

Causal Inferences and Expectations in Discourse Processing



Thesis submitted for the Degree of
Doctor of Philosophy in Linguistics, Philology and Phonetics

by
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Statement of Authorship

This thesis is presented in an integrated thesis format and includes four manuscripts reporting original research. I am the first author on each paper.

The manuscripts are:

1. *An incremental QUD approach to causal discourse expectations* (submitted for publication)
2. *Discourse expectations are sensitive to the Right Frontier Constraint* (published as Yao, R., Altshuler, D., and Husband, E. M. (2026), *Discourse Processes*, 1-13.)
3. *Topichood and temporal interpretation of DPs guide clause-internal causal coherence* (published as Yao, R., Husband, E. M., & Altshuler, D. (2024), *Proceedings of Sinn und Bedeutung*, 28, 1034–1048)
4. *Clause-internal Explanation fails in online processing* (unsubmitted manuscript)

All manuscripts were co-authored with Daniel Altshuler and E. Matthew Husband. I was responsible for conceptualization, methodology, data collection, data analysis, and drafting and revising the manuscripts. Co-authors provided supervision, feedback, and guidance throughout the development of these projects.

I declare that these manuscripts report original research conducted during my DPhil studies at the University of Oxford. I am the primary contributor to all manuscripts included in this thesis. The co-authors provided feedback and guidance throughout the development of these projects. Permission to include each manuscript in this thesis has been obtained from all co-authors.

Signature

Date

December 6, 2025

Abstract

Successful language comprehension requires comprehenders to understand not just individual linguistic elements, but also the relationships between them. One set of relations central to discourse comprehension is causal coherence relations, such as Result (cause-effect) and Explanation (effect-cause). This thesis investigates the establishment of implicit Explanation relations, a sub-type of causal relations, in discourse processing.

Prior studies have demonstrated that local linguistic cues can guide comprehenders to infer and expect Explanation relations in discourse processing. For example, when reading the sentence *Jenny fired the guy who had been embezzling money*, comprehenders will infer an Explanation relation between the *firing* event and the *embezzling* event. Even before they reach the relative clause, they may expect an upcoming Explanation that explains the *firing* event. However, significant questions remained about what linguistic elements constrain implicit Explanation relations, how comprehenders infer such relations across different discourse contexts, and where in the linguistic structure these relations can be established.

The present thesis addresses these gaps through experimental methods and formal semantic analysis. A series of studies examined both inter-clausal and clause-internal Explanation relations using comprehension tasks, self-paced reading, and eye-tracking-while-reading. The findings show that discourse expectations for upcoming Explanation relations are constrained by syntactic embedding (e.g., islands) and discourse structure (e.g., right frontier). Furthermore, the present thesis shows that while Explanation relations can be established within a clause through cues such as resultative adjectives (e.g., *The broken window got struck with a stone.* $\rightsquigarrow$ ‘the window was broken because of the stone.’), clause-internal relations are more fragile and delayed compared to inter-clausal relations. Together, these findings advance our understanding of discourse processing by shedding light on how and when readers establish implicit Explanation relations during discourse comprehension.

To my parents, Jing Zhou and Zheng Yao

献给我的父母，周景和姚争

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People often say that a DPhil is a long journey. But for me, it has been such a happy time that it passed more quickly than I could have imagined. I can still clearly recall the day of my matriculation, when my roommate joked that matriculation is the most important event at Oxford, even more important than graduation, because it is the moment you become a member of the University. It was, of course, said in jest, but it stayed with me to this day, as I now reach the "less important" moment.

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On a lovely spring day, in the old Bodleian Library

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1 Introduction

‘And even in our wildest and most wandering reveries, nay in our very dreams, we shall find, if we reflect, that the imagination ran not altogether at adventures, but that there was still a connexion upheld among the different ideas, which succeeded each other. Were the loosest and freest conversation to be transcribed, there would immediately be observed something which connected it in all its transitions.’ (Hume, 1748)

Similar to the way in which our imaginations and thoughts were described by David Hume, language does not normally consist of isolated, unrelated units, but of structured and connected groups of words or sentences. One way to account for this connectedness is coherence, which can be achieved through relationships between discourse units. These relationships are what many formal theories of discourse call *coherence relations*. Among these coherence relations, causal relations might be the most straightforward and fundamental one. This thesis project investigates how comprehenders infer, and sometimes predict, causal relations, especially Explanation relations¹ (i.e., backwards causal, effect-cause), when processing discourse.

1.1 Why study the processing of causal relations?

Successful language comprehension not only requires comprehenders to understand each linguistic unit, but also to determine what relationships hold between linguistic units. Some of these relationships in discourse comprehension are what many formal theories

¹ Throughout this thesis, I use uppercase (e.g., Explanation) to refer to a specific coherence relation to distinguish it from the everyday word (e.g., explanation).

1.1. WHY STUDY THE PROCESSING OF CAUSAL RELATIONS?

of discourse call *coherence relations*, which are meaningful and sometimes non-obligatory relationships, not fully governed by syntactic or semantic constraints, but instead largely determined pragmatically by factors including a comprehender's world knowledge. For example, (1) might seem like two unrelated statements to some readers. However, for my friends who know that the dining hall in my college always serves fish and chips on Fridays, they will infer a causal relation (or more specifically, an Explanation relation) between the two sentences, as the second sentence explains that I don't like Friday because the typical Friday meal is something I dislike.

(1) I don't like Friday. I don't like fish and chips.

In real-time discourse processing, comprehenders may establish coherence relations anticipatorily, before encountering subsequent discourse units, or they may arrive at coherence through a more integrative, later process once some additional information becomes available. Which pattern emerges depends on factors such as the context and the type of coherence relation involved.

Since most coherence relations in communications are implicit, as in the above case, inferring coherence relations is crucial for understanding discourse correctly. For instance, the pronoun *her* in (2) is ambiguous as it can refer to either *Mia* or *Winona*. To resolve this pronoun, we need to understand the coherence relation between the two sentences: if it's a Parallel relation (i.e., two sentences seem to describe a series of parallel events), *her* should refer to *Winona*, but if it's a Result relation (i.e., forward causal, cause-effect), *her* should refer to *Mia*.

(2) Mia hit Winona with a pea. Ian kicked her under the table. (Duff and Altshuler, 2024)

Moreover, among all types of coherence relations, causal relations, which typically include Result relations and Explanation relations, are argued to be a fundamental one, probably because understanding causal information is vital in every aspect of human life, from deciding what to eat for lunch to grasping the rise and fall of human societies

(e.g., Lewis, 1973; Sloman and Lagnado, 2015). Some psycholinguistic research has also indicated that causal relations have a privileged status in discourse processing, as they tend to be processed more quickly and with less cognitive effort than other types of coherence relations (e.g., Mak and Sanders, 2010; Sanders, 2005; Sanders and Noordman, 2000). In addition, causal relations are relatively easy to investigate experimentally for some reasons. First, comprehenders’ interpretations of causal connections are typically straightforward to probe (e.g., Singer et al., 1992). Second, it is well established that cues such as implicit causality verbs can reliably guide the establishment of Explanation relations (e.g., Kehler, 2002; Kehler et al., 2008).

Therefore, given the central role of understanding coherence relations in discourse comprehension, the importance of causal relations in human cognition, and the methodological advantages of studying causal relations (especially Explanation relations), it is necessary to investigate how comprehenders infer such relations in both offline interpretation and online processing. While a sizable body of literature has shed light on certain aspects of this topic, several key questions remain regarding the constraints and triggers of causal inference, as well as its incremental and predictive nature in real-time processing.

1.2 Research questions

Motivated by the theoretical importance and the methodological advantages of studying causal relations, this thesis focuses on the processing of Explanation relations. It investigates how and when readers infer and anticipate Explanation relations during comprehension, and what linguistic cues guide them to do so.

A considerable body of research has shown that certain linguistic cues, such as implicit causality verbs, can guide comprehenders to establish Explanation relations in discourse comprehension (e.g., Hoek et al., 2021a,b; Kehler et al., 2008; Mak and Sanders, 2013; Rohde, 2008). For example, *praised* in (3) is an implicit causality verb, and it can guide comprehenders to infer an Explanation relation between the praising event in π_1 and the money-making event in π_2 . Moreover, during online processing, this inference can be predictive, which means comprehenders can form expectations for upcoming Explanation

relations, reflected in, for instance, faster reading times when π_2 is consistent with these coherence expectations generated by π_1 .

- (3) [Jenny praised the guy.] $_{\pi_1}$ [He had made a lot of money for the company.] $_{\pi_2}$

However, it remains unclear what constraints shape these discourse expectations. While implicit causality verbs reliably guide comprehenders toward Explanation relations, the availability and strength of these expectations may be constrained by discourse-level information. Therefore, the first research question of this thesis concerns the constraints on discourse expectations, specifically examining expectations for Explanation relations driven by implicit causality. In this thesis, I examine one such potential constraint to evaluate whether the effect of implicit causality is indeed unconditional, as often assumed.

Research Question 1: What constraints govern the Explanation expectations triggered by implicit causality?

In addition to local dependency as in (3), long-distance causal inferences also appear to be possible, at least in some contexts. For instance, in (4), even though π_2 can hardly serve as a reason for the praising event in π_1 , it's still possible to infer an Explanation relation between π_1 and π_3 despite the presence of the intervening sentence π_2 . This raises important questions about the cognitive mechanisms underlying such long-distance coherence processing; such as, can the establishment of long-distance relations be facilitated by coherence expectations? Based on these observations, the second set of research questions examines long-distance coherence expectations, especially how intervening material affects the maintenance of coherence expectations during real-time processing. Since the establishment of coherence relations is closely related with discourse structure, I expect long-distance coherence expectations would be affected by discourse structural constraints, such as the Right Frontier Constraint (Mann and Thompson, 1988; Polanyi, 1985; Thompson and Mann, 1987; Webber, 1988).

- (4) [Jenny praised the guy.] $_{\pi_1}$ [He is British.] $_{\pi_2}$ [He had made a lot of money for the company.] $_{\pi_3}$

Research Question 2a: Can coherence expectations be maintained when they are not fulfilled immediately?

Research Question 2b: How do discourse structural constraints affect the maintenance of coherence expectations?

The next two sets of questions concern clause-internal coherence relations, which have been observed in some literature but have not been widely explored experimentally (e.g., Cohen and Kehler, 2021; Hobbs, 1990). For instance, (5-a) can be understood as implying that the dog became injured because it was hit by a car, suggesting a clause-internal Explanation relation between the being-injured event and the hit-by-a-car event. However, intuitively, the causal inference in (5-a) is weaker than that in (5-b), which exemplifies an Explanation relation between clauses. To better understand the strength of clause-internal Explanation relations, and how comprehenders infer clause-internal Explanation relations, this thesis investigates the contexts that allow or constrain such relations, as well as their processing in both offline and online reading tasks.

- (5) a. The injured dog was hit by a car.²
 b. The dog was injured. It was hit by a car.

Research Question 3a: What linguistic elements guide comprehenders to infer clause-internal Explanation relations?

Research Question 3b: What linguistic elements constrain clause-internal Explanation relations?

Research Question 4: Can clause-internal Explanation relations be established during online processing?

Collectively, the above research questions address broader theoretical issues about the incrementality and predictive nature of discourse processing; that is, do comprehenders build discourse coherence immediately when they encounter relevant text, and even an-

² The original example of clause-internal coherence in Hobbs (1990) is *The jogger was hit by a car*.

ticipatorily before they reach subsequent text, or do they wait until more information becomes available?

Research Question 5: Do comprehenders (always) build discourse immediately and predictively?

Human language processing is highly incremental. While it is widely-acknowledged that we immediately and sometimes predictively comprehend linguistic expressions at or below the sentence level, discourse processing involves complex integration across larger spans of text, raising the question of whether the same incrementality principles that govern lexical and syntactic processing also apply to higher-level discourse processing (e.g., Duff, 2023; Köhne and Demberg, 2013). Furthermore, different types of coherence relations (e.g., clause-internal vs. inter-clausal relations) may exhibit distinct processing patterns, with some being more amenable to rapid, predictive processing than others. Therefore, with the exploration of clause-internal coherence relations, this fundamental and overarching question about discourse processing should be reconsidered.

1.3 Roadmap

This article-based thesis includes a cover article and four articles that address the above questions.

Chapter 2 provides a survey of previous research on a number of relevant topics. §2.2 reviews existing work on discourse coherence, where I introduce two influential theoretical frameworks used in this research: Segmented Discourse Representation Theory and Question-under-Discussion. In this chapter, I also discuss the current research trend extending from inter-sentential to intra-sentential coherence. §2.3 focuses on predictive mechanisms in discourse comprehension, discussing questions including what cues can be used to predict, what can be predicted, how people predict, and whether people always make predictions when processing discourse. §2.4 discusses causal inferences and expectations in discourse processing, with particular focus on implicit causality verbs and their role in guiding Explanation expectations.

Chapters 3–6 each present an article preceded by a brief summary.³ In Chapter 3, Article 1 addresses Research Question 1, demonstrating that causal discourse expectations generated by implicit causality verbs are constrained by structural embedding, such as relative clauses. In Chapter 4, Article 2 addresses Research Questions 2a-2b, showing that coherence expectations are constrained by discourse structural factors, such as the Right Frontier Constraint. In Chapters 5-6, the third and fourth articles focus on clause-internal Explanation relations and address Research Questions 3-4. They reveal that clause-internal Explanation relations can be triggered by prenominal adjectives, but only in offline processing, and are constrained by nominal temporal interpretations.

Chapter 7 provides a general discussion. It considers the findings of the preceding chapters in relation to Research Question 5, suggesting that the establishment of clause-internal Explanation relations might not be as immediate or as predictive as that of inter-clausal Explanation relations. Finally, Chapter 8 concludes the thesis project as a whole.

³ These articles are reproduced in their original form; accordingly, their internal section numbering does not follow the thesis numbering.

2 Research background

2.1 Discourse coherence

A key feature of human discourse is its coherence. However, just as random combinations of words do not yield meaningful sentences (as famously illustrated by Chomsky’s “colourless green ideas sleep furiously”), not all adjacent discourse units automatically form coherent discourse. For example, you may find (6) difficult to interpret as a coherent discourse, as it is unclear what relationship, if any, holds between *taking a train to Istanbul* and *liking spinach*.

(6) John took a train from Paris to Istanbul. He likes spinach. (Hobbs, 1979)

The lack of an identifiable relationships between two sentences in this incoherent example illustrates a core insight of discourse theory: coherence emerges through the establishment of meaningful relationships between discourse units. These relationships, which are what many formal discourse theories call coherence relations, capture the semantic and pragmatic links that bind discourse units together. For example, (7) presents a coherent discourse. Compared to (6), the relationship between the two sentences in (7) is much clearer: in (7), the second sentence can be interpreted as providing an explanation for the first (i.e., John travelled to Istanbul because he has family there), and this type of coherence relation is formalized in many discourse theories as an Explanation relation.

(7) John took a train from Paris to Istanbul. He has family there. (Hobbs, 1979)

In the course of discourse processing, an important task for comprehenders is deter-

ining what coherence relations hold between discourse units. Crucially, while coherence relations can be explicitly signalled by connectives such as *because*, *as a result*, and *but*, in naturalistic communication, coherence relations are often established implicitly, without overt linguistic markers, as seen in (7). Therefore, the establishment of discourse coherence relies heavily on inferences that are determined pragmatically through factors including the comprehender's world knowledge and broader discourse context. For instance, even (6), which initially appears incoherent, could be interpreted coherently in an imagined context where the comprehender happens to know that, for example, Paris was out of spinach, or Istanbul is famous for a spinach dish.

Given its central role in human communication and comprehension, discourse coherence has attracted significant attention across multiple research perspectives, such as psychology, linguistics and natural language processing. This chapter provides a brief overview of linguistic theories of discourse coherence from earlier periods, and two major linguistic theories of discourse coherence nowadays, namely Segmented Discourse Representation Theory and the Question-under-Discussion framework, followed by a review of recent developments that have extended the study of coherence from inter-sentential to intra-sentential phenomena.

2.1.1 Linguistic theories of discourse coherence

The history of discourse coherence can be traced back to the 1970s. In *Cohesion in English*, the first modern publication regarding discourse coherence, Halliday and Hasan (1976) argued that all parts of a text must be connected by cohesive devices to ensure coherent. In recent decades, coherence relations have received attention from various perspectives in language sciences, including theoretical linguistics, computational linguistics, and psycholinguistics. Theories of discourse coherence have motivated research across these fields, while findings from these fields have, in turn, informed and advanced discourse theories.

2.1.1.1 Foundational work on discourse coherence

Mainly motivated by the need for computational modelling, Hobbs (1979, 1990) characterized discourse coherence with a set of coherence relations and provided formal definitions of these relations based on a computational inference system, which involves not only linguistic information but also comprehender’s world knowledge-based inference. Later, Kehler (2002) proposed a coherence model that provided a concise inventory of discourse coherence relations based on the principles of general cognitive reasoning and logical inference that are not exclusive to language. Kehler’s model is closely related to Hobbs’ systems of relations, but it followed Hume’s (1748) categorization of the ways in which ideas can be related, and thus classified relations into three categories: Cause-Effect, Re-semblance and Contiguity. This is an appealing model with cognitive grounding and a neat classification. However, as a descriptive model with few claims about how coherence relations are inferred, it doesn’t provide testable predictions on discourse comprehension (Sasaki, 2021).

Another strand of influential work that has significantly informed discourse coherence research is Discourse Representation Theory (DRT), a dynamic semantic theory (Kamp, 1981; Kamp and Reyle, 1993). The DRT framework draws the idea of mental representation from the psychology of language into formal semantics. Its main innovation is that it introduced discourse representation structures (DRSs), a level of mental representation that hearers incrementally build when processing discourses. For example, a box-style notation of the DRS for (8-a) is graphically shown in Figure 2.1a, which includes a set of discourse referents and a set of conditions that specify properties of and relationships between those discourse referents. In Figure 2.1a, x , y , and z are the discourse referents, while the lines below list the conditions: predicates describing their properties (e.g., $\text{Mary}(x)$, $\text{Injured}(x)$) and relationships between them (e.g., $\text{Went_to}(z, y)$). The condition $z = x$ encodes the anaphoric link showing that the subject of the second sentence refers to *Mary*.

- (8) a. Mary was injured. She went to the hospital.

- b. Mary was injured. She was hit by a car.

x, y, z
Mary (x)
The_hospital (y)
$z = x$
Injured (x)
Went_to (z, y)

(a)

x, y, z
Mary (x)
The_car (y)
$z = x$
Injured (x)
hit (y, z)

(b)

Figure 2.1: DRS boxes for *Mary was injured. She went to the hospital.* (left) and *Mary was injured. She was hit by a car.* (right).

However, when using the DRT framework to analyse discourse structure, one disadvantage is that it always interprets discourse as a progression. For example, the DRS for (8-b) is graphically shown in Figure 2.1b, which is very similar to the DRS graph for (8-a), even though the preferred temporal relations in them are intuitively different: in (8-a), Mary was injured and then was sent to the hospital, while in (8-b), Mary was injured after she was hit by a car (Lascarides and Asher, 1993). Moreover, DRT appears to lack an effective mechanism of blocking discourse referents from being antecedents, and thus it tends to over-generate pronoun interpretations in discourse (Lascarides and Asher, 2007). For example, in (9), DRT doesn't prevent the pronoun *it* in π_6 from referring to *salmon* in π_3 . However, intuitively, π_6 feels like an incoherent continuation in (9), as there is no plausible antecedent available for *it*⁴.

- (9) π_1 John had a great evening last night.
 π_2 He had a great meal.
 π_3 He ate salmon.
 π_4 He devoured lots of cheese.
 π_5 He then won a dancing competition.
 π_6 ??It was a beautiful pink.

⁴ Some may interpret the dancing competition as being a beautiful pink, but crucially, the antecedent cannot be the salmon.

2.1.1.2 Segmented Discourse Representation Theory

Asher and Lascarides (2003) developed Segmented Discourse Representation Theory (SDRT) based on the combination of the dynamic semantic framework and world knowledge-based pragmatic reasoning in Hobbs’ coherence theory.

SDRT is a dynamic semantic framework that models discourse as a series of segmented discourse representation structures (SDRSs), where each SDRS can be either a discourse unit⁵ (i.e., a DRS in DRT) or a coherence relation⁶ between discourse units (analogous to “conditions” in DRT) (Asher and Lascarides, 2003). Formally, an SDRS is a triple $\langle A, F, \text{LAST} \rangle$, where:

- A is a set of speech act discourse referents (i.e., $\pi_1, \pi_2, \dots$);
- $\text{LAST} \in A$ (intuitively, this is the label of the content of the last clause that was added to the logical form); and
- F is a function which assigns each member of A an *sdrs*-formula. (Lascarides and Asher, 2007)

As in other Hobbs-descended theories, SDRT structures coherent discourse through coherence relations. Some core coherence relations used to analyse narrative discourse in SDRT are defined and exemplified below⁷:

- Narration (π_1, π_2): π_1 and π_2 share a contingent, common topic and are in a temporal progression relation⁸.
 - Example: *John had a fantastic dinner. He then won a dancing competition.*
- Background (π_1, π_2): π_1 describes a state that overlaps with π_2 (or vice versa).

⁵ Also referred to as “(discourse) segments” in some literature. For consistency, I use “discourse units” throughout this thesis to denote linguistic elements that constitute the discourse.

⁶ Also known as “rhetorical relations” (Mann and Thompson, 1988) or “discourse relations”. For consistency, I use “coherence relations” throughout this thesis.

⁷ Many different classifications and definitions of coherence relations have been discussed in the literature. The definitions used in this thesis are adapted from Sasaki and Altshuler (2025).

⁸ It is also known as Occasion in some literature.

- Example: *John had a fantastic dinner. It was a rainy night.*
- Result (π_1, π_2) : π_1 causes π_2 .
 - Example: *Mary was injured. She went to the hospital.*
- Explanation (π_1, π_2) : π_2 causes π_1 .
 - Example: *Mary was injured. She was hit by a car.*
- Elaboration (π_1, π_2) : π_2 provides more information about the eventuality described by π_1 .
 - Example: *John had a fantastic dinner. He ate salmon.*
- Parallel (π_1, π_2) : π_1 and π_2 are eventuality descriptions with similar in content and thematic structure.
 - Example: *John ate salmon. Mary devoured lots of cheese.*
- Contrast (π_1, π_2) : π_1 and π_2 are eventuality descriptions with similar thematic structure, but there is a contrast in content.
 - Example: *John ate salmon, but Mary didn't eat salmon.*

SDRT treats discourse structure as hierarchical rather than purely sequential, which can be directly visualized in SDRS graphs. In the SDRT framework, the above coherence relations are classified into two main categories: coordinating and subordinating (Asher and Vieu, 2005), and they can be represented either horizontally or vertically in an SDRS graph. Specifically, coordinating relation, such as Narration and Result, change the scene and move forward the narrative, and are represented horizontally in an SDRS graph. In contrast, subordinating relations, such as Elaboration and Background, provide additional details or context about the current discourse unit, and are represented vertically in the SDRS graph. For example, Figure 2.2 exemplifies a SDRS graph for (10). In (10), π_2 and π_5 are in subordinating relations to π_1 , as they elaborate on and provide more information about the event described in π_1 (i.e., John having a great evening). Similarly, π_3 and π_4

are in a subordinating relation to π_2 , providing more details about the dinner event mentioned in π_2 . In contrast, coordinating relations, such as Narration and Result, drive the narrative forward and are represented horizontally in the SDRS graph. For instance, in (10), π_4 is in a coordinating relation with π_3 , as it describes a new event (i.e., devouring cheese) that follows the event described in π_3 (i.e., eating salmon).

- (10) π_1 John had a great evening last night.
 π_2 He had a great meal.
 π_3 He ate salmon.
 π_4 He devoured lots of cheese.
 π_5 He then won a dancing competition.

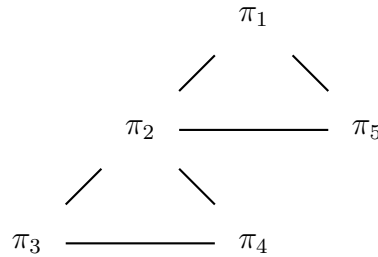


Figure 2.2: The SDRS graph for (10). Nodes represent discourse units. The horizontal lines represent coordinating relations, and the vertical lines represent subordinating relations.

However, not all discourse units (i.e., nodes) in an SDRS graph are equally accessible for establishing new coherence relations. For example, as we discussed in §2.1.1, in the discourse in (10), if we add a continuation such as “it was a beautiful pink” (as π_6), the pronoun *it* intuitively cannot refer to the salmon. This is because π_3 is not an accessible node for further attachment. To capture the accessibility of discourse units for further discourse development, SDRT incorporates the Right Frontier Constraint as a structural constraint.

Right Frontier Constraint. The Right Frontier Constraint (RFC) was first introduced in a series of works by Polanyi in the 1980s, where she applied it specifically to anaphoric pronoun resolution in discourse (Polanyi, 1985, 1988). It was later incorpor-

ated into the SDRT framework, where it was further developed and generalized to address all types of anaphora and discourse attachment problems (Mann and Thompson, 1988; Thompson and Mann, 1987; Webber, 1988).

Within the SDRT framework, the RFC predicts which discourse units are accessible for attachment and anaphoric resolution. Specifically, when attaching a new constituent β^9 , the RFC specifies three possible attachment points: (i) the most recent unit, (ii) any label γ that either outscopes or is in a subordinating relation with the most recent unit, and (iii) any label that dominates the current unit through a chain of such relations (Asher and Lascarides, 2003).

A formal definition of RFC is given in Asher and Lascarides (2003, p148):

Suppose that a constituent β is to be attached to a constituent in the SDRS with a discourse relation other than Parallel or Contrast. Then the available attachment points for β are:

1. The label $\alpha = \text{LAST}$;
2. Any label γ such that: (a) $i - \text{outscopes}(\gamma, \alpha)$ (i.e. $R(\delta, \alpha)$ or $R(\alpha, \delta)$ is a conjunct in $F(\gamma)$ for some R and some δ); or (b) $R(\gamma, \alpha)$ is a conjunct in $F(\lambda)$ for some label λ , where R is a subordinating discourse relation.
We gloss this as $\alpha < \gamma$.
3. Transitive Closure: Any label γ that dominates α through a sequence of labels $\gamma_1, \gamma_2, \dots, \gamma_n$ such that $\alpha < \gamma_1 < \gamma_2 < \dots < \gamma_n < \gamma$

In simpler terms, the RFC can be understood by considering the horizontal and vertical arrangement of coordinating and subordinating relations in an SDRS graph. The right frontier refers to the rightmost edge of an SDRS graph, and all discourse units positioned at the rightmost edge of the SDRS graph remain on the right frontier. Based on this notion, the RFC states that new discourse material can only be attached to discourse units on this right frontier. Put more plainly, it reflects a constraint on discourse

⁹ In some versions of the RFC, Parallel or Contrast relations are exempted from this constraint.

progression that speakers cannot detail scenes that have been changed. For example, as shown in Figure 2.3, the discourse begins with *There were three circles*. It then continues with a subordinating relation: *One of them was red* (π_2), which further details the initial setup by modifying one of the circles. The discourse then moves on via a coordinating relation: *Later, there were three squares* (π_3), which marks a scene change. At this point, only π_3 remains on the right frontier, so the next utterance, *One of them was blue* (π_4), must attach to π_3 . This results in a description of one of the squares in π_3 , rather than circles in π_1 or π_2 . After this attachment, both π_3 and π_4 remain on the right frontier and are accessible for further attachment.

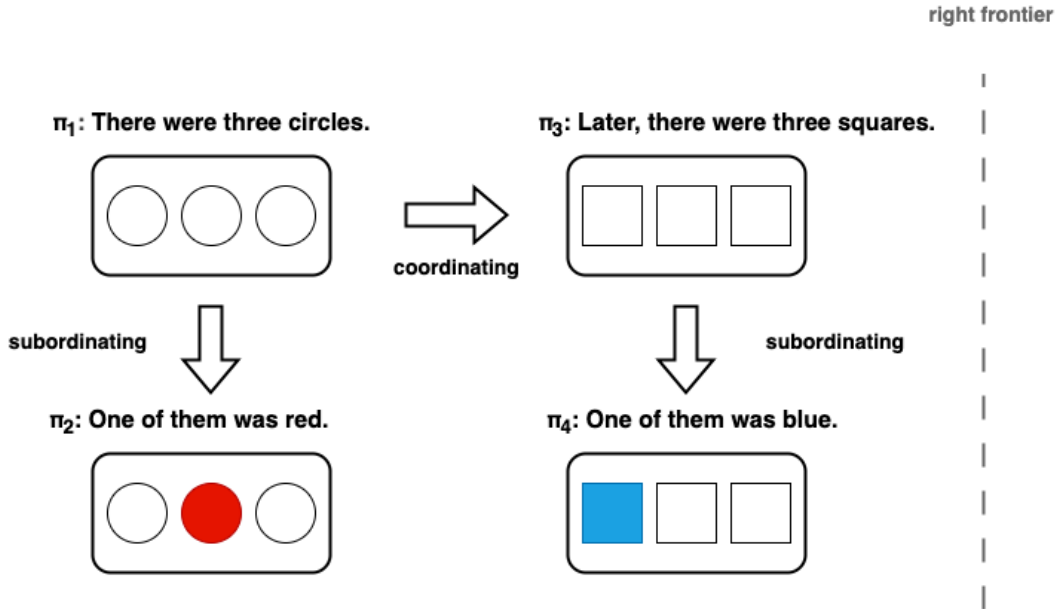


Figure 2.3: An illustration of coordination, subordination, and the right frontier (modified from Altshuler and Truswell (2022)).

Now let's return to the incoherent Example (9), which I repeat below as (11), and analyse it with the RFC. The prediction is that π_6 can only be attached to π_1 or π_5 , as they are on the right frontier of the existing discourse structure. As a result, the pronoun *it* in π_6 can only refer to π_1 , π_5 or an entity in π_1 or π_5 (e.g., dancing competition), even though world knowledge suggests that none of them should be described as “beautiful pink”. If we try to follow our world knowledge and interpret *it* in π_6 as referring to *salmon* in π_3 , π_6 would need to be attached to π_3 , which would violate the RFC and lead to incoherence, as illustrated in Figure 2.4.

- (11) π_1 John had a great evening last night.
 π_2 He had a great meal.
 π_3 He ate salmon.
 π_4 He devoured lots of cheese.
 π_5 He then won a dancing competition.
 π_6 ??It was a beautiful pink.

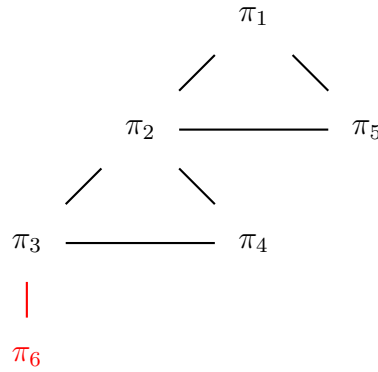


Figure 2.4: The SDRS graph for the incoherent example in (11). π_1 or π_5 are on the right frontier. The red line represents an RFC violation.

