order to discover where the clearest patterns may lie, and to thereby ensure the best chance of observing experimentally any underlying differences which are present.[8]

[8]Cf. Taft & Forster (1975: 645).

6.3 Conversion, complexity and morphological processing in word recognition

Focussing now on the unique contribution of the current study, we turn to a reconsideration of the three experiments taken as a whole, in view of the various issues explored in Chapter 2. Seeking a deeper understanding of either the experiments conducted herein or the context of earlier research will shed light on the issues involved in the other.

Beginning with the masked priming task used in Experiment 1, it was found that all morpho-orthographically related targets were facilitated by prior presentation of their *-ing* primes, regardless of their word class or their potential underlying morphological relationship. In contrast to what was expected given the detailed model of Crepaldi et al. (2010), there was no clear evidence of any distinction between different types of morphological relationship, nor indeed any apparent distinction as regards whether the prime and target belonged to the same word class. Additionally, the small but significant effect of facilitation in the Associative condition suggests that even when the prime is only presented for 50 ms, the beginnings of the activation of semantic associates may still be observed. On the whole, however, when combined with later research (e.g., Morris & Stockall 2012), the results of Experiment 1 suggest that facilitatory effects in masked priming are largely due to an early automatic process which initially decomposes any form which appears to be morphologically structured.

In contrast, Experiments 2 and 3 revealed interesting and complex patterns of results. Across the two tasks conducted in the auditory and visual modalities respectively, related *-ing* primes failed to significantly speed responses to those nominal targets which were judged by speakers to be more basic – e.g., hearing or seeing *nesting* did not make it easier to recognise A NEST as compared to the unprimed baseline. However, all verb targets – whether judged to be basic or not – *were* primed, as well as all those nouns which were rated as falling

somewhere between the categories of 'Noun' and 'Verb.' Finally, one group (the V_BNouns) seemed to behave differently depending on the experiment, showing significant facilitation in the auditory task, but almost no effect when presented visually. I have proposed in §5.3.4 that this difference potentially stems from the greater processing time available in the auditory task, which was the result of the greater overall task difficulty induced by both the auditory presentation and the real-stem-real-suffix nonword trials. As noted previously, however, the various methodological differences between the two delayed priming tasks mean that we cannot be entirely certain why these contrasting results have arisen.[9] Nevertheless, I would argue that the particular pattern of priming for different target categories across these two experiments suggests that the delayed priming task is sensitive to underlying differences in morphological structure – unlike the masked priming task – and that it may reveal these differences independently from those arising from the combination of meaning and form relationships.[10]

Therefore, given the results of these experiments and the theoretical underpinnings of CONVERSION, how can these patterns further inform us about the mechanisms underlying lexical storage, relationships, and processing during recognition? Likewise, what might an understanding of these mechanisms reveal about the cognitive representation of conversion pairs?

The first issue to note is one which has been a central concern throughout the investigations in this study: the distinction between inflection and derivation. As noted, despite the predictions made on the basis of the arguments in Crepaldi et al. (2010), such a distinction does not appear to factor into the degree of facilitation which is observed during short SOA masked priming. However, although the results of Experiment 2 were suggestive of the importance of this distinction in processing, further evidence to support this difference most clearly emerged in Experiment 3. As in the study by Stanners et al. (1979), those conditions in

[9] A visual version of Experiment 2 is currently being conducted, in an effort to further investigate this issue with a more comparable design.

[10] Cf. §2.2.2.1.

which the prime and the target were argued to have an inflectional relationship were those which exhibited the greatest amount of facilitation. In contrast, when the prime and target were arguably related through *derivation* (barring, of course, the V_BNouns in Experiment 2), facilitation was not observed. Furthermore, in spite of the claims of Fowler et al. (1985) and Raveh & Rueckl (2000) that any priming difference of this sort was due to the influence of episodic factors conditioned by greater formal overlap between inflectional relatives, the differences detected here are unlikely to have arisen in this way, as all conditions had the same degree of phonological/orthographic overlap, as well as the same suffix. Instead, like Stanners et al. (1979), I would argue that the difference in the degree of priming across these experiments has arisen from the fact that derived forms have a *separate* lexical representation from their bases, while (regularly) inflected forms do not. Thus, inflected forms must directly access their bases (the targets). Still, given the interesting pattern found by Morris & Stockall (2012) – wherein an analysis of ERPs produced different results from those of the lexical decision latencies – it is worth investigating this issue further.[11]

Moving on to the numerous issues concerning frequency, we find first that the frequencies of the primes or the targets do not, on their own, seem to have a clear effect on the degree of priming produced. Although it was suggested that higher frequency primes may potentially induce greater facilitation (Giraudo & Grainger 2000), this measure did not seem to influence any of the experiments. As for target frequency in terms of frequency attenuation (Forster & Davis 1984), this effect also does not seem to have manifested in the experiments here, as some high frequency targets were facilitated (V_BVerbs), while others (N_BNouns) were not. Even if we consider the influence of both lemma and surface frequency, differences in priming were also observed across pairs in Experiment 3 which were matched on both these parameters. As the frequency attenuation effect was in fact only demonstrated with *identity* priming, it may simply be the case that this

[11] See §6.5.

effect does not hold when the prime and target differ.

We also do not find much evidence to support the arguments of Taft (2004) regarding the Reverse Base Frequency Effect. As discussed extensively in Chapter 4, the use of real-stem-real-suffix nonwords in Experiment 2 did not seem to have the effect which would be predicted on the basis of Taft's arguments. In particular, although increasing the importance of Taft's proposed recombination stage should have led to less priming for the lower frequency, non-verbal V_BNouns, this did not correspond to the results. In fact, the facilitatory effect for V_BNouns only disappeared when these nonwords were removed. While I have noted that this cross-experiment difference suggests some kind of (indirect) effect from these specially-constructed nonwords, it does not seem likely that this effect is related to a stage at which bases and affixes of decomposed complex words are recombined.

A further factor whose influence is not entirely clear is that of affix type and productivity. It was suggested in §2.3.3 that the recognition of a complex form resulting from a particular morphological process might depend on which 'level' this process has occurred on (cf. Kiparsky 1982); such an analysis was then proposed for the asymmetrical priming behaviour of the two N_B groups in Experiment 2 as opposed to the very similar behaviour of the V_B groups. However, given the subsequent results of Experiment 3, where the same kind of pattern did not manifest, we cannot be sure what impact, if any, such level differences may have had on the processing of directional conversion pairs.

Proceeding, therefore, to the particularly pertinent issue of stem-suffix compatibility – more specifically, transition probability – it was suggested that this distributional measure may interact with morphotactic restrictions regarding which stems and suffixes may be combined. However, as noted above, it does not seem as though these restrictions *per se* have affected the results, except through the identification of the *-ing* stems as verbal (or underspecified) rather than nominal. The contribution of transition probability, on the other hand, has not been thoroughly investigated with regards to the primes in the experiments

here. Thus, following Solomyak & Marantz (2010), the transition probability was computed for all primes as the ratio between the surface frequency of the -*ing* prime to the combined frequency of its morphological family members.[12]

For the primes in Experiments 1 and 2, transition probability between the base and the -*ing* suffix was unsurprisingly different for the N_B forms as opposed to the V_B forms [$t(21.43) = 7.03$, $p<.0001$]. The probability that, having encountered the particular stem, one would also encounter a following -*ing* was much higher in the V_B group, though neither probability was particularly high (based on normalised frequencies: N_B: 0.04; V_B: 0.26). Of greater interest are the transition probabilities across the four groups in Experiment 3, each of which contained a different set of items. When the mean probabilities were assessed according to these four groups using a Tukey HSD test, no significant differences emerged [all $p>.10$]. However, when the two 'u' categories were grouped together, the differences between V_B and N_B, as well as between V_B and the 'u' groups, approached significance [V_B-N_B: $p=.0661$; V_B-'u': $p=.0841$; 'u'-N_B: $p=.8895$]. As might be expected, the primes in the V_B group had the highest transition probability (0.23), the 'u' groups the next highest (uV_B: 0.15; uN_B: 0.11), and N_B the lowest (0.06). Although these patterns are certainly suggestive of the potential influence of stem-suffix transition probability on the processing of the primes in Experiments 1-3, an issue would still remain concerning the behaviour of V_BNouns – that is, high transition probability was associated with priming in one case, and not priming in another. It therefore does not seem that transition probability alone can account for the overall patterns of results.