The RFC is arguably the most empirically testable aspect of SDRT (Sasaki, 2021). In recent decades, empirical evidence from discourse processing and computational linguistics has examined the RFC’s validity within the SDRT framework. For example, Afantenos and Asher (2010) studied a doubly annotated corpus of French newspaper texts and Wikipedia articles and demonstrated that the RFC is respected approximately 95% of the time in terms of discourse attachment, suggesting that the RFC is a robust feature that can enhance discourse parsers. Experimental work has also explored the RFC with respect to anaphora resolution using controlled mini-discourses. Questionnaire-based evidence suggests that right-frontier status can modulate pronoun resolution when morphosyntactic cues do not disambiguate the antecedent (Holler and Irmen, 2007). In two forced-choice tasks, Göbel (2019) showed that final appositive relative clauses can extend the right frontier, keeping antecedents accessible for pronoun resolution, thus supporting the RFC’s predictions.

More recently, Sasaki (2021) conducted a series of sentence-by-sentence stops-making-

sense tasks (Boland et al., 1990, 1995) to investigate how the RFC modulates the salience of antecedents in long-distance pronoun resolution during discourse processing. As illustrated in (12), the study manipulated antecedent salience by varying both the animacy of the antecedent¹⁰ and whether the pronoun violated the RFC. Participants read the discourse sentence by sentence and indicated whether each sentence constituted a coherent continuation of the preceding discourse. At Sentence 3, where an RFC violation could occur, continuations that violated the RFC were more often judged as incoherent than their RFC-observing counterparts, indicating a reliable RFC effect. However, overall rates of incoherence judgments remained very low, suggesting that RFC violations rarely led participants to perceive the discourse as incoherent. Moreover, the presence of an animate antecedent (e.g., (12-b)) reduced the rate that RFC-violating continuations were judged as more incoherent, indicating that the RFC is one of multiple factors that modulates antecedent salience. Although these results can be attributed to the coarse-grained nature of the stops-making-sense task, a stronger alternative explanation is that they indicate the RFC might not be a strict, deterministic rule but rather a principle of accessibility that modulates the salience of antecedents.

- (12)
- a. **Animate, RFC-observing:** Jessie saw **an elderly man** in front of a quaint farmhouse on her morning walk. She continued toward the end of the lane. **The man** fell over. Jessie circled back to investigate what had happened.
 - b. **Animate, RFC-violating:** Jessie saw **an elderly man** in front of a quaint farmhouse on her morning walk. She continued toward the end of the lane. **He** fell over. Jessie circled back to investigate what had happened.
 - c. **Inanimate, RFC-observing:** Jessie saw **a rickety mailbox** in front of a quaint farmhouse on her morning walk. She continued toward the end of the lane. **The mailbox** fell over. Jessie circled back to investigate what had happened.

¹⁰ According to animacy hierarchy effects, human entities are expected to be more accessible pronominal referents than inanimate entities (e.g., Silverstein, 1976).

- d. **Inanimate, RFC-violating:** Jessie saw **a rickety mailbox** in front of a quaint farmhouse on her morning walk. She continued toward the end of the lane. **It** fell over. Jessie circled back to investigate what had happened.

Some recent work has also claimed support for the RFC based on online discourse processing. An eye-tracking-while-reading study by Scholman et al. (2017) investigated whether the discourse marker *On the one hand* cues readers to anticipate an upcoming contrastive continuation, potentially involving non-local dependencies. For instance, in (13-a), the use of *On the one hand* raises an expectation for a global contrast. When the continuation in (13-b) fails to fulfil this expectation, as in the local contrast or no contrast conditions, readers still appear to maintain the expectation for a global contrast. Although the authors interpreted their findings as consistent with the RFC, arguing that readers track the “open” positions in a discourse structure, as illustrated in Figure 2.5, which is adapted from a diagram in Polanyi (1988, p. 613) and cited by Scholman et al. (2017), their experiments did not directly manipulate the RFC as a testable factor. Nor do their results demonstrate that RFC violations block discourse expectations in a way predicted by a structural constraint. Rather, the study shows that comprehenders are sensitive to the hierarchical organization of contrastive structures, which may be compatible with RFC-based accounts, but does not constitute a direct empirical test of the constraint itself.

- (13) a. Joseph got a job offer from the Edinburgh Zoo and he’s pondering whether he should take it. On the one hand, he needs the money that this job will pay, because he should start paying off his student loans this year.
- b. i. **Global contrast:** But he could keep looking for a nicer, better-paying job.
ii. **Local contrast:** But the loans could be deferred for a few more months.
iii. **No contrast:** Also, his car needs to be serviced by the end of the month.

Another related study is Wilke et al. (2025). Although the examples in (14) were originally designed to test claims about clause type, clause position, and at-issueness, they

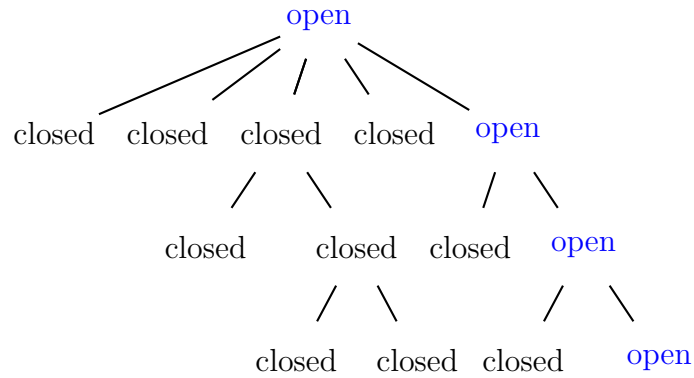


Figure 2.5: A sample discourse structure illustrating open and closed positions at the right frontier. “Open” positions are marked in blue for clarity.

also involve manipulations of RFC. In a self-paced reading task, the italicized region was read more slowly in (14-a), which violates the RFC, than in (14-b). This reading slowdown indicates a processing penalty when comprehenders attempt to resolve a pronoun to an antecedent that is not located on the right frontier (i.e., *French bistro* in (14-a)), suggesting that comprehenders are sensitive to the RFC during online pronoun resolution. However, one limitation of this study is that it doesn’t control the distance between the antecedent and the referent across conditions, which may act as a potential confound by affecting referential accessibility and processing difficulty.

- (14) a. My parents went out yesterday. After they dined at a French bistro, they went to a violin concert. It was *a very small cozy restaurant*. The food was exquisite.
- b. My parents went out yesterday. After they went to a violin concert, they dined at a French bistro. It was *a very small cozy restaurant*. The food was exquisite.

In sum, while some psycholinguistic research has discussed the RFC in relation to discourse comprehension (e.g., Göbel, 2019; Holler and Irmen, 2007; Sasaki, 2021; Scholman et al., 2017), few studies have directly examined the RFC in real-time discourse processing, particularly with respect to its role in predictive processing. Although prior studies have suggested that the RFC constrains discourse interpretations at some stage

of processing, it remains unclear whether the RFC applied early enough to interfere with discourse expectations, and whether RFC violation can elicit measurable time-course effects in online processing.

2.1.1.3 Question-under-Discussion

While SDRT focuses on the hierarchical structure of discourse and the constraints governing discourse attachment, the Question-under-Discussion (QUD) framework approaches discourse coherence from a different angle, emphasizing the role of implicit questions in organizing discourse flow (e.g., Benz and Jasinskaja, 2017; Onea, 2016; Onea and Zimmermann, 2019). It reflects an interaction between discourse coherence and the speaker’s conversational goals (Kehler and Rohde, 2017; Roberts, 1996).

According to the QUD framework, discourse is structured by a series of questions (i.e., QUDs), and each subsequent sentence should address the questions raised in the preceding discourse to ensure coherence. This idea can be traced back to early work by Von Stutterheim and Klein (1989) and Van Kuppevelt (1995), who proposed that a narrative discourse could be structured by a sequence of questions *What happened at t_1 ?*, *What happened at t_2 ?*, *What happened at t_3 ?*, etc. These local questions are seen as subordinate to a global “quaestio”, the overarching informational goal of the discourse. This notion was then further developed through the influential work of Roberts (1996), who provided a comprehensive QUD-based approach to pragmatics and focus. This laid the groundwork for extensive research on information structure, including studies on contrastive topics (Büring, 2003) and focus particles (Beaver and Clark, 2009).

The QUD framework analyses discourse structure using various representational formats, with dynamic QUD stacks (Roberts, 1996) and static QUD-trees (Büring, 2003; Riester, 2019) being two major approaches. The QUD stack captures the dynamic processing of questions during discourse comprehension. In a QUD stack, questions higher on the stack are subquestions of the lower questions on it. As the subquestions are answered, they pop out of the stack, revealing a bigger question. For example, (16) is the QUD stack of (15). In (16), when QUD₃ and QUD₄ are answered, QUD₂ will be removed from the

current QUD stack, while the larger question, QUD_1 will remain on the stack until it is fully addressed (Lee, 2024).

- (15) π_1 John had a great evening last night.
 π_2 He had a great meal.
 π_3 He ate salmon.
 π_4 He devoured lots of cheese.
 π_5 He then won a dancing competition.

- (16) QUD_1 : What was John’s evening like?
 QUD_2 : What did he eat?
 QUD_3 : Did he eat salmon?
 QUD_4 : Did he eat cheese?
 QUD_5 : What did he do after the meal?

Another approach, QUD-trees, represent the hierarchical relationships between questions and answers. These trees are similar to SDRT graphs but with all nodes labelled as Q (questions) and A (answers). For example, Figure 2.6 shows one possible QUD-tree for (15) (Riester, 2019, p. 169). The tree starts with a root question Q_0 : {What is the way things are?}, as suggested in (Roberts, 1996). Q_0 is followed by sub-questions such as $Q_{0.1}$ and $Q_{0.1.1}$, and all of them are answered as the discourse unfolds. Parallel and partial answers are indicated as $A_{0.1}$ ’ and $A_{0.1}$ ”.

The increasing application of the QUD framework to various linguistic phenomena, alongside the development of relation-based discourse coherence theories such as SDRT, has led to growing interest in integrating the two approaches, with some researchers beginning to explore the use of QUD as a general model of discourse coherence¹¹ (e.g., Benz and Jasinskaja, 2017; Jasinskaja, 2009; Onea, 2016). Unlike SDRT, which accounts

¹¹ There has been some debate about whether SDRT and the QUD framework are compatible and how the two frameworks might be related to one another (e.g., Hunter and Abrusán, 2015; Lee, 2024). While this is not the central focus of the current research, I am inclined to say that they are. I will return to this issue in §7.2.

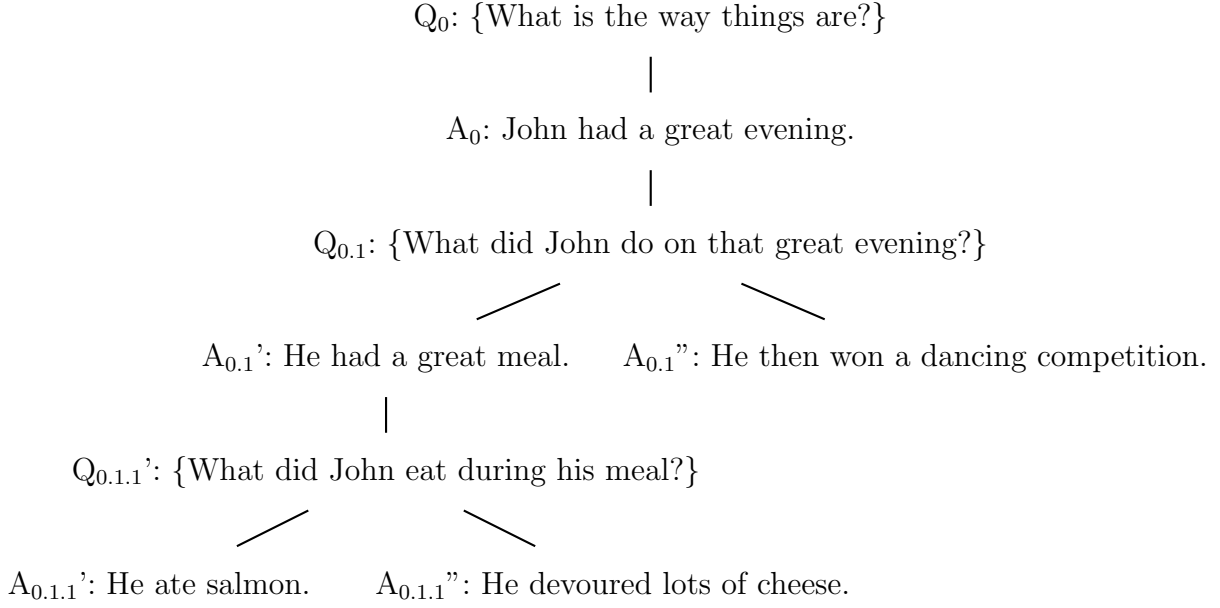


Figure 2.6: One possible QUD-tree for (15).

for discourse coherence through predefined rhetorical relations between segments, the QUD framework derives coherence from how well each discourse move addresses the current QUD; that is, to ensure coherence in a discourse, each subsequent utterance should address the questions raised in the preceding discourse. Such a difference can be illustrated by the examples in (17) - (18). From an SDRT perspective, (17) is coherent because (17-b) can be linked to (17-a) via an appropriate coherence relation (i.e., Elaboration), whereas (18) is less coherent, as no obvious discourse relation connects (18-b) to (18-a). While within the QUD framework, (17) is coherent because (17-b) addresses a plausible QUD raised by (17-a) (i.e., *How will Sally go to Paris?*). In contrast, (18) is less coherent, since (18-b) does not readily address any QUD naturally raised by (18-a) without additional contextual support.

- (17) a. Sally will go to Paris next week.
 b. She will take the train.
- (18) a. Sally will go to Paris next week.
 b. She dislikes abstract art.

Compared to SDRT, one advantage of the QUD framework is that it not only accounts for how discourse units are connected, but also captures what may be missing from a discourse (Benz and Jasinskaja, 2017). For example, from an SDRT perspective, (19) is a coherent discourse, as we can identify an Elaboration relation between (19-a) and (19-b). However, intuitively, (19) feels unnatural, because sentence (19-a) mentions that the speaker did two things, but (19-b) describes only one of them. This sense of incompleteness is naturally captured by the QUD framework. Sentence (19-a) raises an implicit question such as *What two things did the speaker do on their seventy-fifth birthday?*, but (19-b) provides only a partial answer. This mismatch between the raised QUD and its incomplete resolution gives rise to the perceived incoherence.

- (19) a. I did two things on my seventy-fifth birthday.
 b. I visited my wife’s grave. (Benz and Jasinskaja, 2017)

The ability of the QUD framework to capture what is missing in discourse also makes it a powerful tool in the field of psycholinguistics, as it is compatible with forward-looking mechanisms and incremental processing models (Benz and Jasinskaja, 2017). In recent decades, psycholinguists have attempted to adopt the QUD framework for the study of sentence and discourse processing (e.g., Clifton Jr and Frazier, 2012; Grant et al., 2012; Kehler and Rohde, 2017; Zondervan et al., 2008). Kehler and Rohde (2017) proposed an expectation-based QUD model of discourse interpretation to account for the effects of implicit causality verbs. In a passage completion task and a self-paced reading study, they found that implicit causality verbs are more likely to raise “why” questions, whereas other verbs tend to raise “what next” questions. This difference leads comprehenders to form different expectations about upcoming discourse continuations during real-time processing.

However, while some studies have used the QUD framework to explain discourse-level expectations, little attention has been paid to how QUDs evolve incrementally during online discourse processing. If psycholinguists are to adopt QUD as a framework for real-time comprehension, it must account not only for the content of the QUDs but also

for how they are updated incrementally as the discourse unfolds. Therefore, to make QUD a more comprehensive tool for modelling sentence and discourse processing, this incremental dimension must be explicitly incorporated.

2.1.2 From inter-sentential coherence to intra-sentential coherence

Discourse coherence pertains to how discourse units can be strung together (Knott, 1996). Therefore, a fundamental question in discourse coherence studies is what constitutes a discourse unit, as this definition delimits the scope of coherence research.

Traditionally, discourse coherence research has operated under the assumption that discourse units correspond to sentences, so most previous studies have focused on inter-sentential coherence. In recent years, however, a growing body of literature has turned its attention to intra-sentential coherence, including coherence relations between (overt) clauses. For example, a region-by-region self-paced reading experiment showed that comprehenders were able to build Explanation relations in real-time between main clauses and restrictive relative clauses, even when such relations are not obligatory, as in sentence (20) (Hoek et al., 2021b). For instance, readers are able to infer an Explanation relation between being praised and made a lot of money in (20), even though this Explanation relation is not required for the sentence to be coherent. This study demonstrates that linguistic elements previously considered too small to constitute discourse units, such as relative clauses, can also participate in discourse coherence.

(20) Jenny praised the guy who made a lot of money for the company.

In addition, clause-internal coherence, which was also termed *eliciture* in some literature (Cohen and Kehler, 2021), remains underexplored, but has not gone entirely undiscussed. A classic example in Anscombe (1979), as shown in (21), illustrates how a coherence relation can arise within a single clause: it can be naturally understood as inviting an inference that the woman became a widow after and because she stabbed and killed her husband with a knife. This interpretation suggests a clause-internal Explan-

ation relation: The woman became a widow because she stabbed her husband. Similar cases show that coherence relations can be inferred between adjacent nominal segments and verb phrases (e.g., Cohen and Kehler, 2021; Hobbs, 1990, 2010). For instance, in (22), it is natural to draw an inference in (22-a) that the jogger was hit by a car *when* and *because* she was jogging. In contrast, in (22-b), no similar inference arises about the teacher being hit *when* and *because* she was teaching. These examples suggest an event-based perspective on discourse units¹²: each unit corresponds to a single event description (Afantenos et al., 2012); therefore, it is possible to have more than one discourse unit in a single clause, and to establish coherence relations within a single clause.

(21) The widow stuck a knife into her husband. (Anscombe, 1979)

(22) a. The jogger was hit by a car.
b. The teacher was hit by a car. (Hobbs, 2010)

The event-based perspective on discourse units and the establishment of clause-internal coherence have been supported by recent experimental studies. For example, a series of comprehension tasks has revealed that in offline processing, attributive adjectives and some nouns can trigger causal inferences, enabling readers to establish Explanation relations between the result state described by the adjective and the event described in the main clause, such as in sentence (23) (Sasaki and Altshuler, 2022, 2023; Yao, 2022). Similarly, Sasaki et al. (2025a) found readers can establish Result relations between verbs and nouns, such as in (24), in offline comprehension. However, it remains unclear whether comprehenders can establish Explanation relations triggered by adjectives during online processing. Yao (2022) conducted a self-paced reading study to investigate clause-internal coherence using items such as (23), but found no significant effects. This null result may reflect a genuine difficulty in inferring Explanation relations within a clause in real time; but alternatively, it could be due to the coarse-grained nature of the self-paced reading paradigm or the absence of sufficiently strong materials in the experimental design, as

¹² Here, “discourse unit” refers to an elementary discourse unit.

noted in the general discussion.

(23) The broken window was struck by a stone.

(24) Bob congratulated a winner.

It seems that the current trend toward studying intra-sentential coherence has made the boundary between discourse processing and sentence processing less clear-cut, since discourse units can exist within individual sentences. Nevertheless, this might provide motivation to rethink how we conceptualize discourse processing. In this thesis, what I want to highlight is that by using the term “discourse processing”, I am not only aiming to study the processing of “larger” units (e.g., larger than a single sentence), but are concerned with discourse-level information processing, such as coherence-related phenomena and the pragmatic inference processes that establish meaningful connections between discourse units.

2.2 Predictive mechanisms in discourse comprehension

The idea that human brains are prediction machines can be traced back to the 19th century, when Von Helmholtz (1867) proposed that the things we perceive are our brain’s best guesses as to what is causing its sensory inputs (Clark, 2013). Throughout the history of psycholinguistics and cognitive psychology, predictive accounts and more bottom-up approaches have coexisted, often in ongoing theoretical tension. From the 1970s through the 1990s, however, predictive processing approaches were relatively marginalized under a “bottom-up priority” assumption (Marslen-Wilson, 1987). Early critiques of predictive processing argued that much of the language we encounter in everyday life appears unpredictable, seemingly limiting the value of predictive mechanisms in comprehension, except in some unusual contexts (Stanovich and West, 1979).

The development of probabilistic models of comprehension (e.g., Hale, 2001; Kuper-

berg and Jaeger, 2016; Levy, 2008), together with advances in experimental methodologies, such as the use of the N400 component in ERP studies (DeLong et al., 2005; Federmeier and Kutas, 1999)¹³ and the visual world paradigm (Altmann and Kamide, 1999; Kamide et al., 2003), have set the stage for a renewed interest in predictive processing. Recent decades have witnessed a surge of interest in predictive processing across psychology and neuroscience, both experimentally and computationally (see Clark, 2013; Huettig, 2015; Kuperberg and Jaeger, 2016; Pickering and Gambi, 2018, for reviews). A substantial body of evidence now demonstrates that predictions are widespread in language comprehension. Readers and listeners can use various cues to make predictions that facilitate language processing at different levels. For example, after reading the context in (25), comprehenders will predict the next word to be *kite* rather than *plane*, which would be reflected in faster reading times for *kite* or increased N400 amplitude for *plane* (Kuperberg and Jaeger, 2016).

- (25) The day was breezy so the boy went outside to fly a...
- i kite
 - ii plane

At the discourse level, a growing body of research has suggested that comprehenders can make or update their predictions about upcoming discourse-level information based on information that they have encountered so far (e.g., Hoek et al., 2021a,b; Köhne-Fuetterer et al., 2021; Rohde and Horton, 2014; Scholman et al., 2017, 2024, 2025; Schwab and Liu, 2020; Xiang and Kuperberg, 2015). This chapter will focus on predictive mechanisms in discourse comprehension. Specifically, I will discuss two central questions in predictive discourse processing: What (i.e., what are the cues used to make predictions and what can be predicted), How (i.e., What mechanisms are involved in discourse-level expectations)? and When (i.e., Do comprehenders always make predictions in discourse

¹³ Though N400 was originally linked to semantic integration processes (Kutas and Hillyard, 1980), subsequent work has shown that its amplitude is modulated by expectations (DeLong et al., 2005; Federmeier and Kutas, 1999), making it currently a useful tool for investigating predictive aspects of language comprehension.

processing)?¹⁴

2.2.1 What?

The “what question” includes interconnected sub-questions. The first concerns the cues used for predictions: What types of linguistic cues do comprehenders use to anticipate upcoming discourse-level information? The second concerns the contents of predictions: What types of discourse-level information can be predicted?

2.2.1.1 What to use: cues used for predictions

As in sentence processing, comprehenders are able to use their world knowledge along with contextual cues (e.g., Duff, 2023; Keenan et al., 1984; Kuperberg et al., 2011; Sanders and Noordman, 2000; Schwab and Liu, 2020; Wolfe et al., 2005) to form discourse-level expectations. For example, studies have found systematic differences in reading times depending on how likely a target sentence is given the preceding context and world knowledge. In contexts with high causal relatedness, such as (26-a), the target sentence in (26-c) is processed more quickly than in contexts with low causal relatedness, such as (26-b), where the target sentence is not a typical predictable result according to world knowledge (Wolfe et al., 2005).

- (26)
- a. **High causal relatedness:** Malcolm collapsed while treating patients in his office.
 - b. **Low causal relatedness:** Malcolm was a doctor in family practice.
 - c. **Target sentence:** He was carried unconscious to a hospital.

Another important class of linguistic cues that guide discourse expectations is connectives, such as *because*, *however*, and *even so*. These words serve as explicit signals of the coherence relations between clauses or sentences, allowing comprehenders to anticipate

¹⁴ Huettig (2015) discussed four central questions about prediction in language processing: Why?, What?, How? and When? The discussion in the current chapter adapts his framework to focus on What?, How? and When? questions specifically for discourse-level predictions.

the type of relationship that will unfold between discourse segments. Extensive experimental research has demonstrated that connectives facilitate comprehension by reducing the processing cost of explicitly marked relationships between discourse units compared to implicit relationships that require inferential bridging (e.g., Drenhaus et al., 2014; Haberlandt, 1982; Köhne and Demberg, 2013; Millis and Just, 1994; Scholman et al., 2017, 2024; Xiang and Kuperberg, 2015).

The predictive function of connectives is well-illustrated in reading time studies. For example, Haberlandt (1982) conducted a reading experiment using contexts like (27-a), where readers processed the target sentence in (27-b) more quickly when it was preceded by the connective *however*, which signalled an upcoming contrast relationships between the current discourse and the upcoming utterance. Neurophysiological evidence further supports the predictive role of connectives. In ERP studies, researchers have found that when the content of upcoming discourse is incongruent with the discourse expectations established by the preceding context and connective, the incongruent content elicits stronger N400 effects relative to congruent content. For instance, in examples like (28), the connective *therefore* biases comprehenders toward expecting for a logical consequence. When this expectation is violated, such as when the conclusion does not follow logically from the premises, as in (28-b), the processing difficulty is reflected in enhanced N400 amplitudes, indicating that comprehenders had generated specific predictions based on the connective along with the preceding context that were subsequently disconfirmed (Drenhaus et al., 2014).

- (27) a. The jet had just taken off. The left engine caught fire. The passengers were terrified. They thought the plane would crash.
 b. (However,) the pilot made a safe landing.
- (28) Mr. Brown was planning to look for new glasses and shoes today. The glasses really are more urgent. Therefore, he now heads towards...
- a. an optician that a friend recommended.
 b. a shoe shop that a friend recommended.

Moreover, connectives can actively reverse context-based discourse expectations. For instance, ERP studies by Xiang and Kuperberg (2015) demonstrated that the concessive connective *even so* establishes an alternative world model that reverses default expectations. As exemplified in (29), the context in (29-a) (i.e., failing an exam) would typically not lead to the result in (29-b) (i.e., celebration), but the connective *even so* signals that the upcoming content will contradict this default expectation. This reversal effect was evidenced by attenuated N400 amplitudes when the *even so* was present, indicating that comprehenders had adjusted their predictions based on the concessive connective.

- (29) a. Elizabeth had a history exam on Monday. She took the test and failed it.
 b. (Even so), she went home and celebrated wildly.

Beyond connectives, other types of discourse markers can also elicit discourse expectations. For example, Sanders and Noordman (2000) found that full-sentence linguistic markers, such as (30-b)¹⁵, can facilitate the processing of subsequent sentences compared to conditions without such markers. In their study, the discourse marker in (30-b) functioned as a bridge between a problem description in (30-a) and its solution in (30-c), creating expectations for upcoming content that would resolve the previously established issue.

- (30) a. The construction of a subway in the center of Veendam will begin next year.
 This was decided at a meeting of the city council. When the subway is
 finished, pedestrians and cyclists will be able to cross the road safely.
 b. A solution is in sight now.
 c. The construction of a subway in the center of Veendam will begin next year.

Pragmatic markers, such as *well*, *you know* and *actually*, may also elicit discourse

¹⁵ The experiment was conducted in Dutch. The "discourse marker" in (30-b) is *Nu is er een oplossing in zicht* in Dutch, and it is argued to be functionally equivalent to the causal connective *daarom* ('therefore') in Dutch.

expectations, but mainly in dialogue. For example, it has been found in Dutch, pragmatic markers like *eigenlijk* (‘actually’), explicitly signal expectation violations, prompting listeners to revise discourse predictions (Rasenberg et al., 2020; Van Bergen and Bosker, 2018). However, much of this work remains within the domains of pragmatics and discourse analysis, with limited experimental evidence for measurable predictive effects in real-time processing (e.g., Aijmer, 2013; Aijmer and Simon-Vandenberg, 2004; Baiat et al., 2013; Degand and Van Bergen, 2018).

In addition to explicit cues, there are many implicit cues that lead to discourse-level expectations (e.g., Clifton Jr and Frazier, 2012; Grant et al., 2012; Hoek et al., 2021a,b; Mak and Sanders, 2013; Rohde et al., 2011; Scholman et al., 2020). A story-continuation study in Scholman et al. (2020) showed that some quantifiers, such as *several* and *multiple*, can guide expectations for List relations. For example, in (31), participants tend to continue the discourse with specifying multiple instances of unfortunate events (e.g., “She got wine thrown at her and her heel broke”). This is arguably because quantifiers semantically require plural referents and trigger a discourse expectation for enumeration to satisfy coherence demands (Moxey and Sanford, 2000; Paterson et al., 2009).

(31) The woman experienced several unfortunate events last night.

The most well-studied implicit cue in discourse processing might be implicit causality (IC) verbs, a class of verbs that contain implicit information about causal directionality within their semantic structure, such as *praise* and *frighten* (e.g., Au, 1986; Chafe, 1972; Garvey and Caramazza, 1974). A substantial body of experimental research has demonstrated that IC verbs can elicit causal expectations (i.e., expectations for Explanation relations) in discourse processing using various methodological approaches (e.g., Hoek et al., 2021a,b; Mak and Sanders, 2013; Rohde, 2008; Rohde et al., 2011). I will discuss IC verbs and the causal expectations they raise in more detail in §2.3.2.

2.2.1.2 What to predict: contents of predictions

In discourse processing, comprehenders constantly generate predictions about multiple aspects of upcoming discourse-level information, including discourse structure (e.g., Rohde et al., 2011; Scholman et al., 2017), coherence relations (e.g., Drenhaus et al., 2014; Hoek et al., 2021b; Scholman et al., 2024), and event structure (e.g., Lee and Kaiser, 2021; Stewart et al., 2007, 2000; Xiang and Kuperberg, 2015).

Among these, coherence relations, such as Result, Explanation, and Contrast, are the most extensively studied targets of prediction in discourse processing. Most of the examples discussed in §2.2.1.1 illustrate how specific cues (e.g., contextual cues, connectives, or implicit cues) can bias comprehenders toward expecting particular coherence relations. For instance, the connective *therefore* raises an expectation for an upcoming Result relation (Drenhaus et al., 2014), while IC verbs such as *praise* in (32) lead to expectations for an Explanation relation between the main clause and its relative clause (RC) (Hoek et al., 2021b).

(32) Jenny praised the guy who made a lot of money for the company.

Expectations for coherence relations often support predictions about discourse structure (e.g., Rohde, 2008; Rohde et al., 2011; Scholman et al., 2017). For example, it has been found that *on the one hand* creates structural expectations that span across multiple discourse segments (Scholman et al., 2017). An eye-tracking-while-reading study demonstrated that after encountering *on the other hand*, comprehenders keep track of embedded constituents and anticipate non-local structural dependencies; that is, in discourse contexts such as (33-a), when the subsequent sentence provides a global contrast, *On the other hand* in (33-c) will be read slower (e.g., in first pass duration and total fixation duration), indicating comprehenders had generated expectations for the long-distance discourse structure and experienced difficulty when those structural expectations were violated.

(33) a. Joseph got a job offer from the Edinburgh Zoo and he’s pondering whether

he should take it. On the one hand, he needs the money that this job will pay, because he should start paying off his student loans this year.

- b. i. **Global contrast:** But he could keep looking for a nicer, better-paying job.
- ii. **Local contrast:** But the loans could be deferred for a few more months.
- iii. **No contrast:** Also, his car needs to be serviced by the end of the month.
- c. On the other hand, he hates the idea of cleaning out panda cages and lion dens every day.

Comprehenders also predict event structure as part of their discourse-level expectations. For instance, Lee and Kaiser (2021) found that the result state of an event (e.g., *damaged* in (34)) was read faster when preceded by a result verb, such as *broke* in (34-b), compared to a manner verb, such as *hit* in (34-a). This indicates that readers can make predictions about event structure, with result verbs raising expectations for subsequent result states.

(34) Trevor called and asked Mary what happened to the merick.¹⁶

- a. She replied that she hit it in the morning on Monday. She said that it is damaged.
- b. She replied that she broke it in the morning on Monday. She said that it is damaged.

Similarly, IC verbs generate expectations about what thematic role (i.e., agent or patient) will be described in the subsequent utterance. For example, NP₂-biased verbs, such as *praise*, bias comprehenders to expect the patient as the reason for the IC event, while NP₁-biased verbs, such as *frighten*, bias comprehenders to expect the agent as the reason for the IC event (e.g., Koornneef and Van Berkum, 2006; Mak and Sanders, 2013; Rohde, 2008; Vonk, 1984). As a result, comprehenders tend to interpret *she* in (35-a) as referring to *Mary*, expecting the clause to describe what Mary did, while they interpret

¹⁶ To avoid object properties affecting result state representations, all object nouns used in this experiment were nonce words (e.g. merick) (Lee and Kaiser, 2021).

she in (35-b) as referring to *Sally*, expecting the clause to describe what Sally did (e.g., Stewart et al., 2007, 2000).

- | | | | |
|------|----|--|--------------------------------|
| (35) | a. | Sally praised Mary because she _{Mary} ... | [NP ₂ -biased verb] |
| | b. | Sally frightened Mary because she _{Sally} ... | [NP ₁ -biased verb] |

2.2.2 How?

Most research on predictive discourse processing has focused on the “what to use” and “what to predict” questions, while much less has investigated how discourse-level expectations are generated and updated during comprehension. In this section, I discuss two influential theoretical frameworks that aim to provide an uniform explanation to discourse expectations.

2.2.2.1 Coherence-driven expectations

Coherence has been considered a key feature of discourse, and one way to approach discourse-level expectations under the relational view of discourse is through coherence-driven models (Kehler, 2022; Rohde, 2008). As illustrated in the previous section, discourse expectations are tightly interconnected with coherence relations. In coherence-driven models, expectations arise from the comprehender’s attempt to establish a meaningful coherence relation between discourse units. The assumption is that discourse interpretation is guided by the goal of identifying coherence relations, such as Explanation, Result, or Contrast, between discourse units.

For example, when reading a sentence like *Lucy talked to Dina yesterday*, comprehenders may expect a Narration relation or an Explanation relation, depending on their prior knowledge, contextual cues and/or verb features. This illustrates a central idea of coherence-driven models: comprehenders generate top-down predictions about coherence relations that are likely to follow, and these in turn constrain their expectations about upcoming discourse content and structure.

Importantly, coherence-based expectations are not just post-hoc interpretations but can be deployed incrementally and predictively during comprehension. Kehler and Ro-

hde (2013) present experimental and theoretical evidence for a predictive, probabilistic model of pronoun interpretation, which integrates coherence-driven and Centering-based accounts (Grosz et al., 1995). Their model assumes that comprehenders compute expectations about coherence relations and referents in real time, and that pronoun interpretation reflects these dynamic expectations. They formalize this using the following equation:

$$(36) \quad P(\text{pronoun} = \text{referent}) = \sum_{\text{CR} \in \text{CR}_s} P(\text{CR}) \times P(\text{pronoun} = \text{referent} | \text{CR}).$$

Here, CR stands for a coherence relation. The model predicts that a probabilistic interpretation of a specific pronoun depends on (i) the comprehender’s prior expectations about what coherence relation is likely to hold next, and (ii) the referent preferences conditioned on that coherence relation. More broadly, this equation could be extended to any discourse property conditional on coherence relations, allowing such properties to be predicted from the probabilities of those relations.

Coherence-based expectations extend beyond pronoun resolution. For example, as shown in (33), structural expectations can be shaped by discourse markers such as *on the one hand*, which typically signal a Contrast relation (Halliday and Hasan, 1976). This connective introduces a strong expectation for Contrast relation in subsequent utterances, and if this coherence expectation is not fulfilled, it will lead to long-distance discourse expectations on discourse structure (Scholman et al., 2017).

Further evidence for coherence-based expectations comes from the role of IC verbs in shaping event representation and discourse structure. As mentioned above, IC verbs are argued to raise expectations for upcoming Explanation relations. Some studies have shown that these IC-driven expectations can guide ambiguous RC attachment, even overriding the default late closure preference typically observed in sentence processing.¹⁷ According to the Late Closure Principle, comprehenders prefer to attach new material to the most recent clause or phrase being processed (i.e., the lowest possible non-terminal node)

¹⁷ Although RC attachment is a syntactic phenomenon as the syntax determines what grammatical possibilities exist, I argue that it also involves discourse structure according to the event-based perspective on discourse units, which I discussed in §2.1.2, and the potential coherence relation that can be established between a main clause and its RC.

(Frazier, 1979). This principle predicts a low-attachment preference of RCs (e.g., Carreiras and Clifton, 1999; Frazier, 1979). However, a self-paced reading study conducted by Rohde et al. (2011) found that this preference is modulated by IC-driven expectations. They showed that in IC contexts, low-attaching continuations, such as (37-a), were read slower than high-attaching ones, such as (37-b). Crucially, this effect emerged at the disambiguating verb (i.e., *is/are*), before readers had encountered any explicit linguistic cue that the RC would in fact express an explanation. This is arguably because the IC verb *praise* in the main clause triggers an expectation for an Explanation relation, and the high-attached RC better satisfies this coherence expectation by providing information about the individual who was praised (i.e., the teacher).

- (37) a. Alan praised the teacher of the students who are friendly and polite.
 b. Alan praised the teacher of the students who is friendly and polite.

In sum, the core idea of coherence-driven expectations is that coherence relations play a central role in discourse comprehension. During online processing, comprehenders actively generate and update expectations about these relations, which in turn shape real-time discourse interpretation and give rise to expectations about other aspects of discourse, such as discourse structure and event structure. While this provides a compelling explanatory account of discourse expectations, an important concern remains: do comprehenders always anticipate a specific relation, even when there are no explicit signals or implicit cues such as IC verbs? If so, is there a default relation that serves as the basis for prediction¹⁸? Alternatively, in the absence of sufficient cues, do comprehenders suspend their expectations and wait until more information becomes available, rather than engaging in highly incremental and predictive processing?

¹⁸ Some studies have explored the idea of default coherence relations (e.g., Sasaki, 2021), but the findings remain inconclusive

2.2.2.2 QUD-based expectations

A competing theory of discourse expectations is the QUD framework, where discourse is structured by a series of question–answer relationships rather than coherence relations (e.g., Benz and Jasinskaja, 2017; Onea, 2016; Onea and Zimmermann, 2019; Roberts, 1996). On this view, comprehenders track the current question under discussion and generate expectations aimed at resolving that question. Compared to coherence-driven approach, the QUD approach focuses on the information-seeking goals that drive discourse, rather than the semantic relationships that connect discourse units.

Within this framework, IC verbs drive expectations for Explanation relations because they tend to raise “why” questions while non-IC verbs tend to raise a “what” questions (Benz and Jasinskaja, 2017; Kehler and Rohde, 2017). Based on this argument, Kehler and Rohde (2017) proposed a probabilistic model of pronoun interpretation. The model mirrors the coherence-based formulation (36) but replaces coherence relations with potential QUDs:

$$(38) \quad P(\text{pronoun} = \text{referent}) = \sum_{\text{QUD} \in \text{QUDs}} P(\text{QUD}) \times P(\text{pronoun} = \text{referent} | \text{QUD}).$$

This equation formalizes the idea that comprehenders compute a distribution over possible QUDs at each point in the discourse and use these to guide reference resolution. Like the coherence-based model, it assumes that pronoun interpretation is shaped by expectations, but here the relevant expectations concern which questions are currently operative and what answers they license.

A series of studies has provided experimental support for this QUD-based equation. For example, in a self-paced reading task, participants read passages like (39) under explicit QUD instructions (e.g., “The second sentence answers WHY” or “...answers WHAT NEXT”). Reading times at the disambiguating name (e.g., Emily vs. Jessica in the second sentence) were significantly faster in the WHAT NEXT condition than in the WHY condition. This suggests that comprehenders’ referential expectations can be modulated by the current QUD. Notably, this effect emerged at the disambiguating region itself, indic-

ating that QUD-based expectations immediately constrain pronoun interpretation during incremental parsing, independent of subsequent coherence-driven inferences (Kehler and Rohde, 2017).

- (39) Jessica served chili to Emily. She explained to Jessica...
- i [WHY] ... in the kitchen that morning that she can only eat soft foods.
 - ii [WHAT NEXT] ... in the kitchen that night that the chili was a bit too spicy.

Similarly, Lee and Kaiser (2021) found that manipulating QUDs modulates comprehenders' expectations for result states. In contexts like (40), participants were more likely to anticipate a result state (e.g., *damaged*) when there is an "about" QUD, as in (40-b), compared to a "what happened" QUD, as in (40-a). This was reflected in faster reading times on the result state in the about condition, suggesting that comprehenders adjust their expectations about eventual outcomes depending on the type of question under discussion.

- (40) a. Trevor called and asked Mary what happened to the merick. She replied that she hit it in the morning on Monday. She said that it is damaged. [“what happened” QUD]
- b. Trevor called and asked Mary about the merick. She replied that she hit it in the morning on Monday. She said that it is damaged. [“about” QUD]¹⁹

QUD-based expectations have also been used to account for some other discourse processing phenomena, under the assumption that some lexical items can evoke relevant QUDs. For example, it has been argued that words that can raise non-actuality implicatures, such as non-epistemic modals like *should* and other verbs such as *want to* and *be eager to* (Grant et al., 2012), can give rise to a yes/no question (e.g., “Did she go to

¹⁹ To avoid object properties affecting result state representations, all object nouns used in this experiment were nonce words (e.g. merick) (Lee and Kaiser, 2021).

Paris?” for (41)), which then lead to expectations for upcoming answers. This argument is arguably supported by eye-tracking evidence from Clifton Jr and Frazier (2012), which found when sentences contained non-actuality implicatures, as in (41-a), the denial phrase *but she hasn’t* was read faster (e.g., in total reading time and second-pass time) compared to conditions without such implicatures. However, the subsequent phrase *been to Rome any time recently* was processed more slowly in the non-actuality condition (41-a) than in the control condition (41-b) (e.g., in go-past times and total reading times), suggesting that readers had generated QUD-based expectations about what information would be provided in the subsequent discourse.

- (41) a. Jessica could go to Paris, but she hasn’t, according to her sister, been to Rome any time recently.
- b. Jessica went to Paris, but she hasn’t, according to her sister, been to Rome any time recently.

In recent years, the QUD-based approach has gained increasing popularity in psycholinguistics. One likely reason is that, compared to coherence-based models, the idea that comprehenders continuously seek answers to the current QUD aligns more naturally with the predictive and incremental nature of language processing (Benz and Jasinskaja, 2017). However, a significant challenge for the QUD framework lies in the fact that, while most experimental work shows manipulating explicit questions affects discourse expectations, in most natural discourse, QUDs, if they exist at all, are typically implicit. It is often unclear whether comprehenders actually generate QUDs during real-time processing, and if so, what specific QUDs they entertain at any given moment. While some evidence has shown that certain discourse cues, such as IC verbs (Kehler and Rohde, 2017; Rohde et al., 2011), raise some specific questions, it remains unclear whether these questions are always questions that are under discussion (i.e., QUDs), and whether there is a default QUD such as “what happened next” in other contexts. In this sense, the QUD approach risks being too post hoc to serve as a fully predictive model of online comprehension. In other words, although the QUD-based approach offers theoretically appealing accounts

of discourse expectations, it also faces empirical challenges in demonstrating how such expectations are generated and updated in real time.

2.2.3 When?

The ‘when’ question refers to the constraints on making discourse-level expectations, which includes, do people always generate discourse expectations across different contexts and different languages?

While language processing is generally highly incremental and predictive, discourse processing involves complex integration across larger spans of text, raising the question of whether comprehenders process discourse incrementally and predictively, or whether they wait until more information becomes available. Some studies have suggested that certain types of discourse-level information may be more difficult to process and thus may be processed with a delay (e.g., Duff, 2023; Huang and Gordon, 2011; Köhne and Demberg, 2013; Millis and Just, 1994; Stewart et al., 2007). For example, Köhne and Demberg (2013) found that the processing of concessive connectives is delayed, and Stewart et al. (2007) found that under shallow processing conditions, the resolution of ambiguous pronouns is delayed in discourse processing. These studies suggest in discourse comprehension, predictive mechanisms may be selectively deployed, weakened, or overridden by bottom-up input in certain discourse contexts, resulting in delayed integration.

Several studies have investigated individual differences, such as working memory capacity and linguistic experience, in discourse expectations. For instance, in a story-continuation study, Scholman et al. (2020) found that neither verbal working memory (measured by a reading span task) nor nonverbal working memory (measured by an operation span task), nor educational background, significantly influenced coherence expectations triggered by quantifiers. Instead, linguistic experience was the significant predictor: participants scoring higher on the Author Recognition Test, a robust measure of print exposure and predictor of reading skill (Freed et al., 2017), were more likely to use quantifiers such as *several* and *multiple* to generate coherence expectations.

Other work has examined the role of working memory in discourse expectations per-

sistence. A series of studies by Scholman et al. (2025) investigated whether discourse expectations are constrained by the length of the dependencies. The results demonstrated that the coherence expectation triggered by *on the one hand* diminishes when intervening material is present. In contexts such as (42), the authors found that the presence of an intervening clause (e.g., *because he studied accounting in college* in (42-b)) reduces or even eliminates the facilitation effect of *on the one hand* in (42-b) on the subsequent processing of *on the other hand* in (42-c). These results support memory-based models of language processing, indicating that working memory is a key factor that constrains long-distance discourse expectations.

- (42)
- a. Ronan is thinking about quitting his job at the supermarket after working there for five years.
 - b.
 - i. On the one hand, he thinks he could get a more promising job at a multinational, because he studied accounting in college.
 - ii. On the one hand, he thinks he could get a more promising job at a multinational.
 - iii. He thinks he could get a more promising job at a multinational, because he studied accounting in college.
 - iv. He thinks he could get a more promising job at a multinational.
 - c. On the other hand, he has a good chance of becoming a manager at the supermarket next year.

In addition, little attention has been paid to how syntactic and structural factors constrain discourse expectations, perhaps because discourse expectations have usually been viewed as primarily driven by high-level knowledge structures. Existing studies appear to focus more on identifying which linguistic cues can be used for prediction, rather than examining how these cues interact with contextual constraints such as (morpho)syntactic information. For example, research on IC verbs typically assumes that such verbs can always generate coherence expectations for upcoming Explanation relations, without considering how syntactic structure might modulate these effects.

Moreover, research on discourse expectations (or more generally, in psycholinguistics) has been conducted in a very limited number of languages. While the predictive nature of the human brain appears to be universal, discourse processing may involve many language-specific aspects. Language shows remarkable diversity in all levels of linguistic organization (Evans and Levinson, 2009; Huettig, 2015). Cross-linguistic variation in discourse processing could reveal important constraints on when discourse expectations are generated. For instance, if certain languages tend to use less explicit connectives than English (e.g., Mandarin, Japanese and some Indigenous languages of the Americas such as Navajo and Quechua (e.g., Weber, 1989; Willie and Jelinek, 2014)), do speakers of those languages generate fewer discourse-level predictions, or do they rely on alternative cues? Therefore, more cross-linguistic study is required to answer the ‘when’ question and to better understand predictive mechanisms in discourse comprehension.

2.3 Causal inferences and expectations

Causality is fundamental to human cognition (Sloman and Lagnado, 2015). It is crucial for us to understand how everything works, make decisions, and communicate with each other successfully. Developmental studies have shown that children acquire causal reasoning skills and begin using causal expressions in discourse from an early age, suggesting causal cognition is a foundational skill for interacting with the world (Hood et al., 1979). As a primary medium for expressing causality in everyday life, natural language offers multiple ways of encoding causal relations. Causal connectives and causative auxiliaries are salient and universal across languages (Sanders and Sweetser, 2009). And even without those explicit causal signals, comprehenders are able to draw causal inferences, and even make causal predictions sometimes, during discourse comprehension. For example, in all three sentences in (43), we can easily establish a causal link between the *firing* event and the *embezzling money* event based on our world knowledge, despite the lack of any overt causal signals.

- (43) a. Jenny fired the man. He had been embezzling money for years.

- b. Jenny fired the man who had been embezzling money for years.
- c. The fired man had been embezzling money for years.

From the perspective of discourse coherence, causal information is encoded through causal relations, which are typically categorized into Result and Explanation relations.²⁰ These are defined as follows (Sasaki and Altshuler, 2025):

- Result (π_1, π_2) : π_1 causes π_2 .
 - Example: *Mary was injured. She went to the hospital.*
- Explanation (π_1, π_2) : π_2 causes π_1 .
 - Example: *Mary was injured. She was hit by a car.*

A substantial body of research has investigated causal inferences in discourse, with many studies providing experimental evidence that such inferences are processed anticipatorily. In this chapter, I review and critically discuss prior work on the processing causal relations, with a particular focus on what are commonly referred to as Result and Explanation relations in coherence theories.²¹

2.3.1 Inferring and Expecting Results

It appears that comprehenders can easily infer Result relations in discourse based on contextual information and world knowledge about the relatedness of events described in adjacent discourse units. Perhaps for this reason, to the best of my knowledge, no existing research has specifically investigated what linguistic cues, if any, guide the inference of Result relations. This raises a further question: If there are no specific linguistic cues guide

²⁰ Some theoretical frameworks include additional subtypes about causality, such as Volitional Result, Volitional Cause and Problem-Solution (e.g., Mann and Thompson, 1988; Sanders, 1997; Sanders and Noordman, 2000; Sanders et al., 1992, 1993), but Result and Explanation are widely recognized as the core categories.

²¹ While I use the terms Result and Explanation for the sake of consistency throughout this thesis, I note that these correspond closely to the more intuitive labels Cause–Effect and Effect–Cause, which may be more compatible with alternative theoretical frameworks and more familiar to readers with backgrounds in psycholinguistics or cognitive science.

Result inferences, can comprehenders anticipate Result relations before they occur? And if so, what types of information might support such predictive processing?

Reading time measurements and ERP results have showed that readers can generate expectations for Result relations during real-time discourse processing, at least sometimes (e.g., Kuperberg et al., 2011; Mulder, 2008; Sanders and Noordman, 2000; Wolfe et al., 2005). Studies manipulating causal relatedness have found that the N400 component and reading times on target sentences are significantly reduced when preceded by highly causally related contexts (Kuperberg et al., 2011; Wolfe et al., 2005). For example, Kuperberg et al. (2011) found in the context of (44), the target sentence (44-d) elicited the smallest N400 amplitude when following the highly related context (44-a)²².

- (44)
- a. **Highly related:** Jill had very fair skin. She forgot to put sunscreen on.
 - b. **Intermediately related:** Jill had very fair skin. She usually remembered to wear sunscreen.
 - c. **Causally unrelated:** Jill’s skin always tanned well. She always put on sunscreen.
 - d. **Target:** She had sunburn on Monday.

Such results not only indicate that comprehenders can anticipate Result relations before they occur, but also suggest a processing preference for causal continuations in discourse. After all, causal relatedness represents just one dimension among many possible ways to establish coherence between discourse segments. Consider that while examples (44-c) and (44-d) are causally unrelated, they are not unrelated in other semantic dimensions. In fact, the LSA semantic similarity value between (44-c) and (44-d) is similar to that between (44-a) and (44-d), yet (44-d) is considered to be less predictable following (44-c). This pattern suggests that comprehenders may prioritize Result relations (or causal relations) over other relations during discourse processing, which has been summarized as the Causality-by-Default Hypothesis (Sanders, 2005; Sanders and Noordman,

²² Causal relatedness in this study was determined based on a norming study where participants were asked to rate the causal relationship between two scenarios.

2000). Under this hypothesis, when processing discourse, comprehenders will first try to establish a causal relation by default; in other words, it argues that causal expectations are default expectations during discourse processing.

However, not all experimental evidence supports this hypothesis. For instance, Murray (1997) manipulated coherence relations by varying the first sentence (as exemplified in (45-a)). The results showed that although the target sentence (45-b) was read faster when it served as a Result continuation rather than a Contrast continuation, there was no significant difference between the Result continuation and the Elaboration continuation. These findings indicate that while Result relations are more predictable than Contrast relations, they are not necessarily more expected than other relations, such as Elaboration relations. In addition, critics argued that evidence from existing studies is not sufficient to establish causal relations as default relations, as no study has reported the processing difficulty or effort (e.g., costly reanalysis) that would be expected when encountering non-default relations (Duff, 2023).

- (45) a. i. **Result:** Manny needed to publicize the garage sale.
 ii. **Contrast:** Manny forgot to publicize the garage sale in the paper.
 iii. **Elaboration:** Manny informed his staff about the garage sale.
 b. **Target:** He arranged for flyers to be made.

Another problem with the Causality-by-Default Hypothesis concerns the scope of what constitutes causal relations. As mentioned above, the scope of causal relations varies in different theoretical frameworks, with at least Result and Explanation as two core relations. The Causality-by-Default Hypothesis was largely based on the categorization system by Sanders et al. (1992, 1993), which distinguished coherence relations according to four binary cognitive-based dimensions, as shown in Table 2.1. Most relevant here is the basic operation dimension, which refers to whether discourse segments are strongly connected or weakly connected; all intuitively strongly connected relations are classified as causal relations, which includes some relations that might be categorized as Elaboration relations in other frameworks. While this broad categorization may explain the results in

Basic operation	Source	Order	Polarity	Coherence relations
Causal	Semantics	Basic	+	Cause-consequence
Causal	Semantics	Basic	-	Contrastive cause-consequence
Causal	Semantics	Non-basic	+	Consequence-cause
Causal	Semantics	Non-basic	-	Contrastive consequence-cause
Causal	Pragmatics	Basic	+	Argument-claim/Instrument-goal/ Condition-consequence
Causal	Pragmatics	Basic	-	Contrastive argument-claim
Causal	Pragmatics	Non-basic	+	Claim-argument/Goal-instrument/ Consequence-condition
Causal	Pragmatics	Non-basic	-	Contrastive claim-argument
Additive	Semantics	\	+	List
Additive	Semantics	\	-	Exception/Opposition
Additive	Pragmatics	\	+	Enumeration
Additive	Pragmatics	\	-	Concession

Table 2.1: Coherence relations classified according to four binary dimensions (Sanders et al., 1992, 1993).

Murray (1997) by classifying the Elaboration condition as a causal relation, it weakens the explanatory power of the hypothesis. As the hypothesis becomes overly inclusive, it becomes unclear whether comprehenders are specifically predicting Result relations or rather any strongly connected continuations.

Furthermore, the assumption that humans take Result relations as default relations to expect seems incompatible with some QUD-based analyses. For example, Kehler and Rohde (2017) indicates that in non-IC conditions, the default QUD is “what happened next?”, which should be linked with Narration relations rather than Result relations. Some psychological theories of discourse also assume (non-causal) progression (i.e., Narration relations) as default, as it reflects the way in which humans experience time (e.g., Dickey, 2001; Zwaan and Radvansky, 1998, see also Sasaki (2021) for a review and discussion). Intuitively, not every action elicits results that are relevant or informative enough to be expressed in discourse. For instance, if I want to describe what I did this morning, I might say “I woke up at 9 as usual”, and intuitively, listeners should expect me to say what I did next rather than describe the consequences of waking up (which might be something as uninformative as “I was no longer asleep”).

After all, although the notion of a “default” coherence relation is appealing, it should be treated with caution, as “default” is not theory-neutral term and it presupposes that the discourse interpretation system contains a privileged, baseline relation that is applied in the absence of stronger evidence. However, even if some relations may be more strongly preferred in particular contexts than others, it remains unclear whether such preferences arise from an interplay between linguistic input (e.g., semantic information and structural constraints) and pragmatic knowledge, or from an actual default setting in human cognition. In fact, most studies that report processing advantages for causal relations rely on biases induced by prior context. Therefore, at the end of this section, I want to return to the question of whether specific linguistic input guide Result inferences and expectations. It seems that, at the current stage, we only know comprehenders can predict Result relations, but it remains unclear under what conditions they do so. While this remains an underexplored area, some recent studies offer intriguing insights. For example, Lee and Kaiser (2021) found that the result state of an event (e.g., *damaged* in (46)) was read faster when preceded by a result verb such as *broke* in (46-b), compared to a manner verb such as *hit* in (46-a). While the authors analysed the results in the QUD framework, this finding also suggests that result verbs, rather than manner verbs, may raise expectations for Result relations.

- (46) Trevor called and asked Mary what happened to the merick.
- a. She replied that she hit it in the morning on Monday. She said that it is damaged.
 - b. She replied that she broke it in the morning on Monday. She said that it is damaged.

2.3.2 Inferring and Expecting Explanations

A large body of literature has investigated Explanation inferences and expectations. Compared to Result relations, it may be more difficult for comprehenders to establish Explanation relations in discourse. Result relations involve a temporal sequence that aligns

with real-world temporal order (i.e., cause first, then result), while Explanation relations present a temporal sequence that conflicts with real-world temporal order (i.e., result first, then cause). According to some cognitive-based assumptions, such as temporal iconicity (e.g., Mandler, 1986), Explanation relations may require additional processing effort compared to Result relations due to this temporal mismatch.

Most studies on Explanation inferences and expectations actually focus on IC verbs. Given the substantial body of work in this area and the fact that I used IC verbs as cues to elicit discourse expectations in several experiments in the current project, I will discuss studies on IC verbs in a separate subsection. Before doing so, I want to briefly review other linguistic cues that may guide Explanation inferences and expectations.

Even though Explanation relations are not temporally iconic, Explanation inferences are widespread in discourse. The classic case of clause-internal coherence, illustrated in (47), exemplifies Explanation inferences. Although we lack online processing data on whether readers expect clause-internal Explanation relations, we can intuitively establish an Explanation relation between *being a widow* and *stabbing her husband*, at least in offline comprehension. This seems to suggest that our world knowledge about *being a widow* permits an Explanation inference (being a widow results from her husband's death). More broadly, we may assume any words that imply a result state can permit Explanation inferences.

(47) A widow stuck a knife into her husband. (Anscombe, 1979)

Indeed, some studies have provided experimental evidence showing that (deverbal) resultative adjectives can guide Explanation inferences (Sasaki and Altshuler, 2022, 2023; Yao, 2022). In a series of offline rating tasks and forced-choice tasks, Sasaki and Altshuler (2022, 2023) found that comprehenders can infer Explanation relations involving (deverbal) resultative adjectives, such as *drenched* in (48). Similarly, some more recent studies have shown that certain nouns can also guide Explanation inferences, such as in ((49-a)), where readers can infer an Explanation relation between *congratulating* and *winner* (Sasaki et al., 2025a). However, evidence on whether comprehenders can infer Explanation

relations predictively during online processing is limited and mixed. A self-paced reading study found no significant facilitation effects when reading the relevant verb in clause-internal Explanation relations, such as *hit* in (48-b), indicating that readers are unable to use resultative adjectives to generate expectations for clause-internal Explanation relations (Yao, 2022). However, a more recent maze study on clause-internal Explanation relations guided by deverbal nouns found facilitation effects for causal deverbal nouns (i.e., *winners* in (49-a)) relative to non-causal deverbal nouns (i.e., *readers* in (49-b)), suggesting that clause-internal Explanation relations can be built predictively in at least some cases (Sasaki et al., 2025b).

- (48) a. A child was drenched. She got hit by a big water balloon.
 b. A drenched child got hit by a big water balloon.
- (49) a. Alice congratulated two winners.
 b. Alice congratulated two readers.

Implicit causality verbs

Research on implicit causality (IC) verbs can be traced back to Garvey and Caramazza (1974), which introduced an interesting phenomenon that is illustrated in (50): while the pronoun *she* is ambiguous and can refer to either *Sally* or *Mary* in both (50-a) and (50-b), intuitively, native speakers prefer to resolve *she* in (50-a) as *Mary*, while resolving *she* in (50-b) as *Sally*. This coreference bias has been replicated in numerous subsequent studies, and verbs that elicit such coreference biases (e.g., *praise* and *frighten*) are defined as IC verbs, as they implicitly ascribe the cause of an event or state to one of the arguments of the verb (e.g., Au, 1986; Brown and Fish, 1983; Caramazza et al., 1977; Garvey and Caramazza, 1974; Hartshorne, 2014; Koornneef and Van Berkum, 2006; Pickering and Majid, 2007). According to the direction of their causal bias, IC verbs are divided into NP₁-biased IC verbs, which bias the cause toward the subject (e.g., *praise*), and NP₂-biased IC verbs, which bias the cause toward the object (e.g., *frighten*).

- (50) a. Sally praised Mary because she. . .
 b. Sally frightened Mary because she. . .

While IC verbs are initially defined according to coreference biases, subsequent work has shown that they also guide comprehenders to establish Explanation relations in both offline and online discourse processing (e.g., Hoek et al., 2021a,b; Kehler et al., 2008; Rohde, 2008; Rohde and Horton, 2014). A passage completion task in Kehler et al. (2008) using prompts like (51) found that participants were more likely to write explanation continuations in IC contexts, as in (51-a), than they did in non-IC contexts, as in (51-b). In online processing, studies using eye-tracking-while reading tasks and self-paced reading tasks have found that Explanation continuations were read faster in IC conditions than in non-IC conditions (e.g., Hoek et al., 2021a,b; Mak and Sanders, 2013). For example, Hoek et al. (2021b) manipulated the verb type in the main clause to change the coherence relations between the main clause and its RC. As illustrated in (52), the three conditions in the study were: a neutral condition (e.g., (52-a)), which included a non-IC verb such as *joke with*; a causal condition (e.g., (52-b)), which included an IC verb that could be a result of the RC, such as *praise*; and a concessive condition (e.g., (52-c)), which included an IC verb that was unlikely to be a result of the RC, such as *fire*. A region-by-region self-paced reading study found that the causal RCs were read fastest while the concessive RCs were read slowest, indicating that IC verbs can give rise to discourse expectations that guide readers to establish Explanation relations in real-time processing. In recent years, given IC verbs' ability to guide Explanation relations, they have been widely used as cues for coherence expectations in discourse processing studies (e.g., Hoek et al., 2021a,b; Mak and Sanders, 2013; Rohde et al., 2011). The present study adopts the same approach.

- (51) a. Tom praised Mary . . . [IC verb]
 b. Tom saw Mary . . . [non-IC verb]
- (52) a. Jenny joked with the guy who made a lot of money for the company.
 b. Jenny praised the guy who made a lot of money for the company.

- c. Jenny fired the guy who made a lot of money for the company.