Thus, as I have argued throughout this study, it is necessary to consider the influence of levels of morphological complexity – particularly in combination with the distinction between inflection and derivation. The combined results of Experiments 2 and 3 seem to suggest that differences in the underlying morphological

[12] As in Solomyak & Marantz (2010), both frequencies were computed as *log* frequencies, with frequencies of 0 computed as frequencies of 1 (Bertram et al. 2000b). The combined family frequency also excluded compound words.

structure of an item do indeed play a role in the processing of these items during recognition. That said, the oft-noted difference between these two experiments in terms of the facilitation of V_BNouns raises questions regarding the conditions under which we would expect complexity effects to emerge. It may be that these effects are sufficiently subtle enough that, as in the experiments here, it is necessary to design the experiment in such a way that potential differences may be more easily disentangled. I will return to this point in §6.5.

One final issue which may be raised is that, although I have argued for a morphologically-conditioned interpretation of the lack of priming for N_BNouns, it might be suggested that this absence of an effect in delayed priming is simply due to the complete absence of a morphological relationship between the primes and the targets in this group. If this were the case, the relevant nominal and verbal forms would simply be homophonous/homographic – i.e., competitors. However, previous experimental evidence suggests that such homophones actually compete with one another for lexical access, thereby producing *inhibitory* effects in priming tasks (Allen & Badecker 2002). Furthermore, as suggested by the semantic dependency analysis in §6.2.1.1, the nominal and verbal forms in these pairs do indeed seem to be related in meaning. This kind of polysemy in particular has been found to clearly contrast with homophony in lexical decision (Rodd et al. 2002; Klepousniotou & Baum 2007), in that the presence of these related meanings in a form speeds recognition, rather than causing inhibition.[13] Given these patterns – along with the arguments of the more morphologically-conditioned account generally advanced here – the proposal that the forms in N_B pairs are not morphologically related seems unsupported.

To summarise, the results obtained through the three experiments in this study, and in particular through the delayed priming tasks, seem to confirm the influence of factors concerning morphological relationships and structure in the processing of words during lexical decision. These results, I would argue, cannot

[13]Cf., however, Klein & Murphy (2001) and Pylkkänen et al. (2006).

be purely based on either form or meaning alone, nor on purely distributional characteristics. Nevertheless, as has been alluded to, the patterns are not completely straightforwardly interpretable, and leave us with a number of questions to be explored in further research. In particular, these morphological effects seem to be subtle, and subject to change depending on the experimental context. Thus, through the refinement and use of multiple experimental methods – both behavioural and neurological – it may be possible to observe even clearer effects of the systematic differences within and across conversion pairs. However, as hinted at in §6.2 (and explored further below), a major issue remains: the behaviour of conversion pairs – both across speakers as well as across the phenomenon as a whole – seems not to be as categorical as it is represented in §1.5. Rather, the behaviour and treatment of particular pairs as regards their directionality or lack therof is instead likely to be *gradient*. This, in itself, will undoubtedly have implications for our ability to observe consistent patterns in processing.

6.4 Modelling CONVERSION, morphological complexity, and underspecification

In the working model proposed in §1.5, and implicit in the assumptions made throughout the experimental investigation, is the idea that canonical conversion pairs may be divided into three or four categories according to both the relationship between the nominal and verbal forms in a pair, and their underlying morphological structure. I have argued that it is possible to distinguish pairs which consist of (1) nouns morphologically derived from verbs; (2) verbs morphologically derived from nouns; (3) inflected forms of a single item without a word class specification; and (4) two separate words which are independently derived from one underspecified root – although the work reported here has been focussed on the former three types. Through the use of surveys of native speakers and experimental tasks, these ideas seems to be confirmed to certain extent. The results

of these endeavours have revealed clear asymmetries between pairs of the first two types, and have suggested that the derived forms in these groups are formed from the base by the addition of further underlying morphological structure. Among the third group, we have found more balanced behaviour which indicates that the apparently nominal and verbal forms in such pairs share a single, underspecified lexical entry. This third pattern is distinguished from the fourth (likewise symmetrical) pattern in both its linguistic and experimental behaviour. Rather than having the kinds of relatively independent meanings expected in root-derivation, the 'u' forms I have investigated have much closer semantics, with minimal differences between the nominal and verbal uses. Furthermore, their behaviour in the experimental tasks suggests that they are even more closely related to one another than the word-derived forms of patterns (1) and (2). Although I have not provided direct experimental evidence bearing on the processing of root-derived forms, the structures which are proposed to underlie the forms in this pattern do not lead us to expect the behaviour observed in Experiment 3.

However, as I have begun to suggest, the distinctions between the types of relationships described above are not always completely clear-cut. In particular, the less clear patterns of behaviour in the V_B groups as compared to the other types – both across the experiments and within the surveys – have not been fully discussed. Beginning with the variation found across the experiments, it seems that there are a number of possible interpretations beyond the suggested additional processing time available in Experiment 2.

One of these possibilities concerns the potential differences in the kinds of intuitions elicited by the two surveys. Following the discussion in §5.2.1 regarding the cross-speaker inconsistency of the forced-choice responses for some forms, the design of the second basicness survey was modified. The inclusion in this modified survey of the scalar responses and confidence ratings was not only intended to allow us to disentangle the different sources of this inconsistency, but also to elicit both 'extreme' groups and a group fairly directly in the middle. The rationale

behind this intention was that such extreme and middling groups would be more likely to lead to clearer patterns in processing, which is particularly necessary here given the dearth of earlier work on the processing of conversion pairs. It is possible, however, that the modified survey succeeded in doing just that – essentially, the V_B forms in Experiment 3 may have been more strongly 'verb based' than the V_B forms in Experiments 1 and 2. This in turn may have led to the complete lack of facilitation for the corresponding nominal forms in Experiment 3, as opposed to the strong priming found in Experiment 2.[14]

The obvious question that this proposal raises is: how can directionality – and consequently, the mental representation of underlying morphological structure – be gradient? In fact, upon reconsideration of both the nature of the phenomenon under investigation and the possibilities for discovering speakers' mental representations of this phenomenon, the proposal of a *lack* of gradience seems to become more surprising. To begin with, the patterns in many conversion pairs (particularly those which are potentially directional) are fundamentally *lexical* in nature, and thus subject to arbitrariness, lexicalisation/idiomaticity, irregularity of meaning, etc. In line with this, recall the remarks of Clark & Clark (1979: 808; §1.3.1.2), who note in their discussion of denominal verbs that not only do 'idioms [forms with specialised meanings – JD] often shade off into innovations [forms with transparent meanings – JD], with no clear boundary,' but also that 'idioms and innovations can co-exist' within the same pair. In fact, as Croft (1998: 171) also suggests, the gradience and co-existence of these different types of relationship is at least partially a result of taking a synchronic approach: within a particular type of relationship, we may be viewing a stage in a process 'of change in grammatical representation over time.' Thus, those pairs whose relationship is at one particular stage may appear to be more or less 'directional' than other kinds of pairs at different stages.

Closely connected to this issue are the patterns of disagreement which may

[14]Certain others have also been noted in the discussion of Experiment 3 (§5.3.4).

be observed across speakers, as discussed in §5.2.1. In that section, it was noted that there are several potential sources for this kind of disagreement, two of which would seem to be more indicative of the underspecification of a form: when presented with a forced-choice task, speakers who either did not have a strong intuition one way or the other, or had an intuition which fell in the middle, might simply respond more or less randomly. However, a further possibility is simply that speakers sometimes did not agree with one another. Although, as noted, the design of Survey 2 was primarily intended to assist in locating cases of the former two types, some of the words in that task may nevertheless have elicited true inter-speaker disagreement.