While IC verbs can reliably serve as cues for coherence expectations, several issues warrant further discussion. In particular, what makes certain verbs exhibit implicit causality, and how are their coreference biases related to their coherence biases? research on IC verbs began with the observation of coreference bias, and early work on the source of IC bias therefore focused on what gives rise to these coreference preferences. One line of research emphasize the role of general social cognition, indicating that IC biases are largely based on general knowledge, and IC effects are largely due to non-linguistic inferences (e.g., Brown and Fish, 1983; Corrigan, 2001, 2002, 2003; LaFrance et al., 1997; Pickering and Majid, 2007; Semin and Fiedler, 1991). Prominent evidence supporting this hypothesis came from the Brown and Fish (1983) causal attribution tasks, which reported that IC biases persist in non-linguistic tasks; and studies showed IC biases can be modulated by world knowledge such as the social hierarchy of event-participants (Corrigan, 2001, 2002, 2003). In contrast, other researchers have argued that the linguistic structure accounts for IC (e.g., Brown and Fish, 1983; Hartshorne, 2014; Hartshorne and Snedeker, 2013; Hartshorne et al., 2012; Kehler, 2002; Kehler et al., 2008; McKoon et al., 1993). For example, Hartshorne and colleagues proposed that IC biases arise from how verbs encode causal relations between their arguments (Hartshorne, 2014; Hartshorne and Snedeker, 2013; Hartshorne et al., 2012). Specifically, the argument structure of a verb specifies which participant is understood as the cause of the event described by the verb, and this information directly guides pronoun resolution in causal continuations. Based on large-scale norming studies covering hundreds of verbs, they showed that coreference biases can be systematically predicted from fine-grained verb classes defined by their argument structure cross-linguistically.

The above studies have focused on explaining IC in terms of coreference bias, and under these accounts, coherence biases are often treated as by-products of pronoun resolution preferences. However, more recent research suggested that the relationship may in fact run in the opposite direction. For example, the empty slot account argues that IC verbs leave certain causal information unspecified, thereby creating pressure for speakers

and comprehenders to supply an explanatory continuation (Bott and Solstad, 2014, 2021; Solstad and Bott, 2023). On this account, the coreference biases emerge as a by-product of how comprehenders fill this missing explanatory content.

All in all, the coreference biases and coherence biases associated with IC verbs are generally assumed to be closely related. In practice, most norming studies on IC verbs have focused on measuring coreference biases (e.g., Ferstl et al., 2011; Hartshorne, 2014; Hartshorne and Snedeker, 2013). Verbs that show reliable coreference biases are therefore typically classified as IC verbs and subsequently used to elicit coherence expectations in discourse processing studies, as demonstrated by a considerable body of successful research. However, one question that arises from these norming studies is whether coreference biases themselves should be treated as categorical or gradient.

This is an interesting and important question because, on the one hand, if the ability of IC verbs to guide Explanation relations is assumed to be related to their coreference biases, evidence from norming studies shows that these biases appear to be gradient rather than categorical. In particular, some IC verbs exhibit stronger coreference biases than others (e.g., Ferstl et al., 2011; Hartshorne and Snedeker, 2013; Hartshorne et al., 2012)²³. Moreover, given the fact that IC might be a complex phenomenon involving both higher-level cognition, it seems unlikely that IC verb bias can be fully captured by binary distinction (Garvey and Caramazza, 1974; Semin and Fiedler, 1991). On the other hand, many studies investigating online discourse processing have relied on IC verbs as cues to elicit discourse coherence expectations, and most (if not all) of them treated IC/non-IC status as a categorical factor. While these studies claimed that they selected IC verbs with strong and well-established biases from previous studies, and have reported consistent and reliable findings regarding discourse expectations, it also raises the question of whether such binary distinctions adequately capture the graded nature of IC effects in discourse comprehension.

²³

It should be noted that Hartshorne and Snedeker (2013) points out that although the distribution of IC bias strengths appears continuous, this pattern does not necessarily imply that IC bias itself is continuous. Instead, the apparent continuity may arise from factors such as measurement noise, polysemy, or the existence of multiple underlying bias classes.

3 Causal relations between main and relative clauses

3.1 Summary

Article 1 explores the constraints of causal discourse expectations that driven by implicit causality (IC) verbs between a main clause and its restrictive relative clause (RC). In this article, we address this research question within the QUD framework.

During discourse processing, comprehenders are driven by the (implicit) questions raised in the discourse as it unfolds. By raising “why” questions, IC verbs bias comprehenders to seek out causal explanations which drive discourse coherence (i.e., Explanation relations). However, an open question is whether every question can be actively pursued. Specifically, in terms of IC-driven “why” questions and Explanation expectations, on the one hand, all existing studies seems to implicitly assume that IC verbs uniformly trigger “why” questions that are actively under discussion (i.e., *Why*-type QUDs) and can lead to discourse expectations, which we refer to as the *Lexical Consistency Hypothesis*:

- (53) ***Lexical Consistency Hypothesis***: The lexical properties (e.g., lexical semantics) of IC verbs make them uniformly raise “why” questions that are actively under discussion (i.e., *Why*-type QUDs) and guide Explanation relations.

On the other hand, existing work has exclusively examined cases where the IC verb occurs in the main clause and that function as the primary information that the speaker offers that updates common ground. It remains unclear whether an IC-driven “why”

question can enter the discourse as a QUD when the IC event is not the primary information that the speaker offers. For example, some structure, such as RCs, prevent their embedded content from being accessible at the discourse-level and thereby may restrict a question from being promoted to a QUD. RCs have been widely recognized as islands in syntactic analysis (e.g., Christensen and Nyvad, 2022; Liu et al., 2022; Ross, 1967), and, more recently, have also been discussed in terms of their discourse-level restrictions (e.g., Coopmans et al., 2025; Cuneo and Goldberg, 2022, 2023). We adopt the notion of *discourse island* to capture the idea that RCs tend to restrict the content they contain from becoming the current question under discussion.²⁴ For example, in (54-a), the IC verb *praised* raises a “why” question (i.e., Why did Jenny praise the employee?), which is resolved by the *because*-clause in the main clause. In contrast, when *praised* is embedded in an RC, as in (54-b)-(54-c), the question it raises is trapped in the RC; that is, the *because*-clause can only attach locally inside the RC, as in (54-b); while any attempts to attach it at the main-clause level, as in (54-c), result in infelicity. This demonstrates RCs function as discourse islands that tend to restrict the embedded content from becoming the current QUD.

- (54) a. Jenny praised the employee because he made a lot of money for the company.
 b. The employee [who Jenny praised [because he made a lot of money for the company]] had been late.
 c. #The employee [who Jenny praised] had been late [because he made a lot of money for the company].

To distinguish between questions and QUDs, and to capture the interplays between structural constraints and QUD dynamics in generating real-time discourse expectations, we propose an incremental QUD framework in which QUDs that drive discourse expect-

²⁴ Note that although there is some overlap, discourse islands are not intended to be subsets of discourse islands or equivalent to syntactic islands. For instance, sentence-final relative clauses are syntactic islands but need not function as discourse islands (Jasinskaja, 2016; Syrett and Koev, 2015). Also, discourse island effects can arise in configurations that are not syntactic islands, such as parenthetical expressions (e.g., *by the way*), although such cases fall outside the scope of the present study.

ations cannot be raised by questions that are trapped in discourse islands such as RCs. This framework motivates the Discourse Island Hypothesis of IC-driven expectations:

- (55) ***Discourse Island Hypothesis***: While IC-verbs uniformly raise “why” questions, those occurring inside discourse islands (e.g., RCs) cannot generate QUDs which guide expectations for an upcoming Explanation relation.

The incremental QUD framework is tested by manipulating the embedding status of “why” questions raised by IC verbs in a comprehension task and a moving window region-by-region self-paced reading study. In both studies, we manipulated verb type {IC, non-IC} and its position {main clause, RC}. A sample item is shown in Table 3.1.

Introductory sentence		Andrew looked over the crowd that had assembled in the company lounge.
<i>Main clause</i>	<i>Non-IC</i>	He talked to the woman who had built a successful career in sales.
<i>Main clause</i>	<i>IC</i>	He admired the woman who had built a successful career in sales.
<i>RC</i>	<i>Non-IC</i>	The woman who he talked to had built a successful career in sales.
<i>RC</i>	<i>IC</i>	The woman who he admired had built a successful career in sales.
Wrap up		She arrived at the conference room just in time for her next meeting.

Table 3.1: Sample item in all four conditions in Article 1.

The results reveal that “why” questions raised by IC verbs can only generate QUDs that enhance offline causal inference rates and guide online causal discourse expectations to material that is at the same or lower structural level. These findings support the Discourse Island Hypothesis, suggesting discourse islands, such as RCs, constrain IC-driven causal expectations. This work also contributes to discourse processing research by introducing an incremental QUD framework that is supported by our experimental results.²⁵

²⁵ The internal section numbering in §3.2, 4.2, 5.2 and 6.2 is retained and is independent of the thesis numbering.

An incremental QUD approach to causal discourse expectations

ABSTRACT

During discourse processing, comprehenders are driven by the (implicit) questions raised in the discourse as it unfolds. By raising why-questions, implicit causality (IC) verbs bias comprehenders to seek out causal explanations which drive discourse coherence. However, not every question can be actively pursued. We propose an incremental Question-under-Discussion (QUD) framework in which QUDs that drive discourse expectations cannot be raised by questions that are trapped in discourse islands such as relative clauses. This framework is tested by manipulating the position of “why” questions raised by IC verbs in a comprehension task and a self-paced reading study. The results reveal that “why” questions raised by IC verbs can only generate QUDs that enhance offline causal inference rates and guide online causal discourse expectations to material that is at the same or lower structural level, supporting the framework’s core predictions. This work contributes to discourse processing research by introducing an incremental QUD framework that is supported by our experimental results, namely that discourse embedding affects discourse-level inferences and expectations.

KEYWORDS

Causal expectations; discourse coherence; implicit causality;
incrementality; language comprehension; question-under-discussion

1. Introduction

To comprehend discourse, comprehenders need to grasp not only the meaning of linguistic elements but also the relationships between them. One set of relations central to discourse comprehension are coherence relations, which are meaningful, often non-obligatory relationships between discourse segments that connect ideas across discourse (Hobbs, 1979; Mann & Thompson, 1988). These relations organize information in particular ways, e.g., as an Explanation, Result, or Elaboration relation, thereby guiding the comprehender’s interpretation of discourse. An Explanation relation, for example can be explicitly signaled by overt connectives, as seen in (1a), where *because* indicates an Explanation relation between the *firing* event and the event of *being late* ¹. However, Explanation relations do not always need to be overtly signaled. They can also be implied by the speaker, requiring the comprehender to infer the relationship. For instance, in (1b)-(1c), even in the absence of explicit markers, comprehenders can infer an Explanation relation between the *firing* event and the *being late* event. This inference is thought to be driven by comprehenders’ general expectation that speakers will be coherent, together with their real-world knowledge that certain events (e.g., *being late*) can cause some results (e.g., *being fired*). Implicit causality (IC) verbs, such as *fire*, invoke situations that are strongly associated with particular causal scenarios, making it especially likely that comprehenders will infer Explanation relations that are consistent

¹We use the term ‘event’ to encompass both dynamic events and stative situations (i.e., eventualities), following standard practice in event semantics (e.g., Bach, 1986; Davidson, 1969; Parsons, 1990).

with their knowledge of how such events unfold.

- (1) a. Lisa *fired* the employee because the employee had been late for an important meeting.
- b. Lisa *fired* the employee. The employee had been late for an important meeting.
- c. Lisa *fired* the employee who had been late for an important meeting.

A variety of studies have reported that IC verbs can bias discourse interpretation and elicit discourse expectations regarding upcoming Explanation relations between sentences (e.g., Asr & Demberg, 2012; A. Koornneef et al., 2016; Rohde, 2008; Rohde et al., 2011) and between clauses (Hoek et al., 2021a, 2021b). For example, a subsequent discourse segment that provides a plausible explanation for the preceding IC verb, as in (2a), will be read faster than one that does not, as in (2b) (Hoek et al., 2021b).

- (2) a. Lisa *fired* the employee who had been late for an important meeting.
- b. Lisa *praised* the employee who had been late for an important meeting.

Prior studies on IC verbs have consistently shown that these verbs bias discourse interpretations and guide comprehenders to expect Explanation relations. Such IC effects have often been described as if IC verbs uniformly raise Explanation expectations in discourse processing. Within the Question-under-Discussion (QUD) framework, this can be understood as IC verbs uniformly raise *Why*-type QUDs, which then drive comprehenders to build Explanation relations (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017; Rohde et al., 2011). At the same time, however, the QUD perspective raises a new issue: while an IC verb may raise a “why” question, this question is not necessarily the

one currently under discussion. For example, in (3a), *being fired* is in the main clause, where its content contributes directly to the discourse update and can engage with the current QUD that it triggers. In contrast, in (3b), when *being fired* is embedded within a subordinate clause (i.e. relative clause), it remains unclear whether it can raise a QUD at the discourse level or only a locally embedded question. Therefore, an open question concerns the potential constraints that may prevent IC verbs from raising *Why*-type QUDs that can guide Explanation interpretations and expectations.

- (3) a. Lisa *fired* the employee who had been late for an important meeting.
- b. The employee who Lisa *fired* had been late for an important meeting.

Moreover, given that language comprehension is highly incremental (e.g., Garrod & Sanford, 1999; Kamide et al., 2003; Mak & Sanders, 2010), if we assume that comprehension is guided by questions, the generation and updating of these questions should likewise proceed incrementally. In this view, rather than simply stating that IC verbs raise a “why” question, a QUD-based account of IC effects, or more broadly, of discourse comprehension, should also consider how the status of such questions changes dynamically as the discourse unfolds.

In this study, we propose an incremental QUD framework to capture how IC-driven “why” questions generate and update dynamically within a sentence. Based on prior QUD-based account of IC effects (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017; Rohde et al., 2011), the incremental QUD framework aims to explain under what conditions IC verbs can raise “why” questions that are under discussion, and thus guide Explanation relations. After providing background assumptions about implicit causality and QUD frameworks in §2.1 and §2.2 respectively, we introduce a novel incremental QUD framework in §2.3. In §3, we support our model by providing one offline com-

prehension task (Experiment 1) and one self-paced reading task (Experiment 2), which investigated the incremental processing of sentences like (3). In §4, we discuss the implications of this study, including the potential scope of the incremental QUD framework beyond IC effects.

2. Background

Implicit causality (IC) has been a popular topic in semantics, psycholinguistics and social psychology since the 1970s. Linguistic research on IC verbs has extensively examined their role in the establishment of coherence relations, such as how they bias Explanation relations and how they shape discourse expectations about coherence relations. While early research on IC verbs primarily investigated their role in establishing coherence between sentences (e.g., A. Koornneef et al., 2016; Mak & Sanders, 2013; Rohde, 2008; Stewart et al., 2000), subsequent work has also examined IC verbs’ influence within single sentences, such as between a main clause and its relative clause (RC) (Hoek et al., 2021a, 2021b; Rohde et al., 2011); see §2.1.

In addition, with the development of the Question-under-Discussion (QUD) framework, which provides a way to model coherence in terms of questions arising in a discourse (e.g., Onea, 2016; Roberts, 1996; Velleman & Beaver, 2014; Zimmermann et al., 2019), IC verbs have been analyzed as triggers of implicit “why” questions that guide discourse processing (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017; Rohde, 2008). However, it remains unclear under what conditions a “why” question can be promoted to the status of being “under-discussion” (i.e., becoming a QUD), and in particular whether RCs restrict such promotion; see §2.2. Building on these foundations, the current study proposes an incremental QUD model for discourse processing. This model aims to capture how lexical semantics (i.e., IC bias) and discourse embedding (e.g.,

whether the IC verb occurs in the main clause or in an RC)² jointly contribute to the generation of *Why*-type QUD, and thereby shape the comprehension and real-time processing of discourse coherence; see §2.3.

2.1. *Implicit causality in discourse coherence*

Implicit Causality (IC) verbs are verbs that imply a particular causal relationship between the event they describe and the actions or characteristics of one of the participants involved in the event (i.e., either the subject or the object), such as in *praise* and *frighten* (e.g., Au, 1986; Chafe, 1972; Ferstl et al., 2011; Garvey & Caramazza, 1974; Hartshorne, 2014). For example, when talking about *Sally praised Mary*, it is more likely to be because of something Mary did, whereas when talking about *Sally frightens Mary*, it is more likely to be because of something Sally did. This difference affects the likelihood that comprehenders resolve an ambiguous pronoun like *she* in (4) to biased to the object (4a) or the subject (4b).

- (4) a. Sally *praised* Mary because she_{Mary}... [NP₂-biased verb]
 b. Sally *frightened* Mary because she_{Sally}... [NP₁-biased verb]

While IC verbs are defined according to their implicit causal biases towards one of the arguments, they have also been found to guide implicit discourse coherence relations by raising causal expectations. For example, a passage completion task in Kehler et al. (2008) using prompts like (5) found that participants were more likely to write explanation continuations in IC contexts, as in (5a), than they did in non-IC contexts, as in (5b). Several self-paced reading and eye-tracking-while-reading studies have also

²Here and throughout the paper, we use the term discourse embedding to refer to configurations in which syntactic embedding gives rise to constraints on discourse accessibility.

3.2. An incremental QUD approach to causal discourse expectations

shown that IC expectations play an immediate role in processing, and can facilitate real-time processing when subsequent discourse is consistent with the IC expectations (e.g., Hoek et al., 2021a, 2021b; A. Koornneef & Van Berkum, 2006; A. W. Koornneef & Sanders, 2013; Mak & Sanders, 2013; Vonk, 1984).

- (5) a. Sally *praised* Mary ... [IC context]
b. Sally *saw* Mary ... [non-IC context]

With increasing attention to sentence-internal coherence (Anscombe, 1979; Cohen & Kehler, 2021; Hobbs, 2010; Sasaki & Altshuler, 2023; Sasaki et al., 2025; Yao et al., 2024), recent work on IC verbs has also demonstrated such sentence-internal coherence, showing that Explanation relations can hold between a main clause and a restrictive RC (Hoek et al., 2021a, 2021b). A region-by-region self-paced reading task conducted by Hoek et al. (2021b) showed that IC verbs in main clauses can raise readers’ expectations for Explanation relations between main clauses and restrictive RCs. Using stimuli as in (6), they found causal RCs (e.g., (6b)) were read fastest, as they fulfilled the Explanation expectations raised by IC verbs, whereas concessive RCs (e.g., (6c)) were read slowest due to expectation violation.

- (6) a. Jenny *joked with* the guy who made a lot of money for the company. [Neutral RC]
- b. Jenny *praised* the guy who made a lot of money for the company. [Causal RC]
- c. Jenny *fired* the guy who made a lot of money for the company. [Concessive RC]

Similarly, Hoek et al. (2021a) conducted an eye-tracking-while-reading study revealing readers are able to use IC inference to establish sentence-internal coherence and update their expectations of upcoming coherence relations. For example, they found that the connective *because* and the post-connective *astoundingly* were read faster in (7a) than in (7b), as the RC in (7b) fulfills expectations that are triggered by IC verbs. In contrast, the RC in (7a) did not, so IC expectations persisted, which in turn facilitated the processing of the *because*-clause.

- (7) a. Diane *fired* the guy from the London office who was here last month because
 astoundingly he hired a stripper for the Christmas party.
- b. Diane *fired* the guy from the London office who was embezzling money
 because astoundingly he hired a stripper for the Christmas party.

In sum, a considerable body of literature has demonstrated that IC verbs play a critical role in discourse processing by biasing discourse interpretations and generating expectations about upcoming referents and coherence relations. To better understand these effects, researchers have turned to broader theoretical frameworks that explain how and why IC verbs guide discourse processing. One such framework is the QUD approach.

2.2. A QUD-based analysis of IC effects and discourse islands

The QUD framework has been proposed as a way to understand how discourse is structured and how it is processed (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017; Onea, 2016; Roberts, 1996; Rohde, 2008; Velleman & Beaver, 2014; Zimmermann et al., 2019). According to this framework, discourse is structured by a series of questions (i.e., QUDs), and each subsequent sentence should address the questions raised in the preceding dis-

course to ensure coherence. While IC effects have been analyzed within the QUD-based framework (Kehler & Rohde, 2017; Rohde, 2008; Rohde et al., 2007) (see §2.2.1), it remains unclear whether all IC-driven “why” questions can enter the discourse as QUDs. Specifically, RCs seem to block such questions from becoming QUDs, both structurally and pragmatically, thereby constraining the establishment of discourse coherence (see §2.2.2).

2.2.1. A QUD-based analysis of IC effects

In recent decades, psycholinguists have attempted to adopt the QUD framework for the study of sentence and discourse processing. A growing body of research has demonstrated that QUDs can influence discourse interpretation and processing (e.g., Clifton & Frazier, 2012; Grant et al., 2012; Kehler & Rohde, 2017; Zondervan et al., 2008). In terms of IC effects, Rohde et al. (2011) suggested that, intuitively, the lexical semantics of IC verbs appear to lead comprehenders to ask “why” question while non-IC verbs don’t. Kehler and Rohde (2017) proposed an expectation-based model of pronoun interpretation in discourse, where the probability of a pronoun referring to a specific entity depends on the likelihood of each potential QUD and the probability of that pronoun interpretation given each QUD³. IC verbs affect processing by triggering comprehenders’ probabilistic expectations about *Why*-type QUDs and corresponding answers.

Empirical studies have supported this QUD-based analysis (Kehler & Rohde, 2017; Rohde et al., 2007). For example, a passage completion task showed that after reading a sentence containing an IC verbs, participants were more likely to ask a “why” question (Kehler & Rohde, 2017). In terms of online processing, a self-paced reading study demonstrated that QUD biases are deployed rapidly in online processing. By manipu-

³The model is formalized as: $P(\text{pronoun} = \text{referent}) = \sum_{\text{QUD} \in \text{QUDs}} P(\text{QUD}) \times P(\text{pronoun} = \text{referent} | \text{QUD})$.

lating QUD expectations (*Why?* vs. *What happened next?*), Kehler and Rohde (2017) found that pronoun interpretations were influenced by these expectations in real-time. For instance, when participants read a sentence with an ambiguous pronoun, as in (8), they prefer to interpret *she* as referring to *Jessica* if guided to expect an answer to *Why?*, whereas they preferred *she* to refer to *Emily* when expecting an answer to *What happened next?*. This was reflected in shorter reading times on the disambiguating proper name (i.e., *Jessica/Emily*), suggesting that QUD biases guide discourse expectations in real-time, facilitating online discourse processing.

- (8) Jessica served chili to Emily. She explained to {Jessica/Emily}...

Up to now, all QUD-based analyses of IC verbs focus on lexical contrasts between IC and non-IC verbs, highlighting that IC verbs raise “why” questions while non-IC verbs tend to raise “what” questions. Furthermore, IC-driven why-questions are assumed to be under discussion and are associated with expectations for upcoming Explanation relations. In this way, these studies seem to attribute IC-driven expectations to semantic properties alone. This perspective implicitly assumes that IC verbs uniformly trigger “why” questions that are actively under discussion (i.e., *Why*-type QUDs) and can lead to discourse expectations, which we refer to as the *Lexical Consistency Hypothesis*:

- (9) ***Lexical Consistency Hypothesis***: The lexical properties (e.g., lexical semantics) of IC verbs make them uniformly raise “why” questions that are actively under discussion (i.e., *Why*-type QUDs) and guide Explanation relations.

However, this hypothesis does not account for the conditions under which a “why” question can enter the discourse as a *Why*-type QUD. For example, RCs may restrict the

questions raised by IC verbs, which in turn could influence IC-driven causal inference and discourse expectations.

2.2.2. Relative clauses as islands for QUD generation

Prior studies on IC verbs consistently show that these verbs bias discourse interpretation and lead comprehenders to expect Explanation relations. While these findings can be interpreted as evidence that IC verbs uniformly raise *Why*-type QUDs, a “why” question raised by an IC verb may fail to enter the discourse as a QUD. Existing work has exclusively examined cases where the IC verb occurs in the main clause and that function as the primary information that the speaker offers that updates common ground. However, it remains unclear whether an IC-driven “why” question can enter the discourse as a QUD when the IC event is not the primary information that the speaker offers. For example, some structure, such as RCs, prevent their embedded content from being accessible at the discourse-level and thereby may restrict a question from being promoted to a QUD (cf. Larson, 2010).

RCs have been widely recognized as islands in syntactic analysis (e.g., K. R. Christensen & Nyvad, 2022; Liu et al., 2022; Ross, 1967), and, more recently, have also been discussed in terms of their discourse-level restrictions (e.g., Coopmans et al., 2025; Cuneo & Goldberg, 2022, 2023).⁴ It has been argued that island effects may arise, at least in part, from discourse-level constraints on information packaging, with constructions such as relative clauses typically associated with backgrounded content. Therefore, we adopt the notion of *discourse island* to capture the idea that that RCs tend to restrict the content they contain from becoming the current question under discussion. Importantly, although the concept of islands originates in syntactic theory, we argue that the

⁴See also work on appositive relative clauses and their discourse accessibility (e.g., Jasinskaja, 2016; Potts, 2005; Syrett & Koev, 2015).

restriction imposed by discourse islands is both structural and pragmatic, and that discourse island status does not follow directly from syntactic island status. For instance, constructions that are syntactic islands, such as sentence-final appositive RCs, may be more accessible for attachment to the current QUD (Jasinskaja, 2016; Koev, 2013; Syrett & Koev, 2015), and therefore do not necessarily function as discourse islands .

The pragmatic constraint imposed by relative clauses is closely related to their discourse function of providing background information rather than the primary information. As a result, within QUD frameworks, content embedded in an RC is less relevant to the current QUD. For example, while both (10a) and (10b) provide some information about John and mention John’s occupation, they addressed different QUDs. In (10a), since *being a doctor* is the primary information the speaker offers, the sentence can naturally address a QUD like “Who is John?”. In contrast, the primary information conveyed by (10b) is *went to the party*, while *being a doctor* only provides background information about John. Therefore, although the RC itself may address a backgrounded question like “Who is John?”, (10b) addresses something like “What did John do?” as a whole.

- (10) a. John is a doctor.
 b. John, who is a doctor, went to the party.

The structural constraint within QUD framework concerns where a question can attach, or with which element a question can form a dependency. RCs may impose such a constraint. Since RCs are typically subordinate, questions raised within an RC cannot attach to the main discourse level. Therefore, a question introduced within an RC can only be resolved locally, within the clause itself, and cannot form a dependency with structurally higher content. For example, when IC verbs are embedded in an RC, IC-

driven “why” questions seems to be structurally trapped in the RC. To illustrate, consider the attachment of *because*-clauses, which explicitly resolve *Why*-type QUDs, in the following case:

- (11) a. Jenny praised the employee because he made a lot of money for the company.
- b. The employee [who Jenny praised [because he made a lot of money for the company]] had been late.
- c. #The employee [who Jenny praised] had been late [because he made a lot of money for the company].

In (11a), the IC verb *praised* raises a “why” question (i.e., *Why did Jenny praise the employee?*), which is resolved by the *because*-clause that attaches to the main clause. In contrast, when *praised* is embedded in an RC, as in (11b)-(11c), the “why” question it raises is trapped in the RC; that is, the *because*-clause can only attach locally inside the RC, as in (11b), while any attempts to attach it at the main-clause level, as in (11c), result in infelicity. This demonstrates that RCs function as discourse islands that tend to restrict the embedded content (e.g., *being praised*) from becoming the current QUD and from establishing Explanation relations with non-local content (e.g., *making money*).

The observations in (10)-(11) suggest that RCs function as discourse islands, which constrain the accessibility of questions both structurally and pragmatically. In IC contexts, while IC verbs robustly trigger “why” questions, those raised in island structures are structurally trapped and pragmatically backgrounded, and therefore unable to enter discourse as QUDs during incremental processing. As a result, these “not-under-discussion” questions cannot project causal discourse expectations beyond their local

domain. This restriction on the accessibility of questions motivates the need for a discourse processing model that spells out how a potential question can become the current QUD in real-time discourse processing, and specifically clarifies how IC-driven “why” questions either guide or fail to guide comprehenders’ to establish Explanation relations incrementally.

It is worth noting that the observations in (10)-(11), as well as related work on the discourse properties of RCs (e.g., Coopmans et al. 2025; Cuneo and Goldberg 2022, 2023; Jasinskaja 2016; Koev 2013; Syrett and Koev 2015), are largely based on offline judgments about acceptability and interpretation. Such work provides important evidence that constructions like RCs constrain discourse accessibility and information packaging. However, these approaches leave open how and when such constraints are deployed during real-time comprehension within a QUD framework. In particular, it remains unclear whether content that is in discourse islands give rise to QUDs and expectations during incremental processing.

2.3. An incremental QUD model for discourse processing

Building on the QUD framework (e.g., Onea, 2016; Roberts, 1996; Velleman & Beaver, 2014; Zimmermann et al., 2019) and previous QUD-based analyses of IC effects (Kehler & Rohde, 2017; Rohde, 2008; Rohde et al., 2007), we propose an incremental QUD model of discourse processing to illustrate how discourse islands affect IC-driven expectations, and to spell out how a potential question, especially an IC-driven “why” question, can become the current QUD in real-time discourse processing. Meanwhile, since IC verbs are well-established triggers of “why” questions, as discussed in §2.2.1, the processing of IC-driven coherence can provide empirical evidence supporting the proposed framework.

A considerable body of research has shown that human language processing is highly

incremental. Within QUD frameworks, incrementality concerns how QUDs are formed and updated as discourse unfolds. The incremental QUD framework we proposed distinguishes between *questions* that are potentially of interest given sentential and discourse context, and the *QUDs*, the question(s) currently under discussion and actively driving a comprehender’s expectations of discourse. Compared to traditional stack-based models (e.g., Roberts, 1996) or QUD trees (e.g., Onea, 2016; Riester, 2019), our model treats both questions and QUDs as dynamically updated in real time, reflecting the integration of lexical, syntactic, and discourse cues in incremental language processing. Importantly, not all potential questions become QUDs that can drive comprehenders to seek out discourse-relevant relationships that are related to them. The promotion of questions depends on their structural and pragmatic accessibility that is modulated by their syntactic position. When the relevant content is asserted in the main clause, the question it raises can be promoted to the current QUD; when it is embedded in a discourse island (e.g., an RC), it is structurally and pragmatically blocked from promotion, and thus does not guide coherence expectations.

In distinguishing *questions* from *QUDs*, we are proposing that there is an *expression* whose form determines which question is currently under discussion. We conceive of this *expression* as a syntactic form which carries information about questions of interest, replacing the stack-based representation in traditional QUD models (Hunter & Abrusán, 2015; Jasinskaja, 2016; Riester, 2019; Roberts, 1996). At any point during processing, at least one of these questions of interest is promoted to be under discussion, and thus actively driving a comprehender’s expectations for upcoming answers. The promotion of a question of interest to the current QUD is constrained, however, by syntactic constraints on *wh*-dependencies, such as island structures (e.g., the RC in (11c)). This approach reflects the idea that individuals do not maintain all QUDs in working memory

simultaneously, but rather relies on the current form of the *expression* to hold potential QUDs and to guide which QUD is the current QUD.

We introduce four mechanisms, *Generate QUD*, *Promote*, *Address* and *Attach*, to capture how an expression is updated and how it incrementally generates the QUD within a sentence. Specifically, for any given expression ϵ that has a dedicated syntactic position π for a question, the following mechanisms hold:

- (12) ***Generate QUD***: If there is a *wh*-phrase in π , then generate a QUD for that *wh*-phrase.
- (13) ***Address***: If there is a current QUD, take the next phrase input as a potential answer. If the phrase answers the QUD, ϵ is updated to incorporate the phrase as an answer.
- (14) ***Promote***: If there is no *wh*-phrase currently in π , then promote a *wh*-phrase to π , obeying syntactic and parsing constraints on question formation.