What, then, might further investigation of such cases tell us about the nature of conversion pairs? As Croft (1998: 170) points out, even in experimental tasks which investigate the cognitive organisation of lexical information, '[o]ne should also beware of potential interindividual variation in mental representation' – in other words, how a lexical item is stored mentally may depend on individual speakers. This, in turn, will depend upon the speaker's linguistic experience, such as how often and in what kinds of contexts they have heard a form or forms used. In particular, if a pair is in the process of moving between different diachronic stages, its usage will often vary depending on both linguistic and extralinguistic information, such as the education level, dialect, age, etc. of the speaker who uses it.[15] Thus, as noted in §5.2.1, if individual speakers do indeed have different mental representations for a form, the subsequent disagreement in the results of a judgment survey would not *necessarily* mean that these forms are underspecified at the level of the individual speaker. However, it may still be proposed that the reason these forms are more susceptible to inter-speaker variation in representation is that their inherent linguistic properties do not automatically assign them a word class specification, leaving speakers to deduce their own based on other types of input.

[15]Cf. §6.2.4.

In addition to this possible account of the variations found in the behaviour of the V_B forms, there are two further issues which must be acknowledged. Recall, for instance, that one of the features of underspecified pairs concerns their predictable semantics – i.e., the fact that their meanings only seem to differ according to whether they are predicates or referring expressions (cf. §1.4.2). Thus, *kiss* in its verbal use predicates an event, while its nominal use simply refers to that event as a whole. This minimal meaning shift has been claimed to suggest that these uses only involve the insertion of an underspecified root into a context. This is proposed to contrast with the types of meaning shifts typically found in directional pairs such as *bite*. While the verbal form of *bite* also predicates an event, the nominal form $bite_N$ refers to either 'an act of *biting*' (example 6.1) or 'the result of the action of *biting*' (e.g., a *bite* of mashed potatoes), and thus seems to have more specific semantics, with a meaning which is more complex than its corresponding verb.

However, despite the discussion of 'minimal meaning shifts' in Evans & Osada (2005), it is not always entirely clear which meanings should be considered to be 'minimal'. In the case of *bite*, for instance, it could very well be argued that the sense 'an act of *biting*' is a fully compositional meaning which simply results from the placing of a flexible process-centered root in a referring environment. I have argued in §1.3 that such considerations must be combined with those of semantic dependency – thus, $bite_V$ is not naturally defined as 'to give *bites*', particularly in the result sense of the noun. Nevertheless, we have also seen that the establishment of semantic dependency is often difficult to do in a principled way.

In light of these issues, therefore, it seems that the distinction between the V_B forms and process-centered 'u' forms has not been unequivocally established. Indeed, the apparently deverbal nouns in Experiment 2 seemed to exhibit the same behaviour we would predict of 'u' forms – although, of course, the results more clearly diverged in Experiment 3. Furthermore, we find in the experiments

that forms which seem to have similar meaning patterns have sometimes fallen into different categories based on speaker judgments (e.g., *shred* 'the result of *shredding*' was judged to be V_B, while *scoop* 'the result of *scooping*' elicited more uncertainty). Given these difficulties, it may be necessary to be more cautious in our assessment of the data presented in this study, as it is possible that a different analysis which investigates these distinctions in more detail might lead us to reclassify certain V_B and 'u' forms.

A final point before concluding concerns the contrast between this unclear behaviour in V_B forms when compared to that of the much more easily identifiable N_B pairs. When we consider the linguistic patterns described in Chapter 1, the results of the last two experiments, the correlations between the linguistic characteristics and survey responses, etc., we find over and over that there is a distinct tendency for the patterns among the N_B pairs to be stronger. Thus, forms felt to be basically nominal not only usually have higher nominal lemma frequencies, but also higher frequencies for the unaffixed form of the noun; in contrast, the unaffixed verbs of V_B pairs are not always more frequent than their nominal counterparts. While this particular pattern is due to the fact that unaffixed forms of nouns are in general more frequent than their inflected forms, with verbal stems proportionally less frequent (Sereno & Jongman 1992 in Sereno & Jongman 1997: 428), it is still aligned with the other patterns which favour N_B pairs. As we have seen in Experiments 2 and 3, it is also the N_BNouns which consistently fail to be facilitated in delayed priming. Furthermore, the concreteness ratings for the N_B items were also significantly higher across both sets of experimentally-tested words – in particular, while the N_BNouns from Experiment 3 were rated as significantly more concrete than the forms from the other three groups, these latter groups did not differ from one another. While it is also somewhat to be expected that items which tend to be rated as nouns are also judged to be more concrete, this tendency seems to replicate itself in the analysis of semantic dependency. As noted in Table 6.4, again the N_B group is the only one for which the patterns of

semantic dependency also most clearly indicate asymmetry.

Potentially connected to these distinct tendencies found among N_B pairs are the patterns of meaning remarked upon by Aronoff (1980) in his discussion of denominal verbs. In this paper, Aronoff argues that the rule for forming converted verbs from nouns is highly general. This rule is, for the most part, unrestricted in which nouns it can apply to (Aronoff 1980: 746; however, cf. §1.3.1.1), and has no more specific semantics than 'an activity associated with the noun' (Aronoff 1980: 747). In novel denominal verbs, precisely which activity this is simply a matter of interpretation in context. Aronoff compares this interpretation to that of evaluative phrases like *George is a good nurse* (Aronoff 1980: 748). If it is not George's profession to be a nurse (e.g., he is simply taking care of someone with a cold), we must rely on the use of context to determine which aspects of the noun *nurse* are intended to be evaluated as 'good'. In a similar way, novel denominal verbs may easily be formed on the basis of the more general morpho-semantic rule above, with more specific meanings arising from factors of context.

The assumption of this kind of general rule for novel verbs provides us with a means of explaining many of the patterns found among N_B forms. Firstly, it suggests a reason why N → V conversion seems to be both semantically idiosyncratic *and* more productive. If the semantic idiosyncrasies are simply the result of arbitrary lexicalisations which took place after the application of the general rule, then we might expect a wide variation in meaning patterns among those pairs involved in this rule. Furthermore, while the relatively 'vague' semantics leaves much to be determined by the context in the initial stages of the verb's use, it also allows the rule to have a wide domain of application. In comparison, the more semantically restricted V_B patterns (e.g., the noun describes a 'piece' of the verb's event; cf. Arad 2003: 765) may not be as generally applicable – although this restrictiveness may make the forms involved in V → N conversion appear to be more regular.

Returning now to the strong N_B patterns noted above, we may begin to pro-

vide an explanation for the apparent prominence of these pairs. When this general, semantically-flexible rule of verb-deriving is combined with the distinct tendencies which highlight the nominal form in such pairs (e.g., frequency, concreteness, etc.), it seems likely that the pattern would be strongly reinforced in the minds of speakers. The clear boundaries of a concrete nominal form (e.g., *bottle*) would make it easier to establish semantic dependency, and the high frequency of its stem form would further suggest to speakers that it is 'basic.' This pattern will be repeatedly found throughout the lexicon, and its semantics will additionally suggest that it is not very restricted. This will then encourage speakers to derive new forms on the basis of this unrestricted rule, thereby further increasing the number of word pairs which fit the pattern, and adding to the available evidence in favour of this process. In contrast to this, the patterns involved in V $\rightarrow$ N conversion will not benefit as highly from these systematic biases in favour of N $\rightarrow$ V pairs; thus, this conversion process of noun-deriving will be rather more difficult to identify, in addition to being less productive.

Although considerations like those above will not be investigated systematically here, they emphasise the need for an even more fine-grained approach in moving forward with further research, in order that we may better understand the behaviour those forms which lie along the boundaries between different types of relatedness. Despite this need, the investigations conducted in this study ultimately suggest that the phenomena often grouped under the single label of CONVERSION may in fact be a series of distinct – though not always completely separable – phenomena which fall into general patterns according to how they are treated in both off- and online processing. However, as I will propose below, there are a number of possible ways in which future research on this phenomenon may build upon the findings reported in the present study.

6.5 Conclusions and suggestions for further research

As this study has demonstrated, the behaviour of the widespread pattern of noun-verb CONVERSION in English is both incredibly complex and relatively systematic. Despite the gradient nature of this phenomenon, and the inherent difficulties in discerning the relationships within certain pairs of nominal and verbal forms, the fact that the experiments into the morphological processing and recognition of these forms – as well as the surveys of native speaker judgments which fed into them – nevertheless revealed several distinct patterns speaks to the robustness of these tendencies in the language. While this investigation has provided some insight into the characteristics which may play a role in this system of symmetries and asymmetries, there are still further avenues to be explored, both in terms of theoretical questions which might be asked and alternative experimental methods which may contribute more detailed information.

On the theoretical front, there has been a great deal of work in the minimalist tradition (e.g., Hale & Keyser 1993; Harley 1999, *inter alia*) which has explored potential differences within and across conversion pairs in terms of their underlying argument structure. It would therefore be useful to investigate how far these differences might be able to explain both speaker judgments and differences in processing. A further possibility might be the implementation of a more stochastic model of the information which conditions 'basicness' and 'derivedness,' along the lines of the study of Bresnan & Hay (2008) concerning the dative alternation. The output of this model could then potentially be used to select stimuli for further experimentation.

Methodologically, as suggested previously, it would also be useful to apply other experimental methods, as these may reveal more or different information regarding underlying mechanisms of processing and storage. In particular, studies using fMRI (Meinzer et al. 2009; Pliatsikas et al. 2014), MEG (Pylkkänen et al.

2004), and EEG (Morris & Stockall 2012) to investigate morphological processing have suggested that these methods can provide additional evidence which may not emerge in reaction time data. Experiments using eye-tracking (Niswander et al. 2000) may also prove to be valuable in this respect. Another approach might involve eliciting native speaker judgments from the same population on which the experiments are run, perhaps in the form of post testing.[16] This may help to minimise some of the variation encountered due to speakers' different linguistic experience.

On the whole, however, the theoretical and experimental work undertaken in the present study has begun to lay the groundwork for a deeper understanding of how nominal and verbal forms involved in CONVERSION may be processed and represented, and in turn how we might best understand these paired forms theoretically. This study confirms the importance of distinguishing between different kinds of conversion pairs rather than treating them as cases of a single phenomenon, and suggests that this is indeed what speakers of English already do with regards to how they recognise and store the words of their language.

[16]I am grateful to Kyle Mahowald for this suggestion.

Bibliography

Aarts, Bas (2007) *Syntactic Gradience: The Nature of Grammatical Indeterminacy*. Oxford: Oxford University Press.

Acquaviva, Paolo (2009) Roots and Lexicality in Distributed Morphology. *York-Essex Morphology Meeting* **5**(10): 1–21, URL `http://ling.auf.net/lingBuzz/000654`.

Adams, Valerie (1973) *An Introduction to Modrn English Word-Formation*. London: Longman.

Alegre, Maria & Peter Gordon (1999) Frequency Effects and the Representational Status of Regular Inflections. *Journal of Memory and Language* **40**: 41–61.

Alexiadou, Artemis (2001) *Functional Structure in Nominals: Nominalization and ergativity*. Amsterdam: John Benjamins.

Allen, Mark & William Badecker (2002) Stem Homographs and Lemma Level Representations. *Brain and Language* **81**(1-3): 79–88.

Altarriba, Jeanette, Lisa M. Bauer, & Claudia Benvenuto (1999) Concreteness, context availability, and imageability ratings and word associations for abstract, concrete, and emotion words. *Behavior Research Methods, Instruments, & Computers* **31**(4): 578–602.

Altarriba, Jeannette & Dana M. Basnight-Brown (2009) An Overview of Semantic Processing in bilinguals: Methods and Findings. In *The Bilingual Mental*

Lexicon: Interdisciplinary Approaches, Aneta Pavlenko, ed., Bristol: Multilingual Matters, 79–98.

Amenta, Simona & Davide Crepaldi (2012) Morphological processing as we know it: an analytical review of morphological effects in visual word recognition. *Frontiers in Psychology* **3**(232): 1–12.

Anderson, Stephen R. (1992) *A-morphous Morphology*. Cambridge: Cambridge University Press.

Arad, Maya (2003) Locality Constraints on the Interpretation of roots: the Case of Hebrew Denominal Verbs. *Natural Language & Linguistic Theory* **21**(4): 737–78.

Aronoff, Mark (1980) Contextuals. *Language* **56**(4): 744–58.

Baayen, R. Harald, Ton Dijkstra, & Robert Schreuder (1997) Singulars and plurals in Dutch: Evidence for a parallel dual route model. *Journal of Memory and Language* **37**: 94–117.

Baayen, R. Harald & Rochelle Lieber (1991) Productivity and English derivation: a corpus-based study. *Linguistics* **29**(5): 801–43.

Baayen, R.H., R. Pipenbrock, & H. van Rijn (1993) The CELEX lexical database. University of Pennsylvania: Linguistic Data Consortium, URL `http://celex.mpi.nl`.

Badecker, William & Mark Allen (2002) Morphological Parsing and the Perception of Lexical Identity: A Masked Priming Study of Stem Homographs. *Journal of Memory and Language* **47**(1): 125–44.

Balteiro, Isabel (2007) *The Directionality of Conversion in English: A Dia-Synchronic Study*. Bern: Peter Lang.

Barber, Horacio A., Leun J. Otten, Stavroula-Thaleia Kousta, & Gabriella Vigliocco (2013) Concreteness in word processing: ERP and behavioral effects in a lexical decision task. *Brain and Language* **125**(1): 47–53.

Bauer, Laurie (1983) *English Word-formation*. Cambridge: Cambridge University Press.

Bauer, Laurie, Rochelle Lieber, & Ingo Plag (2013) *The Oxford Reference Guide to English Morphology*. Oxford: Oxford University Press.

Beard, Robert (1995) *Lexeme-Morpheme Base Morphology: a general theory of inflection and word formation*. Albany: State University of New York.

Beard, Robert & Mark Volpe (2005) Lexeme-Morpheme Base Morphology. In *Handbook of Word-Formation*, Pavol Štekauer & Rochelle Lieber, eds., Dordrecht: Springer, 189–205.

Bentin, Shlomo & Laurie B. Feldman (1990) The Contribution of Morphological and Semantic Relatedness to Repetition Priming at Short and Long Lags: Evidence from Hebrew. *The Quarterly Journal of Experimental Psychology* **42A**(4): 693–711.

Berko, Jean (1958) The Child's Learning of English Morphology. *Word* **14**: 150–168.

Bertram, Raymond, Jukka Hyönä, & Matti Laine (2000a) The role of context in morphological processing: Evidence from Finnish. *Language and Cognitive Processes* **15**(4/5): 367–88.

Bertram, Raymond, Jukka Hyönä, & Matti Laine (2011) Morphology in language comprehension, production, and acquisition. *Language and Cognitive Processes* **26**(4-6): 457–81.

Bertram, Raymond, Robert Schreuder, & R. Harald Baayen (2000b) The Balance of Storage and Computation in Morphological Processing: The Role of Word

Formation Type, Affixal Homonymy, and Productivity. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **26**(2): 489–511.

Booij, Geert (1996) Inherent versus contextual inflection and the split morphology hypothesis. In *Yearbook of Morphology 1995*, Geert Booij & Jaap van Marle, eds., Dordrecht: Kluwer, 1–16.

Bozic, Mirjana & William Marslen-Wilson (2010) Neurocognitive Contexts for Morphological Complexity: Dissociating Inflection and Derivation. *Language and Linguistics Compass* **4**(11): 1063–73.

Bozic, Mirjana, Zanna Szlachta, & William Marslen-Wilson (2013a) Cross-linguistic parallels in processing derivational morphology: Evidence from Polish. *Brain and Language* **127**(3): 533–38.

Bozic, Mirjana, Lorraine K. Tyler, Li Su, Cai Wingfield, & William Marslen-Wilson (2013b) Neurobiological Systems for Lexical Representation and Analysis in English. *Journal of Cognitive Neuroscience* **25**(10): 1678–91.

Bradley, Dianne (1980) Lexical representation of derivational relation. In *Juncture*, Mark Aronoff & M.L. Kean, eds., Cambridge, MA: MIT Press, 37–55.

Bresnan, Joan & Jennifer Hay (2008) Gradient grammar: An effect of animacy on the syntax of *give* in New Zealand and American English. *Lingua* **118**(245-59).

Brysbaert, Marc, Amy Beth Warriner, & Victor Kuperman (2014) Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research Methods* **46**(3): 904–11.

Burani, Cristina, Dario Salmasa, & Alfonso Caramazza (1984) Morphological Structure and Lexical Access. *Visible Language* **18**(4): 342–52.