Figure 1 illustrates how the three mechanisms discussed above operate in an incremental QUD model, using the sentence *John ran* as an example. The expression starts in a default form, here “Who did what?”⁵. In Step 1, a QUD of the form $\lambda x.\lambda e[x \text{ did } e]$ is generated from the expression “Who did what?”. The input *John* addresses this QUD, resulting in an updated expression “John did what?”. In Step 2, since there is no longer a *wh*-phrase in the dedicated syntactic position, the system promotes the next available *wh*-phrase, yielding the expression “What did John do?”, which generates a new QUD $\lambda e[\text{John did } e]$. This QUD is then addressed by the input *ran* which updates

⁵Roberts (1996) suggests that discourse begins with a root question “What is the way things are?”. The “Who did what?” question serves as a convenient representation of this abstract root question, capturing the default expectation that discourse typically concerns agents and their actions or events.

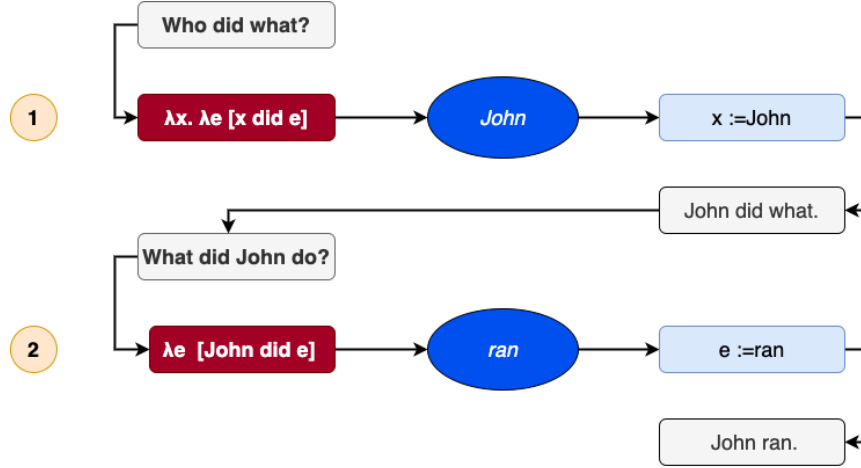


Figure 1. An incremental QUD model for *John ran* illustrating updates to a comprehender’s expression in gray and current QUD in red following sentence input shown in blue. When input addresses the current QUD, given in light blue, the expression is updated and a new question is promoted to generate a new QUD incrementally during sentence comprehension.

the expression to “John ran”.

In addition to the three mechanisms above, we also account for cases in which a new *wh*-question arises during processing. In such cases, the *Attach* mechanism applies:

- (15) **Attach:** When a new *wh*-question is introduced during processing into ϵ (e.g., an IC-driven question), attach that *wh*-question to the currently processed clause.

Figure 2 and Figure 3 show how we apply these mechanisms to our target sentences (16) as the sentence unfolds, illustrating how discourse islands influences the incremental generation of QUDs.

- (16) a. Lisa *fired* the employee who had been late.
b. The employee who Lisa *fired* had been late.

Figure 2 illustrates the processing of (16a) in an incremental QUD model. The discourse begins in Step 1 with an expression of the root question “Who did what?”, which generates an initial QUD $\lambda x.\lambda e[x \text{ did } e]$. As the subject *Lisa* is processed, it addresses this QUD. The “what” component is then promoted to question position, yielding “What did Lisa do?”, which then generates the updated QUD $\lambda x.\lambda e[Lisa \text{ did } e]$. In Step 2, the main clause IC verb *fired* addresses the updated QUD by specifying the action Lisa performed, while also introducing two additional *wh*-phrase into the expression: 1) a “who” question driven by the verb’s transitive argument structure, and 2) a “why” question that implicitly arises from the verb’s semantic bias. Critically, both components are accessible for QUD promotion because they jointly constitute the main assertion (i.e., Lisa fired someone for some reason). Following *Attach*, these questions are attached to the clause currently being processed (i.e., the main clause containing *fired*) in the expression. Given the syntax of English, the “who” question is promoted and the QUD $\lambda x.\lambda R[Lisa \text{ fired } x \text{ because } R]$ is generated. The “why” question remains in a non-promoted position, available but not able to be resolved until the “who” question is answered. In Step 3, as *the employee who* is processed, it addresses the QUD but the relativizer introduces a “which” question, which is attached to the expression and is promoted. The “why” question raised by the IC verb *fired* remains unresolved and is maintained in the expression.⁶ The syntactically obligatory *which*-phrase is promoted to the question position, generating a QUD $\lambda x.\lambda R[Lisa \text{ fired } x \text{ because } R \ \& \ x \text{ is an employee}]$ while leaving “why” again in its non-promoted position. In Step 4, the content of RC *had been late* resolves the “which” QUD by specifying the referent, leading to an updated expression with a “why” question, which is now accessible for promotion (i.e.

⁶A related perspective on unresolved QUDs are maintained comes from Köppe and Onea (2024), who argues that questions that are perceived as imminently answerable yet repeatedly deferred lead to narrative suspense.

Why did Lisa fired the employee?). In Step 5, since the *being late* can be inferred as a reason for firing, the “why” QUD is addressed by the content of the RC. This resolves all questions, as no further *wh*-phrases remain available in the expression.

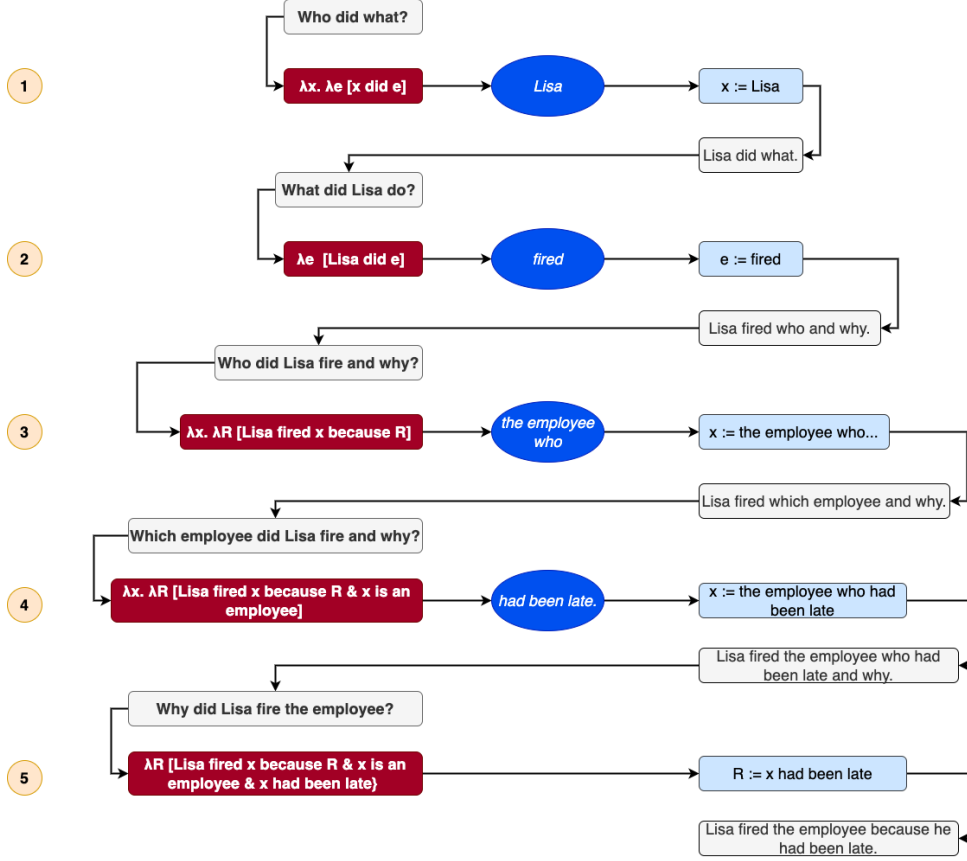


Figure 2. An incremental QUD model for *Lisa fired the employee who had been late* illustrating updates to a comprehender’s expression in gray and current QUD in red following sentence input shown in blue. The input *fired* in Step 2 raises both an object “who” question and a IC-related “why” question which are both attached to the main clause that is currently being processed. The input *had been late* is able to address both of these questions, with promotion of the “which employee” who-question and generation of its QUD in Step 4, followed by promotion of the “why” question to generate its QUD in Step 5.

QUD updates proceed differently for (16b), as shown in Figure 3, where the IC verb is embedded in a discourse island (i.e., an RC). In Step 1, comprehenders start with the same expression “Who did what”, which generates a “who” QUD (i.e., $\lambda x. \lambda e. [x \text{ did } e]$). As *the employee who* is processed, the expression updates to “Which employee

did what?”. In Step 2, English syntactic constraints guide the promotion of the “which” phrase to the question position and the QUD $\lambda x.\lambda e[x \text{ did } e \ \& \ x \text{ is an employee}]$ is generated. Processing *Lisa fired* then has two consequences. First, it addresses the QUD which updates the expression. Second, *fired* is taken to be an IC-verb, which lexically raises a “why” question that needs to be attached to the expression. Together, these consequences update the expression to “The employee [who Lisa fired and why] did what”. Importantly, “why” is attached to the clause that is currently being processed, which is the RC clause. That is because the RC acts as a discourse island that restricts *wh*-phrase promotion, and thus prevents the “why” question from projecting to the main discourse level where it could license an Explanation relation. As a result, the “why” question becomes permanently backgrounded and pragmatically inactive. Instead, the “what” question is promoted, generating the QUD $\lambda e[\text{The employee who Lisa fired did } e]$, shifting focus to the main clause event. In Step 3, when the main clause assertion (i.e., *had been late*) is processed, it addresses the promoted “what” QUD. Although *wh*-phrases remain in the expression, none can be targeted by Promote and no further QUDs can be generated.

The incremental QUD model predicts differences between (16a) and (16b) based on whether the linguistic content is embedded in a discourse island. Specifically, the model assumes that the ability of a *wh*-phrase to be promoted as a QUD during incremental processing depends on its syntactic and pragmatic position in the discourse structure. Only those questions that can be promoted are able to generate QUDs which then drive causal expectations. This runs counter to the *Lexical Consistency Hypothesis* proposed in previous QUD-based IC studies. As demonstrated in (16), while lexical semantics of the IC-verb *fired* may raise a “why” question in the mind of comprehenders, whether this question becomes a QUD depends on its structural embedding. Only when *fired*

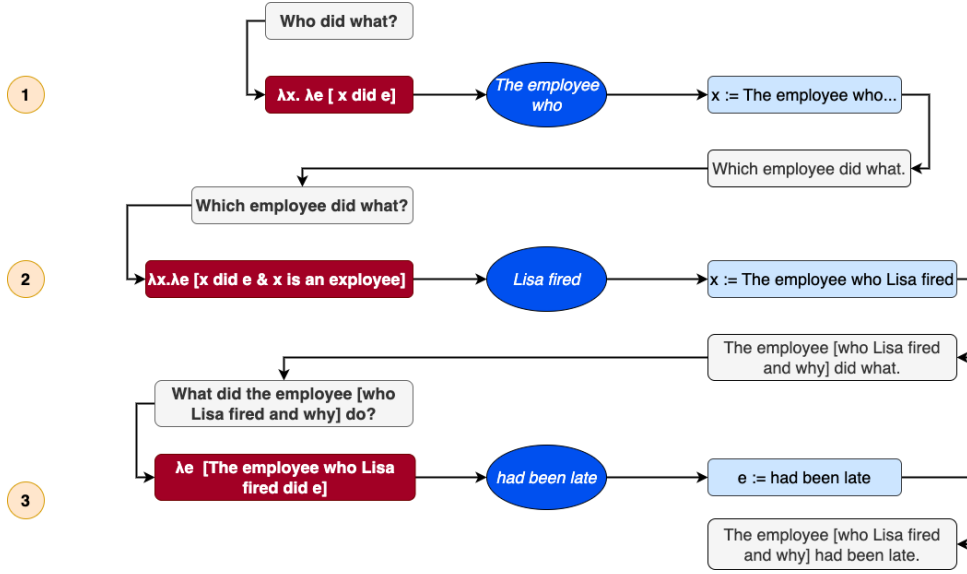


Figure 3. An incremental QUD model for *The employee who Lisa fired had been late* illustrating updates to a comprehender's expression in gray and current QUD in red following sentence input shown in blue. The input *Lisa fired* in Step 2 includes the IC verb *fired* which raises a “why” question that is then attached to the relative clause that is currently being processed. Because the “why” question cannot be promoted out of the RC, the “why” question does not generate a QUD in Step 3 and the input *had been late* cannot be used to address the “why” question.

appears in the main clause, as in (16a), the raised “why” question can be promoted to “under-discussion” status and raise an expectation for an upcoming Explanation relation. In contrast, when *fired* is embedded in a discourse island, such as an RC, as in (16b), the raised question is structurally and pragmatically blocked from promotion and remains backgrounded, failing to guide causal inference. This asymmetry motivates the *Discourse Island Hypothesis*:

- (17) ***Discourse Island Hypothesis***: While IC-verbs uniformly raise “why” questions, those occurring inside discourse islands (e.g., RCs) cannot generate QUDs which guide expectations for an upcoming Explanation relation.

To test this hypothesis, the current study adapts stimuli from Hoek et al. (2020, Experiment 3). Experiment 1 first tests whether both main clause IC verbs and IC verbs embedded in discourse islands can bias causal inferences in an offline comprehension task. Experiment 2 then uses a SPR paradigm to test whether IC verbs embedded in discourse islands can elicit online processing effects in the same way as main clause IC verbs.

3. Experiment 1: Comprehension task

Experiment 1 tests whether both main clause IC verbs and IC verbs embedded in RCs can bias causal inferences in an offline comprehension task. We used a 2×2 design to create four conditions in this study, where we manipulated the verb type {IC, non-IC} and its position {main clause, relative clause}.

Comprehenders were instructed to read short discourses containing one of four versions of a target sentence (see Table 1), followed by a comprehension question assessing

whether they inferred a causal relationship between the main clause and the RC. The key prediction was that while IC verbs generally bias comprehenders toward causal interpretations, such biases would be stronger when the IC verb appears in the main clause rather than when the IC verb occurs within the RC, consistent with the *Discourse Island Hypothesis* that is predicted by the incremental QUD framework.

3.1. Participants

32 monolingual English speakers (mean age 42.4, age range 21 – 69, 18 females) from Prolific (<https://www.prolific.com>, Peer et al., 2017) participated in this study. All the participants provided their written informed consent before participating in the experiment and received financial compensation for their time (£6/hour).

3.2. Materials and design

24 experimental stimuli were adapted from Hoek et al. (2020, Experiment 3), see Table 1 for an example. Each stimulus contained an introductory sentence that introduced participants to a context, a target sentence, which include a main clause and its restrictive RC, and a wrap-up sentence. In the target sentence, we manipulated the verb type {IC, non-IC} and its position {main clause, relative clause}.

Similarly to Hoek et al. (2020, Experiment 3), all IC verbs we used are NP₂-biased verb (e.g., *admire*), and each of them was supplemented with a non-IC verb (e.g., *talk to*) to create a non-IC condition. Each IC verb was only used once and each non-IC verb was used twice in the experiment, and we controlled the occurrence of non-IC verbs in the list to ensure each participant saw each verb only once. In addition, we manipulated the position of these IC or non-IC verbs by placing them in either main clauses or in RCs that function as discourse islands. The comprehension questions following the stimuli

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assess participants' understanding of the potential causality between the main clause and its RC. Participants were required to respond on a 7-point Likert scale, where 1 represents definitely no and 7 represents definitely yes. The full list of experimental items, raw data and analysis scripts are available at <https://osf.io/r5w6u>.

Introductory sentence		Andrew looked over the crowd that had assembled in the company lounge.
Main clause	Non-IC	He talked to the woman who had built a successful career in sales.
Main clause	IC	He admired the woman who had built a successful career in sales.
Relative clause	Non-IC	The woman who he talked to had built a successful career in sales.
Relative clause	IC	The woman who he admired had built a successful career in sales.
Wrap up		She arrived at the conference room just in time for her next meeting.
Comprehension question		Did Andrew admire/talk to the woman because she had built a successful career in sales?

Table 1. Sample item with target sentence in all four conditions in Experiment 1.

The experimental items were distributed over four lists based on a Latin Square design. Experimental stimuli were then intermixed with 48 filler items that are similar to the target items in terms of length and complexity. Filler items described everyday situations and were also followed by comprehension questions that were designed to elicit responses across the whole scale. (18) presents a sample filler item.

- (18) Isabella lived with her grandmother in a cosy cottage. Her grandmother is a wise and gentle soul who passed down her love for nature to her granddaughter. They live in perfect harmony with the natural world around them.

Comprehension question: Did Isabella live with her grandmother?

3.3. Procedure

The experiment was hosted on PCIBex Farm (<https://farm.pcibex.net>, Schwarz & Zehr, 2021). In each trial, participants were presented with one item and its corresponding

comprehension question on the same page, which allows them to reread the item or read the sentence after reading the question. They were required to answer the questions by selecting an option between 1 and 7 by clicking the buttons on the screen or by pressing the numeric keys on their keyboards.

3.4. *Predictions*

Comprehenders understanding of causal relationships is likely to be cued by IC verbs over non-IC verbs. In terms of potential effects of discourse island, the *Lexical Consistency Hypothesis* predicts no difference between main clause IC verbs and IC verb embedded in RCs in their ability to guide comprehenders towards a causal inference. Therefore, we would expect no significant difference between the scores obtained in the main clause IC condition and those obtained in the RC IC condition. The *Discourse Island Hypothesis* predicts a potential asymmetry. While IC verbs can always generate “why” questions, permitting comprehenders to affirm a causal inference offline, those “why” questions that can be promoted to generate QUDs online (i.e., questions generated by main clause IC verbs) may cause comprehenders to actively seek such causal inferences during online processing. This may boost the rate of causal inference for main clause IC verbs over IC verbs that embedded in RCs, resulting in higher scores in the main clause IC condition than in the RC IC condition.

3.5. *Data analysis*

Previous studies on behavioral experiments that are conducted online have noted that a small proportion of participants may complete the task either extremely quickly or extremely slowly, suggesting non-cooperative behavior (e.g., Downs et al., 2010; Eickhoff & de Vries, 2013; Juzek, 2015). In the present study, participants’ total response times

were recorded automatically to monitor attention. We first cleaned the data according to total response times. No participant’s total reaction time was 2.5 standard deviations divergent from the mean, so all 32 participants were considered reliable. We also checked the responses of filler items, which was shown in Figure 4. The results confirmed that participants did use the full range of the scale.

Table 2 provides an overview of the raw data of responses in four conditions. The scores in all conditions were relatively high or medium. We analyzed the results in a Cumulative Link Mixed Model with the Ordinal package (R. H. B. Christensen, 2022), incorporating fixed effects for verb type, verb position, and their interaction, as well as random effects of participant and item. Figure 4 shows model-estimated mean responses to experimental items. Our analysis revealed significant main effects of verb type ($\text{Est} = -3.54, \text{SE} = 0.43, z = -8.14, p < .001$) and verb position ($\text{Est} = -1.16, \text{SE} = 0.43, z = -4.51, p < .001$), along with a significant interaction between them ($\text{Est} = 1.16, \text{SE} = 0.43, z = 2.71, p = .007$). We ran pairwise comparisons with emmeans (Lenth et al., 2024) to further understand the interaction. The results suggest that although verb position significantly affects the inference of Explanation relations in both IC and non-IC conditions, the effects are stronger in the IC condition ($\text{Est} = 0.97, \text{SE} = 0.24, p < .001$) compared to the non-IC condition ($\text{Est} = 0.49, \text{SE} = 0.20, p = .02$).

Conditions		Mean	SD	SE
<i>Main clause</i>	<i>Non-IC</i>	3.51	2.18	0.16
<i>Main clause</i>	<i>IC</i>	6.11	1.74	0.13
<i>Relative clause</i>	<i>Non-IC</i>	3.14	2.06	0.15
<i>Relative clause</i>	<i>IC</i>	5.19	1.74	0.13

Table 2. Mean responses, standard deviations and standard errors per conditions in Experiment 1.

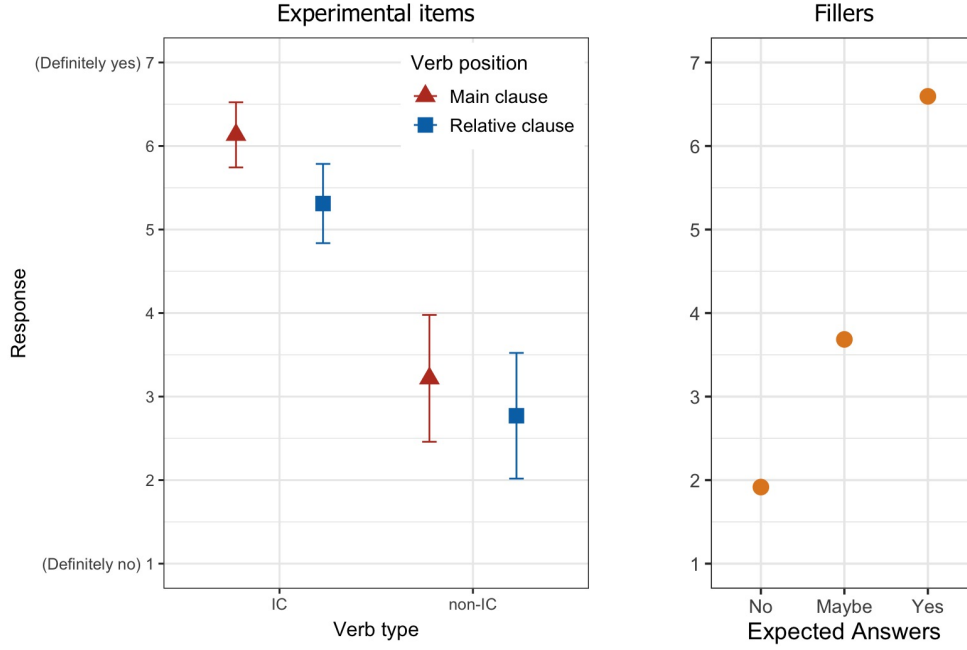


Figure 4. Estimated mean responses for experimental items (left) in Experiment 1, with mean responses to fillers as a reference (right). Error bars represent 95% confidence intervals. For experimental items, we identified main effects of verb type and verb position, as well as an interaction between them.

3.6. Results and discussion

The results of this study demonstrate that in offline processing, while both main clause and RC IC verbs bias comprehenders towards causal inferences, such inferences are stronger for main clause IC verbs. This observation supports the *Discourse Island Hypothesis* and suggests that while IC verbs can always elicit relevant “why” questions that may permit comprehenders to affirm a causal inference offline, discourse islands constrain the extent to which these questions are promoted to QUDs that raise expectations for upcoming Explanation relations in online processing. The effect of discourse islands boost the rate of causal inference for main clause IC verbs over RC IC verbs in offline processing. In the next experiment, we will further examine the effects of

discourse islands in generating online causal expectations.

The significant effect of verb position in the non-IC condition was not anticipated but is interpretable. This finding suggests that non-IC verbs may also give rise to causal inferences, and, similar to IC verbs, their effects are affected by whether they are embedded in discourse islands. It may imply that the generation of “why” questions, or other types of questions, by (non-)IC verbs are a probabilistic choice rather than a binary one (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017). Although non-IC verbs tend to prompt other types of questions, it remains possible for them to trigger “why” questions, ultimately leading to causal inferences.

4. Experiment 2: Self-paced reading

Experiment 1 demonstrated that in offline comprehension, IC verbs in main clauses elicit stronger causal interpretations than those embedded in discourse islands. Importantly, offline judgments may reflect multiple sources of information in addition to QUDs, such as explicit questions introduced by comprehension questions. Therefore, online processing measures that reflect discourse expectations provide a more direct diagnostic of QUD generation.

Experiment 2 further explore whether both main clause IC verbs and IC verbs embedded in relative clauses generate Explanation expectations in real-time discourse processing using self-paced reading paradigm.

Experimental items and manipulations in this study were the same as those in Experiment 1. Participants were required to read short discourse containing an introductory sentence, a target sentence and a wrap up sentence region by region, as illustrated in (19). If discourse islands prevent “why” questions from being promoted to *Why*-type QUDs, as predicted by the incremental QUD model, then only main clause IC verbs

should facilitate the reading of a potential explanation continuation.

4.1. Participants

57 monolingual English speakers (mean age 38.1, age range 19-76, 43 females) took part in this study. The data of one participant was excluded due to language qualifications, leaving 56 participants for the initial analysis. Among them, 52 participants with approval rates of at least 98% were recruited from Prolific (Peer et al., 2017) and received financial compensation at a rate of £6 per hour; 4 participants were Oxford undergraduate students recruited from the SONA system (<https://opr.sona-systems.com/>) and participated in exchange for credits.

4.2. Materials and design

The 24 experimental items and four conditions in this task were the same as those in Experiment 1. They were distributed over four lists based on a Latin Square design and were interspersed with 48 filler items. Each item was followed by a verification statement designed to confirm whether participants had read the sentences carefully. The full list of stimuli, raw data and analysis scripts can be found at <https://osf.io/r5w6u>.

A potential confound in our stimuli is that participants read object RCs in the main clause conditions, while they read subject RCs in the relative clause conditions. Some research reported that in English, object RCs were more difficult to process than subject RCs (e.g., Gordon et al., 2001; Staub, 2010; Traxler et al., 2002). We addressed this confound by a 2×2 design, where the non-IC conditions could serve as a baseline for comparing the differences between the main clause conditions and relative clause conditions.

4.3. Procedure

The study is a moving window self-paced reading task that was hosted on PCIBex Farm (Schwarz & Zehr, 2021). Items initially appeared as a series of underlines that obscured the regions on the screen. Participants were instructed to press the space bar on their keyboards to reveal each region. The presentation was non-cumulative, meaning that the previous region would be replaced by an underline once the next one was revealed, and participants always read only one revealed region at a time.

All experimental items were divided into six regions, with two regions in each part of the introductory sentence, the target sentence and the wrap up sentence. (19) illustrates the presentation of regions, with asterisks marking their boundaries. For the target sentences, in the main clause conditions, as shown in (19a), the first region was the main clause and the relative pronoun, while the second region was the RC; in the relative clause condition, as shown in (19b), the first region was the antecedent and the RC, while the second region was the rest of the main clause. And in all conditions, the first region of target sentences includes the (non)-IC verb, and the second region includes a plausible explanation for the IC verb; the second region was the critical region in the study as we expected it would be an answer to the *Why*-type QUD that raised by the IC verb in the main clause IC condition, but not in the other conditions.

- (19) a. Andrew looked over the crowd that * had assembled in the
company lounge. * He **talked to/admired** the woman who *
had built a successful career in sales. * She arrived at the conference room
* just in time for her next meeting.
- b. Andrew looked over the crowd that * had assembled in the
company lounge. * The woman who he **talked to/admired** *

3.2. An incremental QUD approach to causal discourse expectations

had built a successful career in sales. * She arrived at the conference room
* just in time for her next meeting.

Once participants finished reading each item, they need to press the space bar to move on to the next page, where they saw the verification statement. They were instructed to respond to the statement by pressing F for False and J for True on their keyboards. After responding, they moved on to the next trial automatically.

4.4. *Predictions*

The *Lexical Consistency Hypothesis* predicts that discourse islands won't affect coherence-based expectations driven by IC verbs. As a result, the critical regions in both main clause and relative clause IC conditions should be read faster than the non-IC conditions, with no significant reading time difference between them.

In contrast, the *Discourse Island Hypothesis* predicts that only “why” questions raised by main clause IC verbs can be promoted to a “under-discussion” status that bias Explanation relations and give rise to coherence-based expectations that facilitate processing. Therefore, the critical region in the main clause IC condition should be read faster than in the other three conditions.

4.5. *Data clean and analysis*

Data from one participant were excluded due to low accuracy of verification statements (less than 70%), resulting in 55 participants for further analysis. Among the remaining participants the mean accuracy was notably high at 90.17%, with a remarkable 95.03% accuracy rate for the target items.

3.2. An incremental QUD approach to causal discourse expectations

4.5.1. Reading times

Reading times (RTs) that exceeded 3 standard deviations (SDs) from the mean RT or fell below 3 SDs from the mean RT of this region were identified as outlier data, leading to the removal of 0.9% of the data. The cleaned RTs on each of pre-critical region, critical region and spillover region for all conditions were shown in Table 3.

		Pre-critical region		Critical region		Spillover region	
		Mean	SD	Mean	SD	Mean	SD
<i>Main clause</i>	<i>Non-IC</i>	1103	502	1409	678	1091	553
<i>Main clause</i>	<i>IC</i>	1123	487	1309	642	1071	525
<i>Relative clause</i>	<i>Non-IC</i>	1180	563	1463	749	1089	534
<i>Relative clause</i>	<i>IC</i>	1147	522	1459	710	1113	532

Table 3. Mean reading times and standard deviations on the pre-critical region, the critical region and the spillover per condition in Experiment 2, in milliseconds.

		Pre-critical region	Critical region	Spillover region
<i>Main clause</i>	<i>Non-IC</i>	7.005	7.251	6.995
<i>Main clause</i>	<i>IC</i>	7.024	7.177	6.976
<i>Relative clause</i>	<i>Non-IC</i>	7.073	7.288	6.99
<i>Relative clause</i>	<i>IC</i>	7.045	7.286	7.015

Table 4. Mean log-transformed reading times on the pre-critical, critical, and spillover regions per condition in Experiment 2.

RTs were then log-transformed (See Table 4 for log-transformed RTs.) and were analyzed by fitting linear mixed effects models with maximal random effects using lme4 package (Bates et al., 2014) in R, with p-values determined using the lmerTest package

(Kuznetsova et al., 2017). Figure 5 shows model estimated log-transformed RTs on each region in four conditions. In the critical region, we identified a significant main effect of verb position (Est = 0.76, SE = 0.02, $t = 3.32$, $p = .002$), and an interaction between verb type and verb position (Est = -0.10 , SE = 0.04, $t = -2.39$, $p = .02$). We examined the interaction through post hoc pairwise comparisons between the main clause conditions and the relative clause conditions in two verb type conditions, using the emmeans package (Lenth et al., 2024). The results indicate verb position only significantly affects the reading speed in the IC conditions (Est = -0.13 , SE = 0.03, $p < .001$), but not in the non-IC conditions (Est = -0.03 , SE = 0.03, $p = .39$).⁷ No significant effect was found either on the pre-critical region or the spillover region (all $ps > .11$)

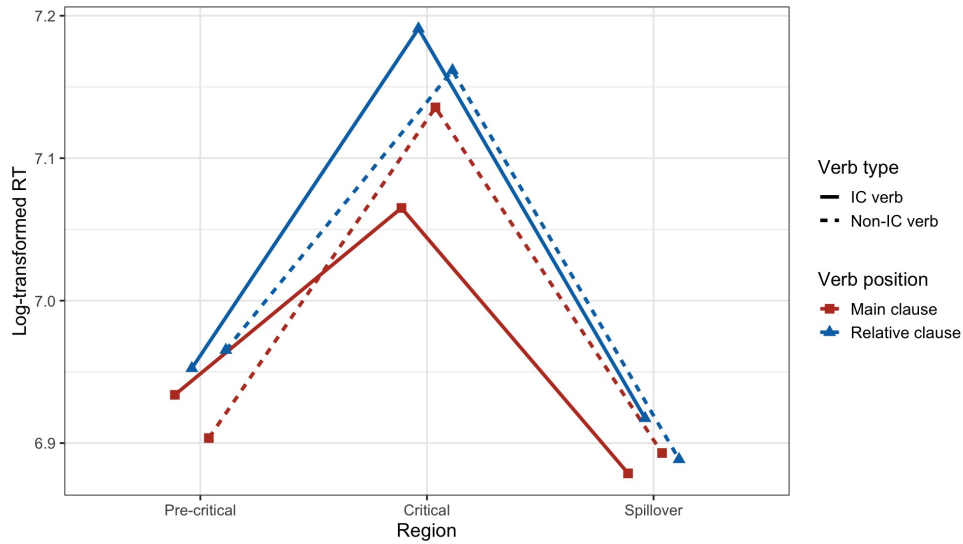


Figure 5. Model estimated log-transformed reading times on the pre-critical region, the critical region and the spillover region per condition in Experiment 2. We observed a significant main effect of verb position and an interaction effect in the critical region.