Butterworth, B. (1983) Lexical Representation. In *Language Production*, vol. 2, B. Butterworth, ed., Academic Press, 257–94.

Caramazza, Alfonso, Alessandra Laudanna, & Cristina Romani (1988) Lexical access and inflectional morphology. *Cognition* **28**(3): 297–332.

Cetnarowska, Bożena (1993) *The Syntax, Semantics and Derivation of Bare Nominalizations*. Katowice: Uniwersytet Śląski.

Chomsky, Noam & Morris Halle (1968) *The Sound Pattern of English*. New York: Harper & Row.

Clahsen, Harald, Ingrid Sonnenstuhl, & James P. Blevins (2003) Derivational morphology in the German mental lexicon: a dual mechanism account. In *Morphological Structure in Language Processing*, R. Harald Baayen & Robert Schreuder, eds., Berlin: Mouton de Gruyter, 125–55.

Clark, Eve V. & Herbert H. Clark (1979) When Nouns Surface as Verbs. *Language* **55**(4): 767–811.

Crepaldi, Davide, Kathleen Rastle, Max Coltheart, & Lyndsey Nickels (2010) 'Fell' primes 'fall', but does 'bell' prime 'ball'? Masked priming with irregularly-inflected primes. *Journal of Memory and Language* **63**(1): 83–99.

Croft, William (1998) Linguistic evidence and mental representations. *Cognitive Linguistics* **9**(2): 151–73.

Croft, William (2001) *Radical Construction Grammar: syntactic theory in typological perspective*. Oxford: Oxford University Press.

Crystal, David (2005/1967) English Word Classes. In *Fuzzy Grammar: A Reader*, Bas Aarts, David Denison, Evilien Keizer, & Gergana Popova, eds., Oxford: Oxford University Press, 191–211.

Cutler, Anne (1983) Lexical Complexity and Sentence Processing. In *The Process of Language Understanding*, Giovanni B. Flores d'Arcais & R. J. Jarvella, eds., New York: Wiley.

Cutler, Anne, John A. Hawkins, & Gary Gilligan (1985) The suffixing preference: a processing explanation. *Linguistics* **23**(5): 723–58.

Darby, Jeannique & Aditi Lahiri (2016) Covert morphological structure and the processing of zero-derived words. *The Mental Lexicon* **11**(2): 186–215.

Davis, Chris, Jeesun Kim, & Angelo Barbaro (2010) Masked speech priming: Neighborhood size matters. *Journal of the Acoustical Society of America* **127**(4): 2110–13.

de Almeida, Roberto & Gary Libben (2005) Changing morphological structures: the effect of sentence context on the interpretation of structurally ambiguous English trimorphemic words. *Language and Cognitive Processes* **20**(1-2): 373–94.

de Lacy, Paul (2014) Evaluating evidence for stress systems. In *Word Stress: Theoretical and Typological Issues*, Harry van der Hulst, ed., Cambridge: Cambridge University Press, 149–193.

Diependale, Kevin, Joanna Morris, Raphael M. Serota, Daisy Bertrand, & Jonathan Grainger (2013) Breaking boundaries: Letter transpositions and morphological processing. *Language and Cognitive Processes* **28**(7): 988–1003.

Don, Jan (1993) *Morphological conversion*. Ph.D. thesis, Utrecht University.

Don, Jan (2005a) On Conversion, Relisting and Zero-derivation. *SKASE Journal of Theoretical Linguistics* **2**(2): 2–16.

Don, Jan (2005b) Roots, Deverbal Nouns and Denominal Verbs. In *Morphology and Linguistic Typology: On-line Proceedings of the Fourth Mediterranean Morphology Meeting (MMM4), Catania, 21-23 September 2003*, Geert Booij, Emiliano Guevara, Angela Ralli, Salvatore Sgroi, & Sergio Scalise, eds., morbo.lingue.unibo.it/mmm/: Universitá degli Studi di Bologna, 91–104.

Don, Jan & Eva van Lier (2013) Derivation and categorization in flexible and differentiated languages. In *Flexible Word Classes: Typological Studies of Underspecified Parts of Speech*, Jan Rijkhoff & Eva van Lier, eds., Oxford University Press, 56–88.

Drews, Etta & Pienie Zwitserlood (1995) Morphological and Orthographic Similarity in Visual Word Recognition. *Journal of Experimental Psychology: Human Perception and Performance* **21**(5): 1098–1116.

Embick, David & Alec Marantz (2008) Architecture and Blocking. *Linguistic Inquiry* **39**(1): 1–53.

Evans, Nicholas & Toshiki Osada (2005) Mundari: The myth of a language without word classes. *Linguistic Typology* **9**: 351–90.

Farrell, Patrick (2001) Functional shift as category underspecification. *English Language and Linguistics* **5**(1): 109–30.

Folli, Raffaella & Heidi Harley (2005) Flavors of v. In *Aspectual Inquiries*, Roumyana Slabakova & Paula Kempchinsky, eds., Dordrecht: Kluwer, 95–120.

Ford, M. A., Matthew H. Davis, & William Marslen-Wilson (2010) Derivational morphology and base morpheme frequency. *Journal of Memory and Language* **63**(1): 117–30.

Forster, Kenneth & Elizabeth S. Bednall (1976) Terminating and exhaustive search in lexical access. *Memory and Cognition* **4**(1): 53–61.

Forster, Kenneth & Susan M. Chambers (1973) Lexical Access and Naming Time. *Journal of Verbal Learning and Verbal Behavior* **12**(6): 627–35.

Forster, Kenneth & Chris Davis (1984) Repetition Priming and Frequency Attenuation in Lexical Access. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **10**(4): 680–98.

Forster, Kenneth I. (1976) Accessing the Mental Lexicon. In *New approaches to language mechanisms*, R. J. Wales & Edward Walker, eds., Oxford: North-Holland Publishing Company, 257–87.

Fowler, Carol A., Shirley E. Napps, & Laurie Beth Feldman (1985) Relations among regular and irregular morphologically related words in the lexicon as revealed by repetition priming. *Memory and Cognition* **13**(3): 241–55.

Frost, Ram, Avital Deutsch, Orna Gilboa, Michal Tannenbaum, & William Marslen-Wilson (2000) Morphological priming: Dissociation of phonological, semantic, and morphological factors. *Memory and Cognition* **28**(8): 1277–88.

Frost, Ram, Kenneth Forster, & Avital Deutsch (1997) What Can We Learn From the Morphology of Hebrew? A Masked-Priming Investigation of Morphological Representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **23**(4): 829–56.

Gennari, Silvia & David Poeppel (2003) Processing correlates of lexical semantic complexity. *Cognition* **89**(1): B27–41.

Giraudo, Hélène & Jonathan Grainger (2000) Effects of prime word frequency and cumulative root frequency in masked morphological priming. *Language and Cognitive Processes* **15**(4/5): 421–44.

Givón, Talmy (2001) *Syntax: An Introduction*, vol. 1. Amsterdam: John Benjamins.

Grainger, Jonathan, Pascale Colé, & Juan Segui (1991) Masked Morphological Priming in Visual Word Recognition. *Journal of Memory and Language* **30**: 370–84.

Haas, William (1957) Zero in Linguistic Description. In *Studies in Linguistic Analysis*, vol. Special volume of the Philological Society, Basil Blackwell, 33–53.

Hale, Ken & Samuel Jay Keyser (1993) On argument structure and the lexical expression of syntactic relations. In *The View from Building 20*, Kenneth Hale & Samuel Jay Keyser, eds., MIT Press, 53–109.

Halle, Morris (1973) Prolegomena to a theory of word formation. *Linguistic Inquiry* **4**: 3–16.

Halle, Morris & Alec Marantz (1993) Distributed Morphology and the Pieces of Inflection. In *The View from Building 20*, Ken Hale & Samuel Jay Keyser, eds., Cambridge, MA: MIT Press, 111–76.

Halle, Morris & K.P. Mohanan (1985) Segmental Phonology of Modern English. *Linguistic Inquiry* **16**(1): 57–116.

Hankamer, Jorge (1989) Morphological Parsing and the Lexicon. In *Lexical representation and process*, William Marslen-Wilson, ed., London: MIT Press, 392–408.

Harley, Heidi (1999) Denominal verbs and aktionsart. In *Proceedings of the 2nd Penn/MIT Roundtable on Event Structure, MIT Working Papers in Linguistics*, Liina Pylkkänen & Angeliek van Hout, eds., Cambridge, MA, 73–85.

Harley, Heidi & Jason D. Haugen (2007) Are there really two different classes of instrumental denominal verbs in English? *Snippets* **16**: 9–10.

Harley, Heidi & Rolf Noyer (1998) Licensing in the non-lexicalist lexicon: nominalizations, Vocabulary Items, and the Encyclopedia. In *MIT Working Papers in Linguistics*, vol. 21, Andrew Carnie & Heidi Harley, eds., Cambridge, MA: MIT-WPL, 321–53.

Harley, Heidi & Rolf Noyer (1999) Distributed Morphology. *Glot International* **4**(4): 3–9.

Harley, Heidi & Rolf Noyer (2000) Formal versus encyclopedic properties of vocabulary: Evidence from nominalisation. In *The Lexicon/Encyclopedia Interface*, Bert Peeters, ed., Amsterdam: Elsevier Press, 349–74.

Harley, Trevor A. (2008) *The Psychology of Language*. Hove, UK: Psychology Press, 3rd ed.

Haspelmath, Martin (2002) *Understanding Morphology*. London: Arnold.

Haspelmath, Martin (2008) Frequency vs. iconicity in explaining grammatical asymmetries. *Cognitive Linguistics* **19**(1): 1–33.

Hayes, Bruce (1981) *A Metrical Theory of Stress Rules*. Bloomington, Indiana: Indiana University Linguistics Club.

Hayes, Bruce (2009) *Introductory Phonology*. Malden, MA: Wiley-Blackwell.

Henderson, L., J. Wallis, & K. Knight (1984) Morphemic structure and lexical access. In *Attention and Performance X: Control of language processes*, H. Bouma & D. Bouwhuis, eds., Hillsdale, NJ: Erlbaum, 211–26.

Henderson, Leslie (1985) Toward a Psychology of Morphemes. In *Progress in the Psychology of Language*, vol. 1, Andrew W. Ellis, ed., chap. 2, Hillsdale, NJ: Erlbaum, 15–72.

Hengeveld, Kees (1992) Parts of Speech. In *Layered Structure and Reference in a Functional Perspective: Papers from the Functional Grammar Conference in Copenhage, 1990*, Michael Fortescue, Peter Harder, & Lars Kristoffersen, eds., Amsterdam: John Benjamins, 29–56.

Hockett, Charles F. (1958) *A Course in Modern Linguistics*. New York: Macmillan.

Hopper, Paul J. & Sandra A. Thompson (1984) The Discourse Basis for Lexical Categories in Universal Grammar. *Language* **60**(4): 703–52.

Hornby, Albert Sydney & Joanna Turnbull, eds. (2010) *Oxford Advanced Learner's Dictionary of Current English*. Oxford: Oxford University Press, 8th ed., URL `http://www.oxfordlearnersdictionaries.com`.

Huddleston, Rodney D. & Geoffrey K. Pullum (2002) *The Cambridge Grammar of the English Language*. Cambridge: Cambridge University Press.

James, Carlton T. (1975) The role of semantic information in lexical decisions. *Journal of Experimental Psychology: Human Perception and Performance* **1**(2): 130–36.

Ježek, Elisabetta & Paolo Ramat (2009) On parts-of-speech transcategorization. *Folia Linguistica* **43**(2): 391–416.

Kiefer, Ferenc (2005) Types of conversion in Hungarian. In *Approaches to Conversion/Zero-Derivation*, Laurie Bauer & Salvador Valera, eds., New York: Waxmann Münster, 51–65.

Kim, John J., Steven Pinker, Alan Prince, & Sandeep Prasada (1991) Why No Mere Mortal Has Ever Flown Out to Center Field. *Cognitive Science* **15**: 173–218.

Kiparsky, Paul (1982) From Cyclic Phonology to Lexical Phonology. In *The Structure of Phonological Representations (Part 1)*, H. van der Hulst & N. Smith, eds., Dordrecht: Foris, 131–75.

Kiparsky, Paul (1983) Word-Formation and the Lexicon. In *Proceedings of the 1982 Mid-America Linguistics Conference*, F. Ingemann, ed., Lawrence: University of Kansas, 3–29.

Klein, Devorah E. & Gregory L. Murphy (2001) The Representation of Polysemous Words. *Journal of Memory and Language* **45**(2): 259–82.

Klepousniotou, Ekaterini & Shari R. Baum (2007) Disambiguating the ambiguity

advantage effect in word recognition: An advantage for polysemous but not homonymous words. *Journal of Neurolinguistics* **20**(1): 1–24.

Kouider, Sid, Vincent de Gardelle, Stanislas Dehaene, Emmanuel Dupoux, & Christophe Pallier (2010) Cerebral bases of subliminal speech priming. *NeuroImage* **49**(1): 922–29.

Kouider, Sid & Emmanuel Dupoux (2005) Subliminal Speech Priming. *Psychological Science* **16**(8): 617–25.

Lahiri, Aditi & Henning Reetz (2010) Distinctive features: Phonological underspecification in representation and processing. *Journal of Phonetics* **38**: 44–59.

Lakoff, George (1987) *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind*. Chicago: University of Chicago Press.

Levelt, Willem J. M., Ardi Roelofs, & Antje S. Meyer (1999) A theory of lexical access in speech production. *Behavioral and Brain Sciences* **22**(1-75).

Lieber, Rochelle (1981a) Morphological conversion within a restrictive theory of the lexicon. In *The Scope of Lexical Rules*, M. Moortgat, H. van der Hulst, & T. Hoekstra, eds., Dordrecht: Foris, 161–200.

Lieber, Rochelle (1981b) *On the organization of the lexicon*. Ph.D. thesis, Indiana University Linguistics Club, Bloomington, Indiana.

Lieber, Rochelle (1992) *Deconstructing Morphology*. Chicago: University of Chicago Press.

Lieber, Rochelle (2005) English Word-Formation Processes: Observations, Issues, and Thoughts on Future Research. In *Handbook of Word-Formation*, Pavol Štekauer & Rochelle Lieber, eds., Dordrecht: Springer, 375–428.

Longtin, Catherine-Marie & Fanny Meunier (2005) Morphological decomposition in early visual word processing. *Journal of Memory and Language* **53**(1): 26–41.

Longtin, Catherine-Marie, Juan Segui, & Pierre A. Hallé (2003) Morphological priming without morphological relationship. *Language and Cognitive Processes* **18**(3): 313–34.

Lowenstamm, Jean (2008) On Little n, $\sqrt{}$, and Types of Nouns. In *Sounds of silence: empty elements in syntax and phonology*, Jutta M. Hartmann, Veronika Hegedűs, & Henk van Riemsdijk, eds., Amsterdam: Elsevier, 105–143.

Luuk, Erkki (2010) Nouns, verbs and flexibles: implications for typologies of word classes. *Language Sciences* **32**(3): 349–65.

Marantz, Alec (1997) No Escape from Syntax: Don't Try Morphological Analysis in the Privacy of Your Own Lexicon. *University of Pennsylvania Working Papers in Linguistics* **4**(2): 201–25.

Marantz, Alec (2013) Verbal argument structure: Events and participants. *Lingua* **130**: 152–68.

Marchand, Hans (1963a) On a Question of Contrary Analysis with Derivationally Connected but Morphologically Uncharacterized Words. *English Studies* **44**(1): 176–87.

Marchand, Hans (1963b) On content as a criterion of derivational relationship with back-derived words. *Indogermanische Forschungen* **68**: 170–75.

Marchand, Hans (1964) A set of criteria for the establishing of derivational relationships between words unmarked by derivational morphemes. *Indogermanische Forschungen* **69**: 10–19.

Marchand, Hans (1969) *The Categories and Types of Present-Day English Word-Formation: A Synchronic-Diachronic Approach*. München: C. Beck.

Marslen-Wilson, William (1987) Functional parallelism in spoken word recognition. *Cognition* **25**: 71–102.

Marslen-Wilson, William (2007) Morphological processes in language comprehension. In *Oxford Handbook of Psycholinguistics*, Gareth Gaskell, ed., Oxford: Oxford University Press, 175–93.