⁷Although the IC condition showed slightly longer mean RTs than the non-IC condition in discourse island conditions, this difference was not significant.

4.5.2. Reaction times on verification statements

Table 5 shows the mean reaction times to the verification statement per condition. No significant effects were observed ($ps > .23$).

		Mean	SD
<i>Main clause</i>	<i>Non-IC</i>	2342	1141
<i>Main clause</i>	<i>IC</i>	2522	1516
<i>Relative clause</i>	<i>Non-IC</i>	2417	1141
<i>Relative clause</i>	<i>IC</i>	2406	1533

Table 5. Mean reaction times and standard deviations of verification statements in Experiment 2, in milliseconds. No significant effects were observed.

4.6. Results and discussion

The results of the SPR study are in line with the predictions of the *Discourse Island Hypothesis* that only main clause IC verbs can accelerate online processing, arguably by raising relevant *Why*-type QUDs and expectations for the corresponding answers in the following discourse. Although the different syntactic complexity in the main clause the relative clause conditions may influence processing speed, the significant interaction and post hoc pairwise comparisons demonstrate that the effects of verb position are significant only when in IC conditions, but not in non-IC conditions, suggesting that the RT differences between conditions are primarily attributed to the position of IC verbs.

The study shows that even in the absence of an explicit comprehension question about causality, comprehenders can use main clause IC verbs but not relative clause IC verbs to generate *Why*-type QUDs that guide processing in real-time. It indicates “why”

questions embedded in discourse islands, such as RCs, cannot be promoted to QUDs that guide comprehension in real-time processing. Moreover, these results demonstrate that QUDs shape expectations for subsequent discourse, providing additional support for an expectation-driven QUD model of discourse processing (e.g., Clifton & Frazier, 2012; Grant et al., 2012; Kehler & Rohde, 2017). Notably, the effects observed were localized in the critical region without any spillover, indicating that comprehenders can immediately generate causal discourse expectations based on IC-driven *Why*-type QUDs, which then further facilitate processing without delay.

In addition, as reported in in Hoek et al. (2021b), we did not observe any differences in reaction times on verification statements across conditions. Hoek et al. (2021b) attributed this result to the way in which participants were required to respond to the statements. They asked participants to indicate their responses by clicking on either the TRUE or FALSE button with their cursors, and the different cursor positions likely contributed to noisy measurements that couldn't distinguish differences across conditions. However, in our current study, we reduced noise by instructing participants to respond to the statements by pressing the keys F or J on their keyboards. Therefore, in combination with localized effects in critical regions, our results indicated that the facilitation effects of main clause IC verbs and QUDs are immediate and do not spill over into subsequent processing stages or interfere with later cognitive tasks.

5. General discussion

The current research explores whether there are constraints on when IC verbs can give rise to *Why*-QUDs during discourse processing. The *Lexical Consistency Hypothesis* predicts that the lexical semantics of IC verbs uniformly raise *Why*-type QUDs as active discourse goals, while the *Discourse Island Hypothesis* predicts that while IC-

verbs raise “why” questions, these questions can be promoted to *Why*-type QUDs that guide Explanation relations only when the IC verb occurring outside discourse islands such as RCs. Results from one comprehension study and one SPR study go against the *Lexical Consistency Hypothesis*, finding that discourse islands have a strong effect on an IC verb’s potential to bias Explanation relations offline (Experiment 1) and to raise coherence-based expectations during real-time processing (Experiment 2). These results suggest that readers are less likely to make use of IC verbs that are embedded in discourse islands to establish Explanation relations between clauses in both offline and online processing. We interpret our results as supporting the *Discourse Island Hypothesis*, and account for the effects of discourse islands with a novel incremental QUD processing framework that we have proposed.

While we have demonstrated that whether the verb is embedded in a discourse island (i.e., discourse embedding) modulates IC verbs’ potential to raise *Why*-type QUDs and thus affects IC-driven discourse coherence, this does not discount the role of lexical semantics in contributing to IC biases. Instead, the current study suggests that IC effects emerge from the interaction of lexical and syntactic and discourse structure, with discourse embedding determining whether verb semantics translates into actionable discourse goals.

The incremental QUD framework proposed here highlights how discourse embedding regulates whether IC-driven questions can be promoted to QUDs that shape coherence-based expectations during processing. Our experimental results support this framework by showing the interaction between verb type and verb position in both offline and online processing. Taken together, this study advances our theoretical understanding of discourse coherence by bridging lexical semantics and structural constraints, while also contributing to discourse processing research by integrating incremental processing into

the QUD framework and discourse expectations.

5.1. The QUD-based approach to discourse processing

5.1.1. The QUD-based account of IC effects

Our results align with and extend the QUD-based framework of discourse coherence. Compared to previous QUD-based analyses of IC effects (Kehler & Rohde, 2017), the incremental QUD model we propose distinguishes between questions and QUDs and argues that while IC verbs robustly raise “why” questions, discourse embedding modulates their promotion to “under-discussion” status. The experimental results demonstrate that only “why” questions raised by IC verbs can be promoted to QUDs, biasing comprehenders toward Explanation relations between main clauses and RCs. In contrast, “why” questions raised by RC IC verbs remain backgrounded in discourse islands, unable to be promoted to “under discussion” status due to their attachment point within the discourse island. This prevents RC IC-verbs from raising causal discourse expectations in real-time processing. The asymmetry between main clause and RC IC verbs manifests in both offline tasks, as evidenced by higher causal inference scores for main clause verbs, and in online processing, where it is reflected in the facilitated processing of upcoming explanations for main clause IC verbs only.

5.1.2. Beyond IC contexts

Beyond IC contexts, this study also extends QUD-based accounts of discourse coherence by showing how questions are generated and updated incrementally within a sentence.

Compared to traditional QUD frameworks that primarily deal with inter-sentential relations, the current study extends the QUD approach to the sentence-internal level. As recent advances in discourse coherence research increasingly emphasize intra-sentential

coherence (e.g., Hoek et al., 2021a, 2021b; Sasaki & Altshuler, 2023; Sasaki et al., 2025; Yao et al., 2024), the QUD framework, as a tool for analyzing discourse structure and processing, should also account for QUD updates within sentences. The incremental QUD model we propose bridges this gap by showing how the QUD updates dynamically on a (quasi-)word-by-word basis as sentences unfold. Notably, in our framework, QUD updates are not strictly tied to fixed linguistic units such as words, phrases, or clauses. Instead, the QUD update process serves as a representational abstraction that captures how discourse expectations are structured and updated as the sentence unfolds. In other words, updates occur whenever an incoming expression contributes information that resolves, refines, or introduces a QUD.

While in this study, we introduce the incremental QUD framework to account for causal discourse expectations raised by IC verbs, we expect this framework could also account for discourse expectations beyond IC contexts. For example, Sasaki and Altshuler (2023) showed that deverbal adjectives such as *drenched* can bias comprehenders toward causal inferences in offline comprehension. From a QUD perspective, encountering a deverbal adjective may prompt comprehenders to raise an implicit “why” question (e.g., Why did the child get drenched?). The incremental QUD model would then predict that this question can only be promoted when the adjective is not embedded in a discourse island, as in (20a), rather than in (20b). If so, comprehenders should generate stronger expectations for upcoming causal relations in (20a) than in (20b). Future research can test this prediction.

- (20) a. The child was drenched. She got hit by a big water balloon.
 b. The child who was drenched got hit by a big water balloon.

However, we also recognize a limitation of the proposed framework: not all discourse

expectations have a corresponding QUD type. For example, while the current study suggests a mapping between *Why*-type QUDs and Explanation relations, the mapping might be much less straightforward for some other coherence relations such as Contrast or Parallel. Future work will need to examine the scope of the incremental QUD framework in greater detail.

5.2. Toward Probabilistic Mechanisms in QUD Frameworks

While the incremental QUD model we propose here does not explicitly incorporate probabilistic mechanisms, our experimental results indicate the need to consider probabilistic verb biases, especially when distinguishing IC and non-IC verbs. Prior research has questioned whether IC verb bias is continuous or categorical (e.g., Garvey & Caramazza, 1974; Hartshorne & Snedeker, 2013; Semin & Fiedler, 1991), and the generation of *Why*-type QUDs by IC bias might be a probabilistic choice rather than a deterministic process (Benz & Jasinskaja, 2017; Kehler & Rohde, 2017). For example, the expectation-driven QUD model proposed by Kehler and Rohde (2017) states that contextual cues, such as IC verbs, give rise only to probabilistic expectations about what QUD the upcoming discourse will address. While we treated IC/non-IC verb as categorical factor in our experiments, following common practice in studies using (non-)IC verbs to probe discourse expectations, our findings of measurable causal inference elicited by non-IC verbs in Experiment 1 support the view that IC bias operates in a more graded fashion, dependent on both lexical semantics, structural and pragmatic factors. Future work could extend our incremental QUD framework by integrating such probabilistic mechanisms to better capture these gradient effects.

5.3. *Is the Causality-by-Default Hypothesis an alternative account for the faster processing?*

The current studies, along with many previous studies on IC-based expectations (e.g., Hoek et al., 2021a, 2021b; A. Koornneef & Van Berkum, 2006) attributed faster processing to expectations: when the upcoming content aligns with IC-driven expectations, it is read more quickly. However, one potential alternative explanation for all these findings stems is the *Causality-by-Default Hypothesis*, a bottom-up perspective of discourse processing which argues that readers will first try to establish a causal relation by default (Sanders, 2005). This hypothesis has been supported by studies demonstrating the representational advantages (Black & Bern, 1981; Trabasso & Sperry, 1985; Trabasso & Van Den Broek, 1985) and processing benefits of causally related information (e.g., Linderholm, 2002; Wolfe et al., 2005).

However, our results argue against this hypothesis as the primary explanation. If faster processing were simply due to a general causal processing advantage, we would expect to observe similar facilitation effects for both main clause and RC IC verbs, as both conditions permit plausible causal relations. The observed processing differences between these conditions suggest that faster processing is due to the interaction between IC biases and discourse embedding, rather than the processing advantage of causal coherence relations.

5.4. *Relation to Prior Work on Relative Clauses*

Although the present study focuses on restrictive RCs and their role as discourse islands within the proposed incremental QUD framework, it is worth considering how the framework relates to appositive RCs (ARCs). Prior work on ARCs has examined their limited role in contributing to discourse structure or supporting QUDs (e.g., Jasinskaja,

2016; Potts, 2005, 2007; Syrett & Koev, 2015). Our findings are broadly compatible with this characterization of sentence-medial ARCs. The present study extends this line of inquiry in two ways: first, by demonstrating that even restrictive RCs, which are syntactically and semantically more integrated into the main clause than ARCs, can function as discourse islands; and second, by offering a framework for modeling how QUDs are generated and updated incrementally as a sentence unfolds. Future work could use materials such as in (21) to examine whether ARC processing is similarly constrained within this framework.

- (21) a. Andrew admired, who had built a successful career in sales.
 b. Joy, who Andrew admired, had built a successful career in sales.

It should be noted, however, that the discourse properties of ARCs are not uniform across syntactic positions. Prior research has shown that sentence-medial ARCs are consistently not-at-issue and discourse-subordinate to their host clauses, whereas sentence-final ARCs can be at-issue and are more accessible for direct discourse attachment (AnderBois et al., 2015; Jasinskaja, 2016; Koev, 2013; Syrett & Koev, 2015). The proposed framework, which models how QUDs are generated and updated incrementally within a sentence, is not designed to make predictions about whether questions raised by sentence-final material can be promoted to a QUD. Extending the framework to sentence-final ARCs would require additional assumptions about how discourse structure is updated at clause boundaries, and we leave this for future work.

6. Conclusion

In sum, the current study highlights how discourse islands constrain IC verbs in guiding Explanation relations and thus supports the incremental QUD framework we proposed. This work contributes to discourse processing research by introducing an incremental QUD model. It also extends previous research on QUD-based IC analysis and Explanation relations between clauses, demonstrating how lexical semantics and discourse embedding jointly shape discourse expectations in real-time processing. Future work may develop the incremental QUD framework by integrating probabilistic mechanisms and examining its applicability beyond IC contexts.

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4 Long-distance causal expectations

4.1 Summary

Article 2 asks whether coherence expectations can be maintained and whether the maintenance of coherence expectations is constrained by discourse structure, such as the Right Frontier Constraint (RFC).

When processing discourse, comprehenders continually generate discourse-level expectations, such as Explanation expectations driven by IC verbs. How long such discourse explanations remain active during real-time language processing has become an active area of research. Recent evidence suggests that when discourse expectations are not immediately fulfilled, they can be maintained across at least one discourse unit. For instance, Hoek et al. (2021a) reported that in IC contexts as 56, the difference in reading times of the post-connective region (e.g., *astoundingly*) between the *because* and *and so* conditions was larger following a neutral relative clause (e.g., *who was here last month* in (56-b)) than a causal relative clause (e.g., *who was embezzling money* in (56-a)). This finding indicates that Explanation expectations raised by IC verbs can be maintained across intervening discourse units.

- (56) a. Diane fired the guy from the London office who was embezzling money
 {because/and so} astoundingly he hired a stripper for the Christmas party.
 b. Diane fired the guy from the London office who was here last month {because/and
 so} astoundingly he hired a lawyer to sue the company.

Theories of discourse structure, however, propose constraints on the relationships

that can be established between discourse units. One major constraint is the RFC. The RFC is a constraint on discourse attachment and anaphora resolution (e.g., Polanyi, 1988; Webber, 1988). It posits that in the Segmented Discourse Representation Theory (SDRT) framework (Asher and Lascarides, 2003), new utterances can only be attached to the right frontier of the existing discourse structure and that a Coordinating relation extends the right frontier of a discourse, whereas a Subordinating relation does not. While the RFC is well integrated into a theory of discourse coherence, few studies have investigated its role in online discourse processing (e.g., Sasaki, 2021, see also Scholman et al. 2017; Wilke et al. 2025). It remains unclear whether the RFC applies early enough to shape readers’ expectations during real-time comprehension, or whether its effects arise only at later stages of discourse integration. To address this gap, this study examines whether readers’ discourse expectations are sensitive to the RFC by investigating whether it blocks IC-driven Explanation expectations in a moving window sentence-by-sentence self-paced reading task.

Introductory sentence		Bill manages many international employees.
<i>IC</i>	<i>Subordinating</i>	This morning he fired Jenny. Jenny is Austrian.
<i>IC</i>	<i>Coordinating</i>	This morning he fired Jenny. Jenny then walked into her office.
<i>Non-IC</i>	<i>Subordinating</i>	This morning he talked to Jenny. Jenny is Austrian.
<i>Non-IC</i>	<i>Coordinating</i>	This morning he talked to Jenny. Jenny then walked into her office.
Target sentence		She had been embezzling money for years.
Wrap-up		It was big news for everyone.

Table 4.1: Sample item in all four conditions in Article 2

In the experiment, 36 experimental items were distributed across four lists using a Latin Square design and were intermixed with 36 filler items. Each experimental item contained an introductory sentence, a sentence with either an IC or non-IC verb, a neutral intervening sentence, a target sentence providing an explanation for the IC event, and a wrap-up sentence (see Table 4.1). We varied the verb in the second sentence {IC verb, non-IC verb} to manipulate whether an Explanation expectation is raised. We also manipulated the coherence relation between the second sentence and the intervening sentence {Subordinating, Coordinating}. In the subordinating conditions, the intervening

sentence was always in a Background relation to the preceding sentence, while in the coordinating conditions, the intervening sentence was always in a Narration relation, signalled by the adverb *then*.

The results showed that the IC-driven expectations only facilitated processing when the intervening unit was Subordinating, supporting our hypothesis that the RFC blocks IC- driven expectations. It suggests that while coherence expectations can be held when they are not fulfilled immediately, the maintenance of coherence expectations are constrained by the RFC, indicating that RFC is applied early enough to shape expectations during discourse processing. Future research could further explore whether the nature of the RFC; i.e., whether it is a violable constraint or a hard discourse grammar rule in discourse comprehension.

Discourse expectations are sensitive to the Right Frontier Constraint

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ABSTRACT

Understanding discourse requires comprehenders to infer the relations between clauses and sentences. These discourse relations are thought to be constrained by discourse structure. This study investigates how the Right Frontier Constraint (RFC), a structural constraint that predicts how discourse units can attach to each other, affects discourse coherence expectations triggered by Implicit Causality (IC) verbs during online comprehension. Using a self-paced reading paradigm, we measured readers' processing times on explanatory continuations following IC verbs with either subordinating or coordinating intervening sentences. Our findings indicate that IC-driven expectations can be held across a subordinating intervening unit but are blocked by a coordinating unit, suggesting that the RFC rapidly influences how readers anticipate upcoming discourse. These results provide new evidence for the RFC and suggest that it is applied early enough to shape expectations during discourse processing.

1. Introduction

Understanding discourse requires comprehenders to not only recover a series of events, but also to understand how these events are related to one another. Prior research has found that comprehenders recover the relations between events in part by continuously generating discourse-level expectations, such as expectations for coherence relations (Hoek et al., 2021b;

Kehler & Rohde, 2017; Rohde & Horton, 2014; Scholman et al., 2024) and discourse structure (Rohde et al., 2011; Scholman et al., 2017). A well-established finding in expectation-driven discourse processing is that comprehenders use implicit causality (IC) verbs, a class of verbs that guide causal inferences (e.g., Au, 1986; Chafe, 1972; Ferstl et al., 2011; Garvey & Caramazza, 1974; Hartshorne, 2014), to predict upcoming EXPLANATION relations.¹ For example, the IC verb *fire* in (1a) can raise an expectation for an upcoming explanation addressing why John fired Mary. A passage completion task by Kehler et al. (2008, Experiment 3), using prompts like (1), found that participants were more likely to write explanation continuations in IC contexts, as in (1a), than in non-IC contexts, as in (1b). IC-driven expectations have also been observed in online processing tasks, reflected by anticipatory eye movements toward explanation-relevant referents (Rohde & Horton, 2014), and by faster reading times when subsequent material matches the expected EXPLANATION relation (e.g., Hoek et al., 2021a, 2021b; Koornneef & Sanders, 2013). For example, it has been found that explanatory content (e.g., *made a lot of money for the company*) following IC verbs, as in (2a), is processed faster than non-IC verbs, as in (2b) (Hoek et al., 2021b).

- (1) a. John **fired** Mary ...
 b. John **talked to** Mary ...
- (2) a. Jenny **praised** the guy who made a lot of money for the company.

¹Formal definitions for coherence relations mentioned in this paper include the following (Kehler, 2019). Here, S_1 and S_2 denote sentences, and P and Q denote the propositions they express.:

- EXPLANATION: Infer P from the assertion of S_1 and Q from the assertion of S_2 , where normally $Q \rightarrow P$.
- OCCASION(NARRATION): Infer a change of state for a system of entities from the assertion of S_2 , establishing the initial state for this system from the final state of the assertion of S_1 .
- RESULT: Infer P from the assertion of S_1 and Q from the assertion of S_2 , where normally $P \rightarrow Q$.

See Sasaki and Altshuler (2025) for further discussion.

- b. Jenny **joked with** the guy who made a lot of money for the company.

How long such discourse expectations remain active during real-time language processing has become an active area of research. Recent evidence from Hoek et al. (2021a) suggests that when discourse expectations are not immediately fulfilled, they can be maintained across at least one discourse unit. They reported that in IC contexts as (3), the difference in reading times of the post-connective region (e.g., *astoundingly*) between the *because* and *and so* conditions was larger following a neutral relative clause (e.g., *who was here last month* in (3b)) than a causal relative clause (e.g., *who was embezzling money* in (3a)). This finding indicates that EXPLANATION expectations raised by IC verbs can be maintained across intervening discourse units.

- (3) a. Diane fired the guy from the London office who was embezzling money
{because/and so} astoundingly he hired a stripper for the Christmas party.
- b. Diane fired the guy from the London office who was here last month
{because/and so} astoundingly he hired a lawyer to sue the company.

Theories of discourse structure, however, propose constraints on the relationships that can be established between discourse units. One major constraint is the Right Frontier Constraint (RFC; Asher, 2012; Asher & Lascarides, 2003; Polanyi, 1988). The RFC, which plays a central role in Segmented Discourse Representation Theory (SDRT; Asher & Lascarides, 2003), is a constraint on discourse attachment and subsequent discourse processes such as anaphora resolution. It posits that a new discourse unit can only be attached to the right frontier of the existing discourse structure, with the the right frontier of a discourse being extended by coordinating, but not subordinating, relations.

Although the RFC is well-developed as a theory of discourse coherence, few studies have

investigated its role in online discourse processing (for relevant work, see Sasaki, 2021; Scholman et al., 2017). The current study, therefore, aims to bridge this gap by examining whether the RFC can block IC-driven EXPLANATION expectations during real-time processing.

2. The Right Frontier Constraint

The RFC was originally proposed by Polanyi (1985, 1986, 1988) as a constraint on anaphoric pronoun resolution. It was later incorporated into the SDRT framework, where it was further developed and generalized to address all types of anaphora and attachment problems in discourse (Hunter & Thompson, 2022; Mann & Thompson, 1988; Thompson & Mann, 1987; Webber, 1988).

In SDRT, coherent discourse is structured by coherence relations, which are classified into two categories: Coordinating and Subordinating (Asher & Vieu, 2005). Coordinating relations, such as NARRATION and RESULT, change the scene and move the narrative forward. Subordinating relations, such as ELABORATION and EXPLANATION, enrich the current scene and deepen the narrative. For example, in (4), π_2 moves the discourse forward and therefore stands in a coordinating relation to π_1 , whereas in (5), π_2 provides background information about the situation introduced by π_1 and is thus subordinated to it. This distinction between coordinating and subordinating relations can be visualized through their representation in a Segmented Discourse Representation Structure (SDRS) graph, as exemplified in Figure 1. Specifically, coordinating continuations, such as π_2 in (4), are connected to the prior discourse unit by a horizontal line, while subordinating continuations, such as π_2 in (5), are connected to the prior discourse unit by a vertical line. Accordingly, coordinating relations extend the discourse structure to the right, while subordinating relations extend it downward. In this way, the rightmost discourse segment(s) form the right frontier of the graph. For instance, in Figure 1-A, only π_2 lies on the right frontier, while in Figure 1-B, both π_1 and π_2 are on the right

frontier.

- (4) π_1 John dropped off his car for repairs.
 π_2 Then he got a rental. (coordinating)
 π_3 It had a broken fuel pump. (Altshuler & Truswell, 2022)
- (5) π_1 John dropped off his car for repairs.
 π_2 He was going to need a rental. (subordinating)
 π_3 It had a broken fuel pump.

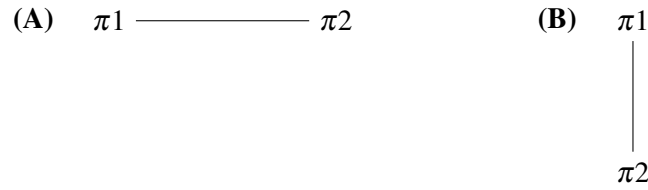


Figure 1. Sample SDRS graphs. (A) SDRS graph illustrating the coordinating relation between π_1 and π_2 in (4). (B) SDRS graph illustrating the subordinating relation between π_1 and π_2 in (5). Coordinating relations are represented by horizontally, and subordinating relations are represented vertically. Lines indicate a relationship between the two discourse unit.

The RFC predicts that new utterances can only be attached to the right frontier of the existing discourse structure,² and discourse attachments that violate the RFC are generally taken to lead to incoherent discourse, or leading to some sort of accommodation. This is because, intuitively, speakers cannot detail scenes that have already been changed. For example, al-

²A formal definition for RFC from Asher and Lascarides (2003, p148): Suppose that a constituent β is to be attached to a constituent in the SDRS with a discourse relation other than Parallel or Contrast. Then the available attachment points for β are:

- (1) The label $\alpha = \text{LAST}$;
- (2) Any label γ such that: (a) $i - \text{outscopes}(\gamma, \alpha)$ (i.e. $R(\delta, \alpha)$ or $R(\alpha, \delta)$ is a conjunct in $F(\gamma)$ for some R and some δ);
or (b) $R(\gamma, \alpha)$ is a conjunct in $F(\lambda)$ for some label λ , where R is a subordinating discourse relation. We gloss this as $\alpha < \gamma$.
- (3) Transitive Closure: Any label γ that dominates α through a sequence of labels $\gamma_1, \gamma_2, \dots, \gamma_n$ such that $\alpha < \gamma_1 < \gamma_2 < \dots < \gamma_n < \gamma$

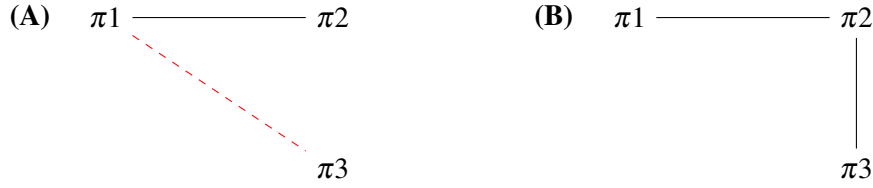


Figure 2. SDRS graphs for (4). (A) An incoherent interpretation of (4) with the interpretation that *it* is anaphoric to *John's car*. The red dashed line represents an RFC violation attempting to link π_3 back to π_1 which is no longer on the right frontier because π_2 coordinating relationship with π_1 pushed the right frontier forward. (B) A coherent interpretation of (4) with the interpretation that *it* is anaphoric to *a rental*. π_3 can form a discourse relationship with π_2 because π_2 is on the right frontier.

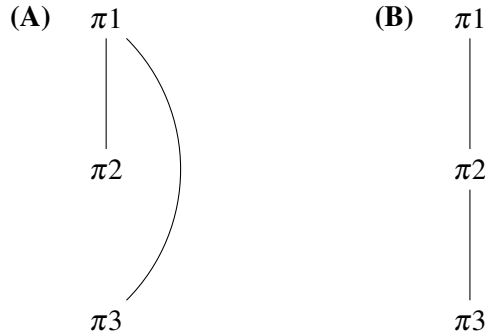


Figure 3. SDRS graphs for (5). (A) The preferred and coherent interpretation of (5) with the interpretation that *it* is anaphoric to *John's car*. (B) An alternative coherent interpretation of (5) with the interpretation that *it* is anaphoric to *a rental*. In both cases, π_1 and π_2 remain on the right frontier of the discourse when π_3 is attached.

though there are two entities, *John's car* and *the rental*, in (4), according to the RFC, *it* in π_3 can only refer to *the rental*. This is because π_2 contributes to a coordinating discourse relation and hence pushes the right frontier; π_3 thus cannot be attached to π_1 , as π_1 is not on the right frontier of the existing discourse structure. As a result, π_3 can only be attached to π_2 and the pronoun *it* in π_3 can only refer to *the rental* in π_2 , even though world knowledge suggests that a rental car is unlikely to be broken. If we try to interpret *it* in π_3 as referring to *John's car* in π_1 , π_3 would need to be attached to π_1 , which would violate the RFC, as illustrated in Figure 2. In contrast, if the discourse progresses like in (5), where π_2 subordinates to π_1 , then both π_1 and π_2 are on the right frontier. Therefore, as shown in Figure 3, *it* in π_3 can refer to either *John's car* in π_1 or *the rental* in π_2 , and world knowledge would likely lead us to take *John's car* as the preferred interpretation.

The RFC is arguably one of the most empirically testable aspects of SDRT (Sasaki, 2021). In recent decades, empirical evidence from corpus linguistics and discourse processing have examined the RFC's validity within the SDRT framework. Afantenos and Asher (2010) studied a doubly annotated corpus of French newspaper texts and Wikipedia articles and demonstrated that the RFC is respected approximately 95% of the time in terms of discourse attachment, suggesting that the RFC provides a useful constraint on discourse parsing by restricting the set of available attachment sites. Experimental work on anaphora resolution has also explored the RFC using controlled mini-discourses. Questionnaire-based evidence suggests that right-frontier status can modulate pronoun resolution when morphosyntactic cues do not disambiguate the antecedent (Holler & Irmen, 2007). In two forced-choice tasks, Göbel (2019) showed that final appositive relative clauses can extend the right frontier, keeping antecedents accessible for pronoun resolution in line with the RFC's predictions. Furthermore, Sasaki (2021) found that the RFC modulates the salience of antecedents in long-distance pronoun resolution during discourse processing using an incremental stop-making-sense task (Boland et al., 1990, 1995).

Despite substantial evidence that the RFC constrains discourse interpretation in corpus-based analyses and offline comprehension tasks, its role in online discourse processing remains underexplored. Previous work has shown that the RFC restricts discourse attachment and antecedent accessibility in offline judgments and incremental acceptability tasks (Göbel, 2019; Holler & Irmen, 2007; Sasaki, 2021), suggesting that the RFC constrains interpretation at some stage of processing. However, these findings do not establish whether the RFC applies early enough to shape readers' expectations during real-time comprehension, or whether its effects arise only at later stages of discourse integration. The RFC may, in fact, be better understood as an accessibility-based constraint that modulates the salience of discourse units, rather than as an inviolable constraint on discourse attachment, given work demonstrating

that it is modulated by other factors that influence discourse prominence, such as animacy (Sasaki, 2021). Under this view, the RFC may primarily affect later stages of interpretation, with more limited consequences for predictive processing, rather than eliciting an immediate influence on how comprehenders anticipate upcoming discourse.

A small number of studies come close to addressing the potential online effects of the RFC. For example, Scholman et al. (2017), investigated long-distance discourse expectations triggered by *On the one hand*. They found that the use of *On the one hand* raises an expectation for a global contrast, and readers can track available attachment positions in the evolving discourse structure. The authors interpreted the results as consistent with the RFC. However, while their results suggest that such expectations align with an RFC-based account, they did not show that violations of the RFC block discourse expectations.

More direct evidence is needed to understand the role of the RFC in discourse processing. In particular, it is not known if the RFC actively guides comprehenders' expectations for upcoming discourse units.

The current study: The interaction between IC-driven expectations and the RFC

According to the SDRT framework, an IC-driven EXPLANATION is a subordinating discourse unit that must be attached to the discourse unit containing the IC verb. Therefore, whether an EXPLANATION expectation can be maintained is predicted to depend on whether the discourse unit containing the IC verb remains on the right frontier, keeping it accessible for attachment. Consider the short discourses in (6) and (7), all starting with a discourse unit, π_1 , containing the IC-verb *fired* which is predicted to raise an expectation for an EXPLANATION relation. If the EXPLANATION is provided as the next subsequent unit (i.e., π_2), as in (6), the clause with the IC verb (i.e., π_1) is undoubtedly accessible and the EXPLANATION expectation is immediately fulfilled. However, when the expectation is not fulfilled in the next unit,

ordinates to the unit containing the IC verb (π_1), as in (7a), the EXPLANATION expectation should be maintained, but when π_2 coordinates with π_1 , as in (7b), comprehenders should discard their EXPLANATION expectations. Alternatively, if the RFC operates only at later stages of discourse integration and does not affect online predictive processing, readers' expectations should be insensitive to changes in the right frontier during online processing. Under this view, IC-driven EXPLANATION expectations are predicted to persist in both (7a) and (7b), yielding comparable facilitation for EXPLANATION continuations regardless of whether the intervening unit is subordinating or coordinating.