Marslen-Wilson, William, Mirjana Bozic, & Billi Randall (2008) Early decomposition in visual word recognition: Dissociating morphology, form, and meaning. *Language and Cognitive Processes* **23**(3): 394–421.

Marslen-Wilson, William & Lorraine K. Tyler (1998) Rules, representations, and the English past tense. *Trends in Cognitive Sciences* **2**(11): 428–35.

Marslen-Wilson, William, Lorraine K. Tyler, Rachelle Waksler, & Lianne Older (1994) Morphology and Meaning in the English Mental Lexicon. *Psychological Review* **101**(1): 3–33.

Martsa, Sándor (2012) *Conversion in English: A cognitive semantic approach.* Ph.D. thesis, University of Pécs, Pécs, Hungary.

McClelland, James L. & Karalyn Patterson (2002) Rules or connections in past-tense inflections: what does the evidence rule out? *Trends in Cognitive Sciences* **6**(11): 465–72.

McCormick, Samantha F., Kathleen Rastle, & Matthew H. Davis (2008) Is there a 'fete' in 'fetish'? Effects of orthographic opacity on morpho-orthographic segmentation in visual word recognition. *Journal of Memory and Language* **58**(2): 307–26.

McCormick, Samantha F., Kathleen Rastle, & Matthew H. Davis (2009) Adoreable not adorable? Orthographic underspecification studied with masked repetition priming. *European Journal of Cognitive Psychology* **21**(6): 813–36.

Meinzer, Marcus, Aditi Lahiri, Tobias Flaisch, Ronny Hanneman, & Carsten Eulitz (2009) Opaque for the reader but transparent for the brain: Neural signatures of morphological complexity. *Neuropsychologia* **47**(8-9): 1964–71.

Meunier, Fanny & Catherine-Marie Longtin (2007) Morphological decomposition and semantic integration in word processing. *Journal of Memory and Language* **56**(4): 457–71.

Monsell, Stephen (1985) Repetition and the Lexicon. In *Progress in the Psychology of Language*, vol. 2, Andrew W. Ellis, ed., Lawrence Erlbaum Associates, 147–95.

Monsell, Stephen (1991) The nature and locus of word frequency effects. In *Basic processes in reading: Visual word recognition*, Derek Besner & Glyn W. Humphreys, eds., Hillsdale, NJ: Erlbaum, 148–97.

Morcom, Linsay A. (2009) *The Universality and Demarcation of Lexical Categories Cross-Linguistically*. Ph.D. thesis, University of Oxford.

Morris, Joanna & Linnaea Stockall (2012) Early, equivalent ERP masked priming effects for regular and irregular morphology. *Brain and Language* **123**(2): 81–93.

Morton, John (1969) Interaction of Information in Word Recognition. *Psychological Review* **76**(2): 165–78.

Murray, W. S. & Kenneth Forster (2004) Serial Mechanisms in Lexical Access: The Rank Hypothesis. *Psychological Review* **111**(3): 721–56.

Myers, Scott (1984) Zero Derivation and Inflection. *MIT Working Papers in Linguistics* **7**: 53–69.

Napps, Shirley E. & Carol A. Fowler (1987) Formal Relationships Among Words and the Organization of the Mental Lexicon. *Journal of Psycholinguistic Research* **16**(3): 257–72.

Neef, Martin (2005) On some alleged constraints on conversion. In *Approaches to Conversion/Zero-Derivation*, Laurie Bauer & Salvador Valera, eds., New York: Waxmann Münster, 103–30.

Niswander, Elizabeth, Alexander Pollatsek, & Keith Rayner (2000) The processing of derived and inflected suffixed words during reading. *Language and Cognitive Processes* **15**: 389–420.

OEC (2007) The Oxford English Corpus. URL `http://www.oxforddictionaries.com/words/the-oxford-english-corpus`.

OED (1989) *Oxford English Dictionary Online*. Oxford University Press, 2nd ed.

Onifer, William & David A. Swinney (1981) Accessing lexical ambiguities during sentence comprehension: Effects of frequency of meaning and contextual bias. *Memory and Cognition* **9**: 1–39.

Perea, Manuel & Arcadio Gotor (1997) Associative and semantic priming effects occur at very short stimulus-onset asynchronies in lexical decision and naming. *Cognition* **62**(2): 223–40.

Perea, Manuel & Eva Rosa (2002) The effects of associative and semantic priming in the lexical decision task. *Psychological Research* **66**(3): 180–94.

Perlmutter, David (1988) The split morphology hypothesis: evidence from Yiddish. In *Theoretical morphology: approaches in modern linguistics*, Michael Hammond & Michael Noonan, eds., Orlando: Academic Press, 79–100.

Pinker, Steven & Alan Prince (1994) Regular and irregular morphology and the psychological status of rules of grammar. In *The Reality of Linguistic Rules*, Susan D. Lima, Roberta Corrigan, & Gregory K. Iverson, eds., Amsterdam: John Benjamins, 321–51.

Plag, Ingo (1999) *Morphological Productivity: Structural Constraints in English Derivation*. Berlin: Mouton de Gruyter.

Plag, Ingo (2003) *Word-Formation in English*. Cambridge: Cambridge University Press.

Plank, Frans (1994) Inflection and derivation. In *The encyclopedia of language and linguistics*, vol. 3, R. E. Asher, ed., Oxford: Pergamon Press, 1671–78.

Plank, Frans (2010) Variable direction in zero-derivation and the unity of polysemous lexical items. *Word Structure* **3**(1): 82–97.

Plank, Frans, Michael Spagnol, & Maialen Iraola Azpiroz (2011) The direction of derivation; today: between abstract nouns and adjectives. GHILM 3rd Conference on Maltese Linguistics, Valletta, Malta.

Pliatsikas, Christos, Linda Wheeldon, Aditi Lahiri, & Peter C. Hansen (2014) Processing of zero-derived words in English: an fMRI investigation. *Neuropsychologia* **53**: 47–53.

Pollatsek, Alexander, Denis Drieghe, Linnaea Stockall, & Roberto de Almeida (2010) The interpretation of ambiguous trimorphemic words in sentence context. *Psychonomic Bulletin and Review* **17**(1): 88–94.

Pylkkänen, Liina, Sophie Feintuch, Emily Hopkins, & Alec Marantz (2004) Neural correlates of the effects of morphological family frequency and family size: an MEG study. *Cognition* **91**(3): B35–45.

Pylkkänen, Liina, Rodolfo Llinás, & Gregory L. Murphy (2006) The Representation of Polysemy: MEG Evidence. *Journal of Cognitive Neuroscience* **18**(1): 97–109.

Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, & Jan Svartvik (1972) *A Grammar of Contemporary English*. London: Longman.

Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, & Jan Svartvik (1985) *A Comprehensive Grammar of the English Language*. London: Longman, 2nd ed.

Rabagliati, Hugh, Gary F. Marcus, & Liina Pylkkänen (2011) Rules, Radical Pragmatics and Restrictions on Regular Polysemy. *Journal of Semantics* **28**(4): 485–512.

Raffelsiefen, Renate (1993) Relating Words: A Model of Base Recognition. *Linguistic Analysis* **23**(1-2): 3–164.

Rastle, Kathleen & Matthew H. Davis (2003) Reading Morphologically Complex Words: Some Thoughts from Masked Priming. In *Masked Priming: The State of the Art*, Sachiko Kinoshita & Stephen J. Lupker, eds., Hove, U.K.: Psychology Press, 279–305.

Rastle, Kathleen & Matthew H. Davis (2008) Morphological decomposition based on the analysis of orthography. *Language and Cognitive Processes* **23**(7): 942–71.

Rastle, Kathleen, Matthew H. Davis, & William Marslen-Wilson (2000) Morphological and semantic effects in visual word recognition: A time-course study. *Language and Cognitive Processes* **15**(4/5): 507–37.

Rastle, Kathleen, Matthew H. Davis, & Boris New (2004) The broth in my brother's brothel: Morpho-orthographic segmentation in visual word recognition. *Psychonomic Bulletin and Review* **11**(6): 1090–98.

Rastle, Kathleen, J. Harrington, & Max Coltheart (2002) Nonwords: The ARC nonword database. *Quarterly Journal of Experimental Psychology* **55**: 1339–62.