It is important to note that prior work on delayed IC-driven expectations has tested situations where the intervening unit is subordinating. For example, Hoek et al. (2021a) probed IC-driven coherence expectations in contexts such as (8), where a subordinating relative clause intervenes between the IC verb and a subsequent connective. Using an eye-tracking paradigm, they found that the processing advantage associated with *because* (vs. *and so*) at the post-connective region (e.g., *astoundingly*) was larger following a neutral relative clause, as in (8b), than following a causal relative clause, as in (8a). While this study was not designed as a direct test of the persistence of discourse expectations, this pattern also indicated that EXPLANATION expectations can remain active across an intervening subordinating clause (π_2) when they are not immediately satisfied. More recently, Scholman et al. (2025) show that the facilitative effect of discourse markers such as *on the one hand* is reduced, but not eliminated, when intervening subordinating material is inserted before the expected continuation (*on the other hand*). This suggests that, although discourse predictions are weakened, they are not blocked by a subordinating intervening unit. However, it remains unclear if discourse expectations persist when the intervening unit is coordinating rather than subordinating.

- (8) a. [Diane fired the guy from the London office] $_{\pi_1}$ [who was embezzling money] $_{\pi_2}$

[because/and so astoundingly he hired a stripper for the Christmas party] π_3 .

- b. [Diane fired the guy from the London office] π_1 [who was here last month] π_2
[because/and so astoundingly he hired a stripper for the Christmas party] π_3 .

To address this gap and test our hypotheses regarding the RFC's role in online discourse processing, we probed comprehenders' expectations for upcoming EXPLANATION relations by measuring reading times on the explanatory unit that follows a neutral intervening unit (e.g., π_3 in (7a)-(7b)). We use a 2x2 design that crosses verb type (IC vs. non-IC) and the type of intervening unit (subordinating vs. coordinating). These two types of intervening units indicate whether the right frontier changes or not. We predicted that readers' discourse expectations would be sensitive to the RFC. Therefore, we expected to observe an interaction between verb type and intervening unit type. For IC verbs followed by subordinating intervening units, we expect faster reading times for EXPLANATION continuations, replicating previous findings on maintained IC-driven expectations. For IC verbs followed by coordinating intervening units, we predict no facilitation for EXPLANATION continuations, as the RFC renders the discourse unit containing the IC verb inaccessible for attachment. It is also possible to observe a reduced facilitation for EXPLANATION continuations if RFC merely modulates the accessibility of prior discourse units rather than being a strict constraint (Sasaki, 2021). In addition, a penalty may also occur in this condition if comprehenders attempt to establish the EXPLANATION relation despite the RFC violation. For non-IC verbs, we do not expect significant differences in reading times for EXPLANATION continuations, regardless of intervening unit type, because non-IC verbs do not raise EXPLANATION expectations.

Alternatively, if readers' discourse expectations are not sensitive to the RFC, we would not expect to observe an interaction between verb type and intervening unit type. In this case, IC verbs should elicit facilitation for EXPLANATION continuations regardless of whether

the intervening unit is subordinating or coordinating, reflecting robust IC-driven expectations that are unaffected by structural constraints. For non-IC verbs, as before, no facilitation for EXPLANATION continuations is expected.

3. Experiment

3.1. *Data availability*

All materials and analyses (including the R script) can be found at the following link:
https://osf.io/muaxn/?view_only=56664918154f4acebd27cc3348787f32.

3.2. *Ethics approval*

The research acquired ethics approval from the Social Sciences and Humanities Interdivisional Research Ethics Committee at the University of Oxford (reference no. R92876/RE001). Participation in the experiments was voluntary, and all participants provided written informed consent. All data used in the current analyses were fully anonymized.

3.3. *Participants*

65 Prolific-recruited native English speakers participated in this study (23 female, 34 male, 8 other; mean age 33.63, age range 18-67) and received financial compensation at a rate of £6 per hour.

3.4. *Materials and norming*

36 experimental items were distributed across four lists using a Latin Square design and were intermixed with 36 filler items. Each experimental item contained an introductory sentence, a sentence with either an IC or non-IC verb, a neutral intervening sentence, a target sentence

providing an explanation for the IC event, and a wrap-up sentence. Table 1 provides a sample item.

Introductory sentence		Bill manages many international employees.
<i>IC</i>	<i>Subordinating</i>	This morning he fired Jenny. Jenny is Austrian.
<i>IC</i>	<i>Coordinating</i>	This morning he fired Jenny. Jenny then walked into her office.
<i>Non-IC</i>	<i>Subordinating</i>	This morning he talked to Jenny. Jenny is Austrian.
<i>Non-IC</i>	<i>Coordinating</i>	This morning he talked to Jenny. Jenny then walked into her office.
Target sentence		She had been embezzling money for years.
Wrap-up		It was big news for everyone.

Table 1. Sample experimental item

We varied the verb in the second sentence (IC verb vs. non-IC verb) to manipulate whether an EXPLANATION expectation is raised. We also manipulated the coherence relation between the second sentence and the intervening sentence (subordinating vs. coordinating). In the subordinating conditions, the intervening sentence was always in a BACKGROUND relation to the preceding sentence, while in the coordinating conditions, the intervening sentence was always in a NARRATION relation, signaled by the adverb *then*. We expect that the EXPLANATION expectation can be maintained across a subordinating intervening sentence but not a coordinating one. The target sentence provides a possible explanation for the IC verb in the second sentence, so if an EXPLANATION expectation is raised and maintained, as we predicted in the IC-subordinating condition, it should facilitate the processing of the target sentence.

To validate that the intervening sentence does not serve as a possible explanation for the IC verb, and that the target sentence is a plausible explanation, we conducted a norming study using a likelihood judgment task. 30 participants with the same demographic restrictions as the intended experiment were recruited from Prolific. For each experimental item, participants

read a sentence containing the IC, followed by either the coordinating intervening clause, the subordinating intervening clause, or the target sentence. They were then asked to rate the likelihood of a causal relationship between the two sentences on a four-point Likert scale, where 1 represented "most implausible" and 4 represented "most plausible." (9) provides an example of the judgment task for the experimental item in Table 1. The conditions were counterbalanced using a Latin Square design, so that participants saw all narratives but never the same narrative across multiple conditions. We expected participants to rate the target sentence as a plausible cause and the intervening sentence, whether in the subordinating or coordinating condition, as an implausible cause.

(9) Bill manages many international employees. This morning he fired Jenny.

We know one more thing:

- a. Jenny is Austrian. [Subordinating intervening sentence]
- b. Jenny then walked into her office. [Coordinating intervening sentence]
- c. Jenny had been embezzling money for years. [Target sentence]

Question: How likely do you think Bill fired Jenny because{she is Austrian\she then walked into her office\she had been embezzling money for years}?

The results showed that, on average, the rating for coordinating intervening sentences and subordinating intervening sentences was 1.47 (SD = 0.9) and 1.97 (SD = 1.1), respectively; while the rating for target sentences was 3.89 (SD = 0.4). To analyze these ratings while accounting for random variability across participants and items, we fit a cumulative link mixed model with Condition as a fixed effect and random intercepts and slopes for participants and items. This analysis confirmed that target sentences were rated as significantly more plausible than both types of intervening sentences ($ps < .001$).

3.5. Procedure

The study used a moving window sentence-by-sentence self-paced reading task that was hosted on PCIBex Farm (Schwarz & Zehr, 2021). Experimental items were intermixed with filler items and presented in a randomized order. At the start of each trial, sentences were hidden by a series of underlines on the screen. Participants pressed the space bar to reveal one sentence at a time. The presentation was non-cumulative, meaning that once a new sentence appeared, the previous one was replaced with underlines, ensuring only one sentence was visible at a time. Participants were instructed to read as quickly and accurately as possible. To ensure engagement, comprehension questions were included after 30% of the items.

3.6. Results

Data from three participants were excluded due to low accuracy of comprehension questions (less than 60%), resulting in 62 participants for further analysis. Among the remaining participants the mean accuracy was at 84%. There was no significant accuracy difference across conditions.

Reading times (RTs) above or below 3 standard deviations (SDs) from the mean RT of the specific region were treated as outliers, leading to the removal of 0.9% of the data. The cleaned RTs for the intervening sentence, target sentence, and spillover sentence across all conditions are shown in Table 2.

We analyzed the data using linear mixed-effects models with maximal random effects, implemented with the `lme4` package (Bates et al., 2015), and p-values were computed using the `lmerTest` package (Kuznetsova et al., 2017) in R (R Core Team, 2021). Raw reading times (in milliseconds) were modelled using a Gaussian distribution with an identity link function. Fixed effects included verb type (IC vs. non-IC), intervening unit type (subordinating vs. coordinating), and their interaction. Both predictors were sum-coded (verb type: IC

4.2. Discourse expectations are sensitive to the Right Frontier Constraint

		Intervening sentence		Target sentence		Spillover sentence	
		Mean	SD	Mean	SD	Mean	SD
<i>IC</i>	<i>Subordinating</i>	1166	670	1400	729	1020	585
<i>IC</i>	<i>Coordinating</i>	1209	708	1509	777	1076	728
<i>Non-IC</i>	<i>Subordinating</i>	1229	695	1522	784	1033	571
<i>Non-IC</i>	<i>Coordinating</i>	1229	689	1523	747	1069	657

Table 2. Mean and SDs of RTs on the intervening sentence, the target sentence and the spillover per condition, in milliseconds

	β	SE	<i>t</i>	<i>p</i>
Verb type	-68.48	23.66	-2.89	.005
Intervening unit type	-54.96	30.31	-1.814	.077
Interaction	-113.61	51.55	-2.20	.030

Table 3. Fixed-effect estimates from the linear mixed-effects model on target-sentence reading times

= +0.5, non-IC = -0.5; intervening unit type: subordination = +0.5, coordination = -0.5). The random-effects structure included by-participant and by-item random intercepts and random slopes for verb type, intervening unit type, and their interaction, corresponding to a maximal random-effects structure. The full model output for the target sentence is reported in Table 3.

Figure 5 displays model-estimated RTs for each sentence across conditions. On the target sentence, we found a significant main effect of verb type ($\beta = -68.48$, $SE = 23.66$, $t = -2.89$, $p = .005$), indicating faster reading times for IC conditions compared to non-IC conditions. Additionally, a significant interaction was observed between verb type and intervening unit type ($\beta = -113.61$, $SE = 51.55$, $t = -2.20$, $p = .03$). Planned comparisons using the *emmeans* package (Lenth et al., 2024) showed a significant difference between IC and non-IC conditions in the subordinating condition ($\beta = -125.3$, $SE = 35.4$, $t = -3.54$, $p = .0015$), but not in the coordinating condition ($\beta = -11.7$, $SE = 34.6$, $t = -0.34$, $p = .74$). This indicates that the EX-

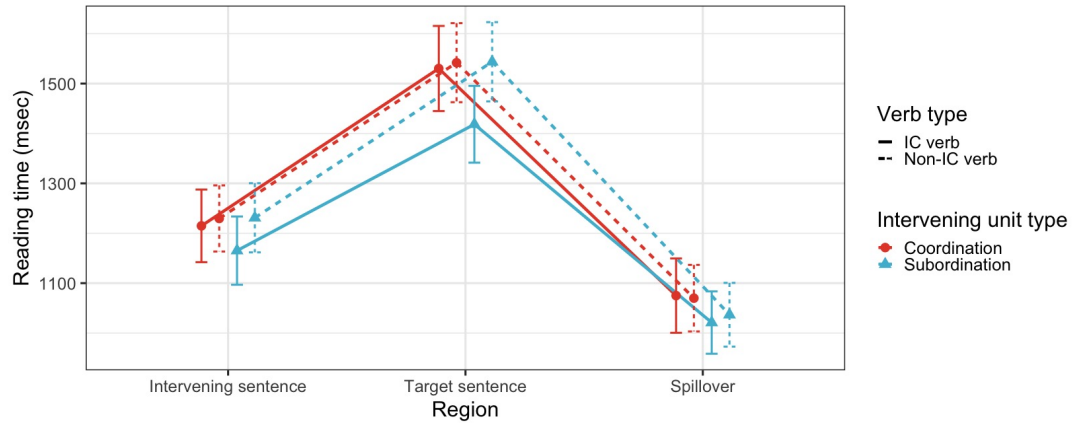


Figure 5. Estimated RTs on the intervening sentence, the target sentence and the spillover per condition. Error bars represent the standard error of the mean.

PLANATION expectation raised by IC verbs only facilitated processing when the intervening unit was subordinating, supporting our hypothesis that the RFC can block IC-driven expectations. In addition, no significant effects were observed on either the intervening sentence or the spillover sentence.

4. Discussion

This study examines the interaction between IC-driven expectations and the RFC in online discourse processing. Consistent with previous findings that IC verbs raise EXPLANATION expectations, RTs were faster when the subsequent sentence provided an explanation for the IC event. Additionally, as predicted, we found an interaction between verb type and intervening unit type on the target sentence reading times: EXPLANATION continuations were read faster in IC-subordinating conditions than in IC-coordinating and non-IC conditions. These effects can be attributed to the RFC, which allowed IC-driven EXPLANATION expectations to be maintained with a subordinating intervening unit but blocked when a coordinating intervening unit was present.

Interestingly, we did not observe slowed reading for IC-coordinating conditions, which

could have signaled difficulty in establishing EXPLANATION relations due to the RFC violation. This lack of a reading-time penalty may suggest that, in the presence of an intervening coordinating discourse unit, participants did not attempt to establish EXPLANATION relations, even though the target sentence could plausibly explain the IC event. Alternatively, it is possible that participants were indeed trying to establish EXPLANATION relations in the IC-coordinating condition, but the RFC violation did not impose a noticeable processing cost. In this case, the effects of the RFC might only manifest in discourse expectations rather than in immediate processing difficulty.

An additional perspective comes from accounts that posit a general bias toward causal interpretations in discourse. For example, the Causality-by-Default theory proposes that comprehenders tend to expect causal relations unless there are cues indicating a non-causal relation (Sanders, 2005; Sanders & Noordman, 2000). Under such an account, one might expect structural manipulations (e.g., coordination vs. subordination) to affect discourse expectations even in the absence of IC verbs. However, we did not observe any such effects in the non-IC conditions. This pattern suggests that, while a general causal bias may exist, it is not sufficient on its own to generate structure-sensitive predictive expectations. Instead, our results indicate that IC verbs play a crucial role in licensing and sustaining such expectations, which can then be modulated or blocked by discourse-structural constraints such as the RFC.

Our findings are consistent with previous corpus-based and experimental work on RFC (Afantenos & Asher, 2010; Holler & Irmen, 2007; Sasaki, 2021). The present results also offer complementary support from online processing, suggesting that such structural constraints are reflected in real-time human discourse processing. Moreover, our results also provide new experimental evidence that the RFC affects discourse comprehension at an early stage. Using a time-course measurement, we show that the RFC has a measurable impact on real-time processing. Comprehenders use the RFC to rapidly anticipate upcoming discourse in online

processing, indicating that the RFC is applied early enough to shape predictive processing. In particular, comprehenders rapidly adjust their IC-driven EXPLANATION expectations depending on whether an intervening unit preserves or shifts the right frontier, suggesting that discourse structure plays an active role in anticipation during real-time processing. At the same time, however, we note that the sentence-by-sentence SPR paradigm does not allow us to precisely determine the time course of this effect within the sentence. Future work using more fine-grained measures, such as eye-tracking-while-reading, will be necessary to establish the temporal dynamics of RFC effects.

While our results indicate that the RFC elicits immediate and observable effects in real-time, these findings do not necessarily entail that the RFC functions as a rigid rule for structuring discourse. It remains possible that the RFC reflects changes in the prominence of discourse units rather than a deterministic rule about discourse attachment (Sasaki, 2021). On this view, RFC effects may be graded and interact with other factors known to influence discourse prominence, such as animacy (Fukumura & Van Gompel, 2011; Zaenen et al., 2004) and topicality (Givón, 1983). Future work can further investigate how discourse-structural constraints interact with such factors, and whether these interaction effects arise at early stages of processing.

While this study found that the RFC constrains IC-driven EXPLANATION expectations in discourse processing, a further question is whether the RFC similarly constrains other types of discourse expectations. For example, as discussed above, the RFC might function as a principle that modulates antecedent prominence/accessibility or as a violable constraint rather than a hard discourse grammar rule. Therefore, if certain cues can generate stronger discourse expectations than IC-driven expectations, or make antecedents more salient, it is possible that these discourse expectations would be less sensitive to RFC constraints than IC-driven expectations. For instance, overt markers, such as *because*, can create stronger expectations

for an upcoming EXPLANATION relation. In (10), the phrase *it was because* grammatically licenses and pragmatically compels comprehenders to search for a cause–effect link. This produces stronger and more obligatory expectations than IC-driven cues, which may override the accessibility limitations imposed by the RFC.

- (10) Bill fired Jenny this morning. Jenny then walked into her office. It was because she had been embezzling money for years.

In addition, contextual information can modulate the prominence of an antecedent in discourse and thereby interact with RFC-based accessibility limitations. One well-studied factor is the Question-under-Discussion (QUD; e.g., Benz & Jasinskaja, 2017; Onea, 2016; Onea & Zimmermann, 2019; Roberts, 1996). As illustrated in (11), explicitly establishing a *why* QUD facilitates comprehenders to search for an EXPLANATION relation. This may increase the prominence of the relevant antecedent event (e.g., *firing*) and strengthen discourse expectations. Future research could explore whether overt cues for coherence relations or contextual manipulations of discourse prominence can generate stronger discourse expectations that weaken or even override the RFC.

- (11) A: I heard Bill fired Jenny! Why?
B: Jenny was fired this morning. She then walked into her office. She had been embezzling money for years.

5. Conclusion

To conclude, the current study examined RFC effects in online discourse processing. In an SPR study, we show that IC-driven EXPLANATION expectations are maintained across a subordinating intervening unit but are disrupted by a coordinating intervening unit, indicating

that RFC violations can block IC-driven expectations. These findings provide new evidence for the validity of the RFC, support its psychological reality, and suggest that it is applied early enough to shape expectations during discourse processing.

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5 Offline comprehension of clause-internal causal relations

5.1 Summary

Article 3 investigates what linguistic elements guide comprehenders to infer clause-internal Explanation relations and what linguistic elements constrain such inferences.

Most studies of discourse coherence focus on relations like Explanation relations that are established between two discourse units whose size is at least a single clause. Such relationships may, however, also be clause-internal. For example, some recent studies found that comprehenders may establish an Explanation relation between *drenched* and *water balloon* in (57).

(57) A drenched child got hit by a big water balloon. (Sasaki and Altshuler, 2023)

While being observed, clause-internal coherence is still understudied, and it is unclear at present what elements permit or constrain such inferences (Cohen and Kehler, 2021). The current study focuses on resultative adjectives (e.g., *drenched*, *broken*), which describe the result states of events - e.g., “broken” describes the result state of a breaking event. We hypothesized that such adjectives have the potential to prompt a sub-QUD, ‘what event caused this result state?’ We focus on contexts where there is a plausible relationship between a result state described by an adjective within a determiner phrase (DP), and the event described by the main clause, such as (58-a).

(58) a. The broken window was struck by a stone.

- b. A broken window was struck by a stone.
- c. Bethany struck the broken window with a stone.
- d. Bethany struck a broken window with a stone.

Notably, the availability of the causal inference seems to be correlated with syntactic structure and definiteness. In comparison to (58-a), (58-b)–(58-d) appear to be constrained to, or at least biased towards, the non-causal reading (i.e., the window was already broken when it was struck by a stone). We confirm this intuition in two off-line comprehension tasks using a 7-point Likert scale, where we manipulated Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness}, as shown in the sample item in Table 5.1.

<i>Passive</i>	<i>Definiteness</i>	The injured dog got hit with a car on a busy street earlier this morning.
<i>Passive</i>	<i>Indefiniteness</i>	An injured dog got hit with a car on a busy street earlier this morning.
<i>Active</i>	<i>Definiteness</i>	Peter hit the injured dog with a car on a busy street earlier this morning.
<i>Active</i>	<i>Indefiniteness</i>	Peter hit an injured dog with a car on a busy street earlier this morning.
Comprehension question		Exp1: Was the dog injured because of the car? Exp2: Do you think the dog was injured because it was hit by the car?

Table 5.1: Sample item in all four conditions in Article 3.

Based on the experimental results, we propose that differences in clause-internal Explanation inferences arise from the possible temporal interpretations that can be established between the result state described by the adjective within a DP and the event described by the clause. Specifically, we propose that only when DPs are definite and serve as subjects (e.g., in (58-a)) do they tend to be sentence topics that can be interpreted outside the scope of an event quantifier (Herburger, 2000), as shown in ((59-b)). Since the existence of the result state s is outside the event quantifier $\exists e$, there is no necessary relationship between the temporal interpretations of s and e . This permits comprehenders to infer that the event e_s that caused the result state s is, in fact, the clausal event e itself, when plausible. In contrast, neither the indefinite subjects (e.g., in

(58-b)) nor the non-subject DPs (e.g., in (58-c) -(58-d)) tend to be sentence topics, so readers are likely to interpret them within the scope of the clause's event quantifier, as shown in ((59-a)). In that case, the existence of the result state s (of being broken) falls within the scope of the event quantifier, $\exists e$, ranging over striking-with-a-stone events e . Therefore, the onset of the temporal interval of s precedes the temporal location of e . Given this temporal relationship between s and e , comprehenders can infer that the event e_s that caused the result state s must be temporally located prior to e , thereby preventing the establishment of an Explanation relation.

- (59) a. $\exists e[\text{strike-with-a-stone}(e) \ \& \ \exists x[\text{Theme}(e, x) \ \& \ \text{window}(x) \ \& \ \exists s[\text{broken}(s) \ \& \ \text{In}(s, x)]]] \models e_s \prec e$
- b. $\exists x[\text{window}(x) \ \& \ \exists s[\text{broken}(s) \ \& \ \text{In}(s, x)]] \ \& \ \exists e[\text{strike-with-a-stone}(e) \ \& \ \text{Theme}(e, x)] \rightsquigarrow e_s = e$

To conclude, Article 3 suggests that resultative adjectives can guide clause-internal Explanation relations in offline processing, while such inferences are constrained by nominal temporal interpretations, which can be constrained by topichood, signalled by definiteness and subjecthood.

Topichood and temporal interpretation of DPs guide clause-internal, causal coherence¹

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Abstract. Most studies of discourse coherence focus on relations like Result (cause-effect) and Explanation (effect-cause) that are established between two discourse units whose size is at least a single clause. Such relationships may, however, also be clause-internal. The current study explores clause-internal coherence triggered by resultative adjectives in examples like *The broken window got struck with a stone* $\rightsquigarrow$ ‘the window was broken because of the stone.’ Based on the results of two comprehension tasks, we propose that topichood, signaled by definiteness and subjecthood, permits and constrains plausible causal inferences clause-internally. This analysis suggests a tighter relationship between (morpho)syntax and coherence than is currently assumed.

Keywords: Coherence relations, QUDs, nominal temporality, topichood, definiteness, experimental pragmatics.

1. Introduction

Coherent discourse emerges from signaled or inferable relations among adjacent discourse units. These relations are known as *coherence relations* (Hobbs, 1979).² Most studies of coherence focus on inter-sentential relationships, as exemplified in (1a), where language users can infer an Explanation (effect-cause) relation between two sentences in both offline comprehension and online processing (e.g., Rohde, 2008; Grüter et al., 2018; Köhne and Demberg, 2013; Mak and Sanders, 2013). Some recent studies have also investigated coherence relations between relative clauses and their main clauses; for example, in (1b) readers can still obtain the causal inference that the employee was praised because he has made lots of money for the company.

- (1) a. Diane praised the employee. He has made lots of money for the company.
 b. Diane praised the employee who has made lots of money for the company. (Hoek et al., 2021b)

These studies indicate that linguistic elements traditionally considered too small to be discourse units, such as relative clauses, can also enter coherence relations (Hoek et al., 2021a, b). Indeed, coherence relations may be more widespread than previously recognized, as clause-internal coherence has also been observed (Anscombe, 1979; Hobbs, 1990; Webber, 1991; Cohen and Kehler, 2021; Sasaki and Altshuler, 2022, 2023). For example, comprehenders often infer that the subject referent in (2a) was hit by the car while jogging, an unfortunately common event,

¹We would like to thank Kelsey Sasaki and the audiences at Sinn und Bedeutung 28 and XPrag 2023 for their questions and comments on this work.

²See also terms like ‘rhetorical relations’ and ‘discourse relations’ which are often used interchangeably with ‘coherence relations.’ For recent overviews of coherence relations, see, e.g., Kehler (2019), Jasinskaja and Karagjosova (2019), Altshuler and Truswell (2022: Ch.5), Hunter and Thompson (2022).

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but do not make a similar inference in (2b) as individuals are unlikely to be hit by cars while teaching. Similarly, clause-internal coherence can also be triggered by adjectives. For example, comprehenders may establish a Result (cause-effect) relation between *loud* and *annoyed* in (3), and an Explanation (effect-cause) relation between *drenched* and *water balloon* in (4).

- (2) a. The jogger was hit by a car. (Hobbs, 2010)
 b. The teacher was hit by a car.
- (3) The loud student annoyed everyone. (Hoek et al., 2021a)
- (4) A drenched child got hit by a big water balloon. (Sasaki and Altshuler, 2023)

However, clause-internal coherence is still understudied, and it is unclear at present what elements permit or constrain such inferences (Cohen and Kehler, 2021). The current study explores a particular context, resultative adjectives (e.g., *drenched*) in definite subjects, that permits clause-internal coherence. We adopt an experimental approach to secure native speaker judgments, and propose that topichood, signaled by definiteness and subjecthood, permits and constrains plausible causal inference.

The paper proceeds as follows. In §2, we motivate an experimental study that considers the availability and strength of clause-internal causal relations triggered by resultative adjectives when grammatical cues of Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness} are manipulated. In §3, we present comprehension tasks whose results suggest that resultative adjectives can induce causal inference within clauses, and this is strongest when they are embedded in definite subjects. We account for these results in §4, where we propose that the availability and strength of causal relations vary under different conditions due to the temporal (in)dependency of the determiner phrases (DPs) with the clauses in which they are embedded. We argue that clause-internal causal relations between DPs and their host clauses are supported when the DP is temporally independent from its host clause. We propose that definite subjects are often interpreted to be temporally independent because they are preferentially taken to be topics. We discuss the implications of this analysis in §5, where we also raise questions for further research.

2. Background

Coherence inferences may have single words as triggers; for example, it is well-known that ‘too’ is a cue of a Parallel relation (Asher and Lascarides, 1998) and that implicit causality verbs bias causal inference, perhaps because they give rise to a *Why*-type Question-Under-Discussion (QUD) (Kehler and Rohde, 2017). In the current study, we focus on resultative adjectives, which describes the result states of events – e.g. ‘broken’ describes the result state of a breaking event. We hypothesized that such adjectives have the potential to prompt a sub-QUD, ‘what event caused this result state?’.³ This invites inferences for causal explanations that establish coherence within the clause. We focus on contexts where there is a plausible relationship between a result state described by an adjective within a DP, and the event described by the main clause – e.g., one infers from (5a) that the window was broken because it was struck by a stone (see Fig. 1a). This is so even though (5a) is compatible with a non-causal reading (the window was already broken when it was struck by a stone; see Figure 1b). Interestingly, the availability

³For an overview of QUDs and how QUDs they may be structured, see, e.g., Beaver et al. (2017).

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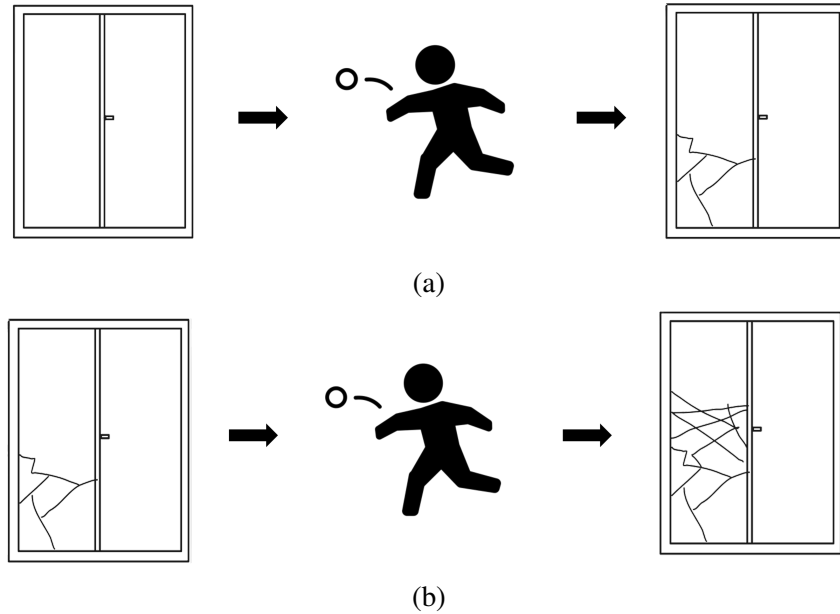


Figure 1: Possible situations described by (5a) - (5d)

of the causal inference seems to be correlated with syntactic structure and definiteness. In comparison to (5a), (5b)-(5d) appear to be constrained to, or at least bias towards, the non-causal reading.

- (5)
- a. The broken window was struck by a stone from the sidewalk next to the building.
 - b. A broken window was struck by a stone from the sidewalk next to the building.
 - c. Bethany struck the broken window with a stone from the sidewalk next to the building.
 - d. Bethany struck a broken window with a stone from the sidewalk next to the building.

If we assume that comprehenders are less likely to establish clause-internal coherence relations than inter-sentential coherence relations (Cohen and Kehler, 2021), then it would not be surprising if the former were influenced by grammatical cues in a way that the latter are not. In our working example above, our hypothesis is that two factors constrain the temporal interpretation of the nominals: Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness}. This hypothesis, we think, is related to the independently motivated observation that the temporal location of a DP description need not be related to the temporal location of its clause (e.g., Enç, 1982, 1986; Musan, 1999; Tonhauser, 2002). For example, the time in which *widow* truthfully describes the subject referent in (6) is likely to be interpreted as being after the temporal location of the clausal event: a person becomes a widow only after their partner passes away (in this case, after the person kills her own husband⁴).

- (6) The widow killed her husband. (Anscombe, 1979)

Moreover, we know that presuppositional DPs are distinguished from non-presuppositional

⁴If the pronoun is used deictically, e.g., the speaker points to a salient woman in the context who is not a widow, then we could infer that the widow was a widow at the time of the killing.