Ratcliff, Roger & Gail McKoon (2008) The Diffusion Decision Model: Theory and Data for Two-Choice Decision Tasks. *Neural Computation* **20**(4): 873–922.

Raveh, Michal & Jay G. Rueckl (2000) Equivalent Effects of Inflected and Derived Primes: Long-Term Morphological Priming in Fragment Completion and Lexical Decision. *Journal of Memory and Language* **42**(1): 103–19.

Reetz, Henning & A Kleinmann (2003) Multi-subject hardware for experiment control and precise reaction time measurement. In *Proceedings of the 15th International Congress of Phonetic Sciences*, M.J. Solé, D. Recasens, & J. Romero, eds., Barcelona, 1489–92.

Rijkhoff, Jan & Eva van Lier, eds. (2013) *Flexible Word Classes: Typological Studies of Underspecified Parts of Speech*. Oxford: Oxford University Press.

Rodd, Jennifer, Gareth Gaskell, & William Marslen-Wilson (2002) Making Sense of Semantic Ambiguity: Semantic Competition in Lexical Access. *Journal of Memory and Language* **46**(2): 245–66.

Rubin, Gary S., Curtis A. Becker, & Roger H. Freeman (1979) Morphological Structure and Its Effect on Visual Word Recognition. *Journal of Verbal Learning and Verbal Behavior* **18**(6): 757–67.

Sasse, Hans-Jürgen (2001) Scales between nouniness and verbiness. In *Language Typology and Language Universals*, Berlin: Walter de Gruyter, 495–509.

Scalise, Sergio (1988) Inflection and derivation. *Linguistics* **26**(4): 561–81.

Scarborough, Don L., Charles Cortese, & Hollis S. Scarborough (1977) Frequency and Repetition Effects in Lexical Memory. *Journal of Experimental Psychology: Human Perception and Performance* **3**(1): 1–17.

Scharinger, Mathias, Henning Reetz, & Aditi Lahiri (2009) Levels of regularity in inflected word form processing. *The Mental Lexicon* **4**(1): 77–114.

Schriefers, Herbert, Pienie Zwitserlood, & Ardi Roelofs (1991) The Identification of Morphologically Complex Spoken Words: Continuous Processing or Decomposition? *Journal of Memory and Language* **30**(1): 26–47.

Schütze, Carson T. & Jon Sprouse (2013) Judgment data. In *Research Methods in Linguistics*, Robert J. Podesva & Devyani Sharma, eds., Cambridge: Cambridge University Press, 27–50.

Schwanenflugel, Paula J. (1991) Why are abstract concepts hard to understand? In *The psychology of word meanings*, Paula J. Schwanenflugel, ed., Hillsdale, NJ: Erlbaum, 223–50.

Schwanenflugel, Paula J., Katherine Kip Harnishfeger, & Randall W. Stowe (1988) Context availability and lexical decisions for abstract and concrete words. *Journal of Memory and Language* **27**(5): 499–520.

Segui, Juan & Jonathan Grainger (1990) Priming Word Recognition With Orthographic Neighbors: Effects of Relative Prime-Target Frequency. *Journal of Experimental Psychology: Human Perception and Performance* **16**(1): 65–76.

Segui, Juan & Maria-Luisa Zubizarreta (1985) Mental representation of morphlogically complex words and lexical access. *Linguistics* **23**(5): 759–74.

Sereno, Joan A. (1986) Stress pattern differentiation of form class in English. *Journal of the Acoustical Society of America* **79**: S36.

Sereno, Joan A. (1991) Graphemic, Associative, and Syntactic Priming Effects at a Brief Stimulus Onset Asynchrony in Lexical Decision and Naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **17**(3): 459–77.

Sereno, Joan A. & Allard Jongman (1995) Acoustic Correlates of Grammatical Class. *Language and Speech* **38**(1): 57–76.

Sereno, Joan A. & Allard Jongman (1997) Processing of English inflectional morphology. *Memory and Cognition* **25**(4): 425–37.

Solomyak, Olla & Alec Marantz (2010) Evidence for Early Morphological Decomposition in Visual Word Recognition. *Journal of Cognitive Neuroscience* **22**(9): 2042–57.

Spencer, Andrew (1991) *Morphological Theory: an introduction to word structure in generative grammar*. Oxford: Blackwell.

Stanners, Robert F., James J. Neiser, William P. Hernon, & Roger Hall (1979) Memory Representation for Morphologically Related Words. *Journal of Verbal Learning and Verbal Behavior* **18**(4): 399–412.

Stockall, Linnaea, Andrew Stringfellow, & Alec Marantz (2004) The precise time course of lexical activation: MEG measurements of the effects of frequency, probability, and density in lexical decision. *Brain and Language* **90**(1-3): 88–94.

Stockwell, Robert & Donka Minkova (2001) *English Words: History and Structure*. Cambridge: Cambridge University Press.

Stolz, Jennifer A. & Laurie Beth Feldman (1995) The Role of Orthographic and Semantic Transparency of the Base Morpheme in Morphological Processing. In *Morphological aspects of language processing*, Laurie Beth Feldman, ed., Hove, U.K.: Lawrence Erlbaum Associates, 109–29.

Taft, Marcus (1979) Recognition of affixed words and the word frequency effect. *Memory and Cognition* **7**(4): 263–72.

Taft, Marcus (2004) Morphological decomposition and the reverse base frequency effect. *Quarterly Journal of Experimental Psychology* **57A**(4): 745–65.

Taft, Marcus & Kenneth Forster (1975) Lexical Storage and Retrieval of Prefixed Words. *Journal of Verbal Learning and Verbal Behavior* **14**(6): 638–47.

Teddiman, Laura (2012) Conversion and the lexicon: Comparing evidence from corpora and experimentation. In *Frequency effects in language representation*, Dagmar Divjak & Stefan Th. Gries, eds., Berlin: Mouton de Gruyter, 235–53.

Tyler, Lorraine K., William Marslen-Wilson, James Rentoul, & Peter Hanney (1988) Continuous and Discontinuous Access in Spoken Word-Recognition: The Role of Derivational Prefixes. *Journal of Memory and Language* **27**(4): 368–81.

Umbreit, Birgit (2010) Does *love* come from *to love* or *to love* from *love*? Why lexical motivation has to be regarded as bidirectional. In *Cognitive Perspectives on Word Formation*, Alexander Onysko & Sascha Michel, eds., Berlin: De Gruyter, 301–34.

Valera, Salvador (2006) Conversion. In *Encyclopedia of Language and Linguistics*, Keith Brown, Anne H. Anderson, Laurie Bauer, Margie Berns, Graeme Hirst, & Jim Miller, eds., Amsterdam: Elsevier, 2nd ed., 172–75.

Vannest, Jennifer & Julie E. Boland (1999) Lexical Morphology and Lexical Access. *Brain and Language* **68**(1-2): 324–32.

Vannest, Jennifer, Thad A. Polk, & Richard L. Lewis (2005) Dual-route processing of complex words: New fMRI evidence from derivational suffixation. *Cognitive, Affective, and Behavioral Neuroscience* **5**(1): 67–76.

Vonen, Arnfinn M. (1994) Multifunctionality and Morphology in Tokelau and English. *Nordic Journal of Linguistics* **17**: 155–78.

Štekauer, Pavol (1996) *A Theory of Conversion in English*. Frankfurt am Main: P. Lang.

Wagenmakers, Eric-Jan (2009) Methodological and empirical developments for the Ratcliff diffusion model of response times and accuracy. *European Journal of Cognitive Psychology* **21**(5): 641–71.

Whaley, C. P. (1978) Word-Nonword Classification Time. *Journal of Verbal Learning and Verbal Behavior* **17**(2): 143–54.

Williams, Edwin (1981) On the Notions "Lexically Related" and "Head of a Word". *Linguistic Inquiry* **12**(2): 245–74.

Yap, Melvin J. & David A. Balota (2009) Visual word recognition of multisyllabic words. *Journal of Memory and Language* **60**(4): 502–29.

Zandvoort, R. W. (1965) *A Handbook of English Grammar*. London: Longmans, Green, and Co. Ltd., 3rd ed.

Zwicky, Arnold (1969) Phonological constraints in syntactic descriptions. *Papers in Linguistics* **1**(411-63).