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DPs according to their determiners and syntactic positions. In particular, the description time of presuppositional DPs does not necessarily overlap with the time of the clausal event, while the description time of non-presuppositional DPs tends to overlap the time of the clausal event (Musan, 1999, 1995; Tonhauser, 2002, 2020). For example, *many fugitives* in (7a) can be a temporally independent presuppositional DP⁵, as shown in (8a). (7a) can thus be interpreted as saying that many former fugitives are now in jail. In contrast, when it occurs in the existential *there*-construction, as in (7b), *many fugitives* can only be a non-presuppositional DP that tends to be interpreted at the time of the verbal predicate, as in (8b). Therefore, (7b) is infelicitous because it is impossible for the individuals to be described as fugitives and to be in jail at the same time (unless they escaped from some other jail).

- (7) a. Many fugitives are in jail.
b. # There are now many fugitives in jail. (Musan, 1995)
- (8) a. $\exists t_{DP}(Many_x(fugitive'(x, t_{DP}))) \wedge \exists t_{VP}(in(jail', x, t_{VP})) \wedge t_{DP} < t_{VP}$
b. $\exists t_{DP}(Many_x(fugitive'(x, t_{DP}))) \wedge \exists t_{VP}(in(jail', x, t_{VP})) \wedge t_{DP} = t_{VP}$

Returning to (5), we can further flesh out our hypothesis as follows: the manipulation of Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness} changes the presuppositional properties of the *broken window* DPs, which leads to their different temporal interpretations, only one of which is compatible with the causal event depicted in Figure 1a. This analysis, however, remains tentative until we have more solid evidence confirming that native speakers do, in fact, infer the aforementioned causal explanations clause-internally.⁶ Therefore, we conducted a comprehension experiment to investigate whether resultative adjectives permit causal inferences within clauses, and if so, whether the causal inference is constrained by Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness}. We predicted that while resultative adjectives permit causal inferences within clauses, the availability and strength of causal inference are, in part, governed by the grammatical cues of Definiteness and Structure, with the Definite-Passive condition, as in (5a), biasing the strongest causal inference.

3. Experiment

We conducted two comprehension tasks, an initial study and a follow-up study, to confirm native speakers' intuition about clause-internal causal relations in different conditions. The designs of the two studies were very similar. In the initial study, we investigated whether resultative adjectives are more likely to enhance explanation coherence in the {Passive, Definite} condition than in other conditions. In the follow-up study, we specifically focused on a subcategory of resultative adjectives, namely deverbal resultative adjectives.

⁵In (7a), *many*, as a weak determiner, is a presuppositional determiner under its partitive reading and is a non-presuppositional determiner under its cardinal reading (Musan, 1995). We only discuss the partitive reading of *many* in (7a).

⁶The only experimental research that we are aware of that tests coherence inferences clause-internally comes from Sasaki and Altshuler (2022, 2023), who consider the manipulation of Structure, but not Definiteness in related examples. See §3.1.4 for more discussion.

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3.1. Initial study

3.1.1. Participants

48 participants (mean age 33.76, age range 20-67, 26 women) were recruited on Prolific. To ensure that only reliable participants would be eligible to take part in this task, we also required the potential participants to have a Prolific approval rate of at least 97%. All the participants reported being native speakers of English living in countries in which English was a primary language. All participants provided their written informed consent before participating in the experiment and received financial compensation (£3) for their time.

3.1.2. Design and stimuli

The experiment was written and hosted on Prolific Farm (Schwarz and Zehr, 2021). We manipulated Structure {Passive, Active} and Definiteness {Definiteness, Indefiniteness} to create 40 target items analogous to (5) (see Appendix for sample stimuli). Each item contained a resultative adjective and an instrument of an event that could lead to such a result, followed by a comprehension question probing explanation coherence, such as ‘Was the man drenched because of the water balloon?’. Participants were instructed to read each sentence and answer the comprehension question using a 7-point Likert scale, where 1 represented ‘definitely yes’ and 7 represented ‘definitely no’. The sentence and question appeared together on the screen.

Target items were distributed across four lists based on a Latin Square design, with each item occurring only once per list, in one of the four conditions. They were interspersed with 40 filler items that were similar to the target items in terms of length and complexity. The filler items were designed to elicit responses across the entire scale, with ‘definitely yes’, ‘definitely no’, or ‘maybe’ as expected answers to their comprehension questions (see Appendix for sample fillers).

3.1.3. Data analysis and Results

To ensure the quality of responses, we first cleaned the data based on reaction times (RTs). RTs falling below 1.5 standard deviations (SDs) below the mean of all participants’ median RTs were considered extremely fast, while RTs exceeding 4 SDs above the mean of all participants’ median RTs were considered extremely slow (Juzek, 2016)⁷. Four participants with extremely fast median RTs were identified as non-cooperative participants, so their data was excluded from further analyses.

The numbers of trials, as well as the means and standard errors (SEs) of the scales for each condition, are summarized in Table 1. Average ratings for causal coherence across all conditions were intermediate compared to those of fillers, while responses to the filler items indicated that participants utilized the full scale (see Figure 2b). The passive-definite condition received higher scores than in the other three conditions. We further analyzed the data with the cumulative link mixed model using the ordinal package (Christensen, 2022) in R (R core team, 2021). We sum-coded Structure and Definiteness as fixed effects, and included random intercepts and slopes for both subjects and items.

⁷Extreme RTs suggested non-cooperative or abnormal language processing (Juzek, 2016). Extremely fast RTs might be the result of careless clicking, while extremely slow RTs could indicate distraction.

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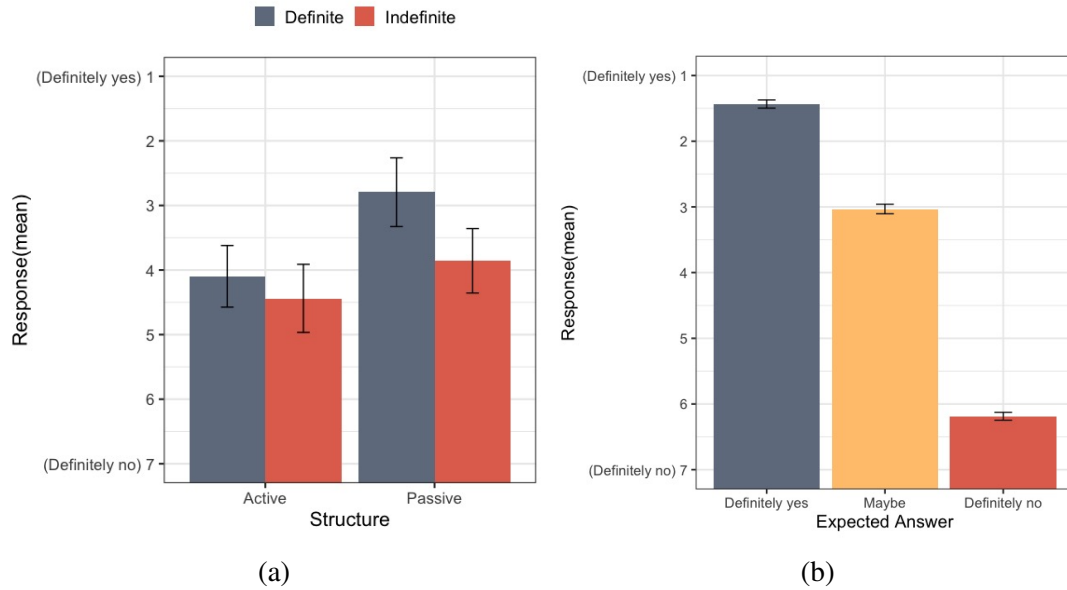


Figure 2: Responses for experimental items (a) and filler items (b) in the initial study.

Condition		Numbers	Means	SDs	SEs
Active	Definite	440	4.07	2.13	0.102
Active	Indefinite	480	4.46	2.07	0.095
Passive	Definite	440	3.00	2.12	0.101
Passive	Indefinite	400	3.95	2.08	0.104

Table 1: An overview of responses for target items in the initial study

The model estimated ratings are shown in Figure 2a. Main effects of Structure (Est = -0.81, SE = 0.18, $z = -4.41$, $p < .001$) and Definiteness (Est = -0.72, SE = 0.13, $z = -5.73$, $p < .001$) were found, along with an interaction between them (Est = -0.71, SE = 0.24, $z = -2.98$, $p = .003$). Planned comparisons between definite and indefinite in two structures were calculated using the emmeans package (Lenth et al., 2018). These comparisons indicated that while Definiteness affected explanation coherence in both active and passive structures, the effect was larger in the passive conditions (Est = -1.14, SE = 0.20, $z = -5.61$, $p < .001$) than in the active conditions (Est = -0.40, SE = 0.15, $z = -2.65$, $p = .008$). This result is consistent with the prediction that causal inference would be strongest in the passive-definite condition.

3.1.4. Discussion

The results of this study suggest that (i) native speakers are able to infer the relation Explanation between a result state described by an adjective within a DP, and the event described by the main clause, and that (ii) such inferences are sensitive to grammatical cues of Structure and Definiteness. Comprehenders are most likely to establish the clause-internal Explanation when the resultative adjective is contained in a definite subject DP, as in (5a).

Our findings are consistent with Sasaki and Altshuler (2022, 2023), who showed that attributive adjectives can trigger the same causal inferences within clauses. However, they investigated

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deverbal adjectives and non-deverbal adjectives separately, finding that while both of them can trigger clause-internal coherence, the coherence triggered by deverbal adjectives is more robust than that triggered by non-deverbal adjectives. The resultative adjectives we used in the stimuli including both deverbals (e.g., *broken*) and non-deverbals (e.g., *slippery*, see Appendix for sample items). Therefore, a further question for us is whether clause-internal causal inferences raised by deverbal resultative adjectives and guided by grammatical cues are more robust. We conducted another comprehension task focusing on deverbal resultative adjectives to address this question.

3.2. Follow-up study

3.2.1. Participants

Monolingual English speakers recruited through Prolific participated in this study (mean age: 39.64, age range: 19-68, 30 women).⁸ Participants from the initial study were prescreened, and as in the initial study, potential participants were required to have a Prolific rate of at least 97%. All participants provided written informed consent before participating in the experiment and received financial compensation (£4) for their time.

3.2.2. Design and stimuli

The design and stimuli used in this study were similar to the initial study. 40 experimental items and 80 filler items were intermixed. Each experimental trial consisted of a target sentence, as exemplified in (5), and a comprehension question. The most significant difference between this study and the initial study was that all resultative adjectives used in this study were deverbals, which have been reported to trigger more robust clause-internal causal inferences than non-deverbals (Sasaki and Altshuler, 2022, 2023). Additionally, the comprehension questions used in this study asked about the causal relationship between the adjective and the main clause event in a more direct way, such as ‘Do you think the man was drenched because he was hit with the water balloon?’ Participants were instructed to response to comprehension questions using a 7-point Likert scale, where 1 represented ‘definitely no’ and 7 represented ‘definitely yes’.

3.2.3. Data analysis and Results

We cleaned and analyzed the data using the same method as employed in the initial study. Data from one participant was removed due to extremely fast RTs, leaving data from 63 participants for further analysis.

Table 2 shows an overview of responses for target items. Similar to the initial study, average ratings for causal inferences across four conditions (see Figure 3a) were intermediate compared to those of fillers (see Figure 3b). Data were analyzed in a cumulative link mixed model, with Structure and Definiteness as sum-coded fixed factors and random intercepts and slopes for subjects and items. The model revealed main effects of Structure (Est = 0.58, SE=0.14, $z = 4.23$, $p < .001$) and Definiteness (Est = 0.40, SE = 0.10, $z = 3.81$, $p < .001$), and an interaction

⁸While we only required participants to be native English speakers in the initial study, we implemented stricter prescreening criteria in the follow-up study, requiring participants to be monolingual English speakers to avoid any potential influence from their second language(s).

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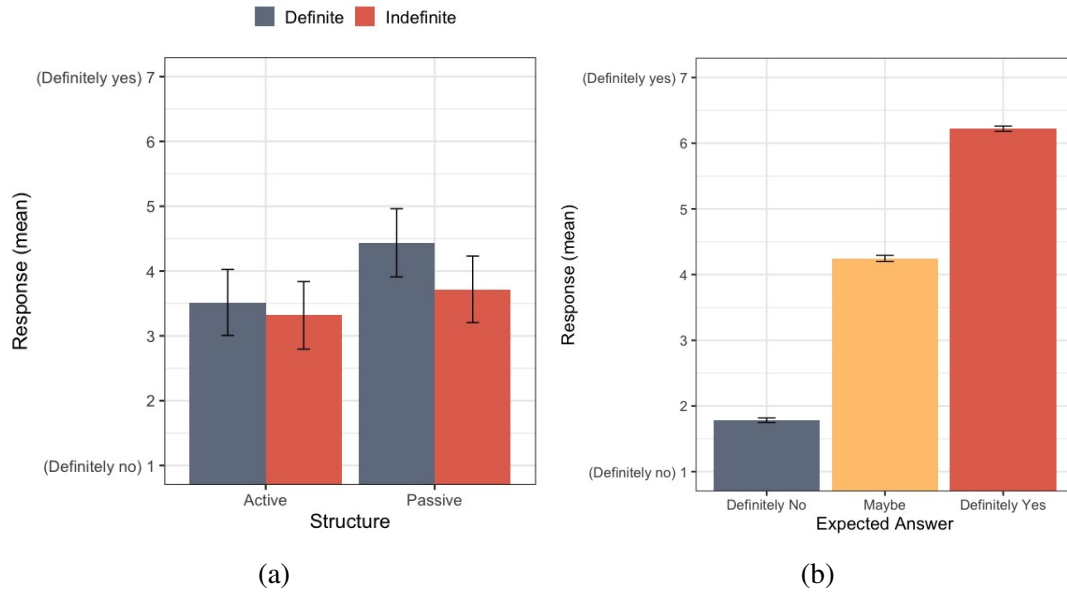


Figure 3: Responses for experimental items (a) and filler items (b) in the follow-up study.

between them (Est = 0.44, SE = 0.21, $z = 2.15$, $p = .03$). Planned comparisons via emmeans (Lenth et al., 2018) confirmed that the effect of Definiteness was significant in the passive conditions (Est = 0.71, SE = 0.20, $z = 3.54$, $p < .001$), but not in active conditions (Est = 0.20, SE = 0.12, $z = 1.64$, $p = .10$).

Condition		Numbers	Means	SDs	SEs
Active	Definite	630	3.58	2.32	0.092
Active	Indefinite	630	4.48	2.28	0.091
Passive	Definite	630	4.40	2.30	0.091
Passive	Indefinite	630	3.80	2.27	0.091

Table 2: An overview of responses for target items in the follow-up study

3.2.4. Discussion

The results of the follow-up study are similar to those of the initial study. They indicate that causal inferences triggered by deverbal resultative adjectives, which give rise to more robust clause-internal Explanations than non-deverbal resultative adjectives (Sasaki and Altshuler, 2022, 2023), are still affected by Structure and Definiteness. Comprehenders are more likely to establish explanation relations between the result state of the deverbal adjective and the main clause event when the adjective is in a definite subject DP. Alongside the initial study, these results further suggest that clause-internal causal coherence raised by resultative adjectives is guided by the grammatical cues of Structure and Definiteness.

4. Analysis

We propose that differences in causal, clause-internal inferences — e.g., in (5a)-(5d), repeated below — arise from the possible temporal interpretations that can be established between the

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result state described by the adjective within a DP and the event described by the clause. We further propose that these interpretative possibilities are constrained by whether a DP is a topic, giving rise to distinct scopal relations between the DP and the event quantifier.

- (5) a. The broken window was struck by a stone from the sidewalk next to the building.
 b. A broken window was struck by a stone from the sidewalk next to the building.
 c. Bethany struck the broken window with a stone from the sidewalk next to the building.
 d. Bethany struck a broken window with a stone from the sidewalk next to the building.

While sentence topics are closely connected to subjects in English (Erteschik-Shir, 1997; Davison, 1984), felicitous topics must also be already familiar to speakers. This familiarity condition is linked to a DP's existence-presuppositional status; that is, a DP is presuppositional only if it is 'hearer-established' while non-presuppositional DPs are not established in the discourse model (Tonhauser, 2020; Musan, 1999). For example, when answering a question asking about the existence of dealers, as in (9a), the response in (9b), with the weak quantifier *two*, is felicitous but the responses in (9c) and (9d), with the strong determiner *the* and strong quantifier *most*, respectively, are not. This is because strong DPs carry existence-presuppositions. Because their existence is presupposed, presuppositional DPs are established in the discourse, and are therefore more likely to be topics than non-presuppositional DPs.

- (9) a. Are there any dealers in this town?
 b. Two dealers have just been arrested. I guess that's evidence!
 c. # The dealer has just been arrested. I guess that's evidence!
 d. # Most dealers have just been arrested. I guess that's evidence! (Büring, 2012)

Topics have also been argued to be interpreted outside the scope of an event quantifier (Herburger, 2000). We propose that, because neither indefinite subjects nor non-subject DPs are preferentially taken to be topics, native speakers preferentially interpret them within the scope of the clause's event quantifier. Taking (5) as an example, neither the indefinite subject in (5b) nor the non-subject DPs in (5c) and (5d) tend to be sentence topics, so readers are likely to interpret them in the scope of the clause's event quantifier, as shown in (10b). In these cases, the existence of the result state *s* (of being broken) falls within the scope of the event quantifier, $\exists e$, ranging over striking-with-a-stone events *e*, therefore the onset of the temporal interval of *s* precedes the temporal location of *e*. Given this temporal relationship between *s* and *e*, comprehenders can surmise that whatever event *e_s* caused the result state *s*, it too must be temporally located prior to *e*. Definite subjects, as exemplified in (5a), however, make good topics and, when taken as such, are interpreted outside of the scope of the event quantifier, as shown in (10b). Since the existence of the result state *s* is outside the event quantifier $\exists e$, there is no necessary relationship between the onset of the temporal interval of *s* and the temporal location of *e*. This permits comprehenders to infer that the event *e_s* that caused the result state *s* is, in fact, the clausal event *e* itself, when plausible.⁹

- (10) a. $\exists e[\text{strike-with-a-stone}(e) \& \exists x[\text{Theme}(e, x) \& \text{window}(x) \& \exists s[\text{broken}(s) \& \text{In}(s, x)]]]$
 $\models e_s \prec e$

⁹See Sasaki and Altshuler (2023) for a discussion of competing pragmatic principles which would guarantee the identification between *e_s* and *e*.

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- b. $\exists x[\text{window}(x) \& \exists s[\text{broken}(s) \& \text{In}(s, x)] \& \exists e[\text{strike-with-a-stone}(e) \& \text{Theme}(e, x)]]$
 $\rightsquigarrow e_s = e$

We take this logic to be a special case of Tonhauser’s generalization that non-presuppositional DPs display a stronger tendency than presuppositional ones to be temporally interpreted at the verbal predication time (Tonhauser, 2020). While Tonhauser proposed that the familiarity condition of presuppositional DPs contributes to their temporal independency, we further link her proposal of presuppositionality to sentence topicality, and propose that the information structure of DPs affects their relationship to the scope of event quantifiers, which then guides their temporal interpretation.

5. Discussion and Conclusion

Although coherence inferences can be fragile clause-internally, we provided experimental evidence showing that native speakers are capable of making these inferences, and demonstrated that clause-internal coherence is constrained by Definiteness and Structure – elements guiding identification of sentence topics. We proposed that clause internal coherence is guided by the topichood of a DP which affects whether it falls under the scope of an event quantifier, thereby impacting the temporal relationship between a result state described by an adjective in a DP and the clausal event.

We conclude by noting that if the topichood of DPs affects clause-internal, causal inferences, we expect similar effects to emerge when manipulating topics. For example, since presuppositional DPs tend to be topics, we expect resultative adjectives in other presuppositional subject DPs, such as in (11a) and (11b), to also allow comprehenders to obtain strong causal inferences, while non-presuppositional subject DPs, such as in (11c), should restrain such inferences. While our intuitions are in line with these predictions, we hope to confirm them with subsequent experiments.

- (11) a. Most of the broken windows were struck by stones.
 b. Every broken window was struck by a stone.
 c. There were many broken windows struck by a stone.

Finally, we note that our analysis relies on an indirect relation between temporal interpretation and causal inferences. Future experiments may examine this relationship more directly by asking comprehension questions that probe temporal relations (e.g., *Was the window broken before it was hit by the stone?*)

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Appendix: Sample stimuli

Non-deverbal resultative adjectives

- (12)
 - a. The slippery floorboard got covered with some oil last Tuesday afternoon.
 - b. A slippery floorboard got covered with some oil last Tuesday afternoon.
 - c. Bill covered the slippery floorboard with some oil last Tuesday afternoon.
 - d. Bill covered a slippery floorboard with some oil last Tuesday afternoon.
- (13)
 - a. The clean mug was washed with detergent after breakfast this morning.
 - b. A clean mug was washed with detergent after breakfast this morning.
 - c. Briant washed the clean mug with detergent after breakfast this morning.
 - d. Briant washed a clean mug with detergent after breakfast this morning.
- (14)
 - a. The happy girl was presented the gift prepared for her on Christmas Eve.
 - b. A happy girl was presented the gift prepared for her on Christmas Eve.
 - c. Gwen presented the happy girl with the gift prepared for her on Christmas Eve.
 - d. Gwen presented a happy girl with the gift prepared for her on Christmas Eve.
- (15)
 - a. The upset student was shown with a failed grade one day before the summer vacation.
 - b. An upset student was shown with a failed grade one day before the summer vacation.
 - c. The teacher shown the upset student with a failed grade one day before the summer vacation.
 - d. The teacher shown an upset student with a failed grade one day before the summer vacation.

Topichood and temporal interpretation of DPs guide clause-internal, causal coherence

Deverbal resultative adjectives

- (16) a. The injured dog got hit with a car on a busy street earlier this morning.
b. An injured dog got hit with a car on a busy street earlier this morning.
c. Peter hit the injured dog with a car on a busy street earlier this morning.
d. Peter hit an injured dog with a car on a busy street earlier this morning.
- (17) a. The poisoned princess got assassinated with a cobra in the film which was popular last year.
b. A poisoned princess got assassinated with a cobra in the film which was popular last year.
c. The jealous queen assassinated the poisoned princess with a cobra in the film which was popular last year.
d. The jealous queen assassinated a poisoned princess with a cobra in the film which was popular last year.
- (18) a. The damaged painting was cut with a razor blade during the heist in a museum.
b. A damaged painting was cut with a razor blade during the heist in a museum.
c. Tina cut the damaged painting with a razor blade during the heist in a museum.
d. Tina cut a damaged painting with a razor blade during the heist in a museum.
- (19) a. The scented room was filled with fresh roses in the old castle for the wedding.
b. A scented room was filled with fresh roses in the old castle for the wedding.
c. Leonard filled the scented room with fresh roses in the old castle for the wedding.
d. Leonard filled a scented room with fresh roses in the old castle for the wedding.

Fillers

Expected to be *definitely yes*

- (20) a. Tom is from Germany and likes beers. | Question: Is Tom from Europe?
b. All students took an exam last month and only three of them failed. | Question: Did any student fail in the exam?

Expected to be *maybe*

- (21) a. The successful businessman has donated billions of dollars to the charity during the past ten years. | Question: Did the successful businessman donate lots of money to the charity last year?
b. Ray wanted to go swimming tomorrow with his brother. | Question: Does Ray like swimming?

Expected to be *definitely no*

- (22) a. Although the project was supported by the local government, it was not welcomed by the residents. | Question: Was the project supported by the residents?
b. It was too noisy in the house, so the sleepy man couldn't fall asleep. | Question: Was the man sleepy because it was noisy in the house?

6 Online processing of clause-internal causal relations

6.1 Summary

The fourth study explores whether clause-internal Explanation relations can be established during online discourse processing.

A series of comprehension tasks using stimuli like (60) have shown that in offline comprehension, readers can infer Explanation relations between the result state indicated by the resultative adjective (i.e., *injured*) and the event described by the verb phrase (i.e., *hit by the car*) (Sasaki and Altshuler, 2022, 2023; Yao et al., 2024). However, clause-internal Explanation relations have not been examined in online processing. On the one hand, a considerable number of studies have demonstrated coherence-driven expectations in multi-clause discourse, indicating that the processing of inter-clause relations is incremental and occurs without delay. On the other hand, clause-internal coherence appears to be more fragile than inter-clause coherence, as the corresponding inferences are not required for discourse felicity and are easily overridden by contextual or structural factors (Cohen and Kehler, 2021; Sasaki and Altshuler, 2023; Yao et al., 2024). The fragility of clause-internal coherence raises a further question: Is the processing of clause-internal coherence as immediate and anticipatory as inter-clausal coherence, and does it elicit similar online processing effects in terms of reading time?

(60) The injured dog was hit by a car.

To address this question, the present study investigates the online processing of clause-internal Explanation coherence through a self-paced reading experiment and an eye-tracking-while-reading experiment. The stimuli were adapted from Yao et al. (2024) to manipulate coherence by varying Structure {Passive, Active} and Definiteness {Definite, Indefinite}.

No significant effects were found on the critical region or the spillover region in any measurements across both experiments. The results suggest that comprehenders may not be able to establish clause-internal Explanation relations immediately during real-time discourse processing. This may be because the establishment of such relations is more fragile than that of inter-clausal coherence relations and, consequently, may not be as immediate and anticipatory. Instead, under the current manipulations, comprehenders may delay committing to a clause-internal Explanation relation until additional information becomes available. However, this study examined only one type of clause-internal coherence and relied on a specific experimental manipulation, leaving open the question of how general these findings are across other types of clause-internal relations and manipulations. Further research is therefore needed to better understand whether and how other types of clause-internal coherence can be established during online processing.

Clause-internal Explanation Fails in Online Processing^{*}

ABSTRACT

This study investigates whether comprehenders can establish clause-internal Explanation relations during online sentence processing. Building on previous offline findings that such relations are most strongly licensed in Passive–Definite contexts, we manipulated Structure (Active vs. Passive) and Definiteness (Definite vs. Indefinite) in a self-paced reading task and an eye-tracking-while-reading task. Across both studies, we found no evidence of an interaction between Structure and Definiteness that would indicate online facilitation in the Passive–Definite condition. This suggests that, during online discourse processing, clause-internal Explanation relations may not be established as immediately and anticipatorily as inter-clausal Explanation relations. Instead, comprehenders may adopt a more conservative strategy, delaying the establishment of such relations until additional linguistic cues become available, perhaps due to the more fragile nature of clause-internal coherence.

KEYWORDS

Discourse coherence; real-time processing; incrementality; language comprehension

^{*}Draft version, March 2025. Earlier versions of this work were presented at HSP 2023 and AMLaP 2023 (Yao et al., 2023a, 2023b).

1. Introduction

A main task for comprehenders when processing sentences is determining what relationships hold between linguistic units in the course of understanding what messages speakers are trying to convey (e.g., Hoek et al., 2021b; Koornneef & Sanders, 2013; Mak & Sanders, 2013; Rohde, 2008). Some of these relationships are what many formal theories of discourse call coherence (e.g., Asher & Lascarides, 2003; Hobbs, 1979; Kehler et al., 2008; Mann & Thompson, 1988; Sanders, 1997; Sanders et al., 1992); that is, meaningful and sometimes non-obligatory relationships which are not only governed by syntactic or semantic constraints, but also determined pragmatically by factors including a comprehender's world knowledge. For instance, (1a) shows a signaled coherence coherence, where the Explanation relation (i.e., backward causal relation) is explicitly indicated by the connective *because*. Coherence relations can also be implicit, as exemplifies in (1b), where comprehenders can infer an Explanation relation between the state *being injured* and the event *being hit by a car*.

- (1) a. The dog was injured, because it was hit by a car.
 b. The dog was injured. It was hit by a car.

A considerable body of research has shown that the establishment of coherence relations is immediate, highly incremental, and even predictive during online discourse processing (e.g., Asr & Demberg, 2012; Levinson, 2000; Murray, 1997; Sanders, 2005). It is well-established that readers can use implicit causality (IC) verbs, such as *fired* in (2a), to build upcoming Explanation relations in real-time immediately and anticipatorily, which, for example, can be reflected in faster processing when the text aligns with these coherence-based expectations (e.g., Asr & Demberg, 2012; Grüter et

al., 2018; Köhne & Demberg, 2013; Koornneef & Van Berkum, 2006; Mak & Sanders, 2013; Rohde, 2008). Recent studies have extended this research to the sentence-internal level, showing that readers can also use IC verbs to establish Explanation relations between main clauses and relative clauses (RCs) rapidly, with IC-driven expectations (Hoek et al., 2021a, 2021b).

More recent studies have shifted attention to coherence relations at the clause-internal level (Cohen & Kehler, 2021; Sasaki & Altshuler, 2022, 2023; Yao et al., 2024). A series of comprehension tasks using stimuli like (3) have shown that in offline comprehension, readers can infer Explanation relations between the result state indicated by the deverbal adjective (i.e., *injured*) and the event described by the verb phrase (i.e., *hit by the car*) (Sasaki & Altshuler, 2022, 2023; Yao et al., 2024). However, clause-internal Explanation relations have not been examined in online processing. The current study aims to investigate whether comprehenders can build clause-internal Explanation relations in online processing immediately, particularly whether they can use resultative adjectives to generate causal expectations that facilitate the establishment of Explanation relations in real-time.

- (2) a. Lisa fired the employee. He had been embezzling money for years.
b. Lisa fired the employee who had been embezzling money for years.
- (3) The injured dog was hit by a car.

2. Background

Prior work has demonstrated that comprehenders establish causal coherence relations rapidly and even anticipatorily during online language comprehension (e.g., Kuperberg et al., 2011; Mak & Sanders, 2013; Zwaan et al., 1995). In particular, when encoun-

tering causally biased linguistic cues, such as IC verbs, comprehenders will expect upcoming Explanation relations between sentences (e.g., Au, 1986; Garvey & Caramazza, 1974; Kehler et al., 2008; Mak & Sanders, 2013; Rohde, 2008) and between clauses (Hoek et al., 2021a, 2021b). As recent studies have shown that resultative adjectives can drive clause-internal coherence on offline comprehension, an open question is whether comprehenders can build such coherence immediately and anticipatorily during online processing, similarly to how they build IC-driven coherence.

2.1. Establishing causal relations in discourse processing

Words and sentences are organized in meaningful ways to form a coherent discourse. To process discourse, comprehenders must determine the relationships between linguistic units, relying on overt syntactic signals such as conjunctions or drawing on pragmatic inferences. Some cognitive theories and experimental evidence suggest that comprehenders can rapidly build coherence relations, particularly causal relations, in online processing in some situations (e.g., Asr & Demberg, 2012; Murray, 1997; Sanders, 2005). For example, it is hypothesized that comprehenders will try to connect sentences by means of a causal relation first, and a non-causal relation will only be established when a causal reading of the text is not possible (causality-by-default hypothesis; Mulder, 2008; Sanders, 2005; Sanders & Noordman, 2000). Experimental findings have supported this hypothesis by showing that processing advantage of causal relations. For instance, in a self-paced reading task, (Sanders & Noordman, 2000) found that causal coherence relations (i.e, Problem–Solution) were processed faster than additive relations (i.e, List), indicating that readers integrate causally related segments more easily than non-causal ones.

In addition, prior research has also shown that comprehenders can use some specific

- (5) a. Jenny *joked with* the guy who made a lot of money for the company.
 b. Jenny *praised* the guy who made a lot of money for the company.

Moreover, readers can use coherence relations to rapidly update their expectations. An eye-tracking-while-reading study found that the connective *because* and the post-connective *astoundingly* were read faster in (6a) than in (6b), as the relative clause in (6b) fulfills the causal expectations triggered by IC verbs. In contrast, in (6a), the expectation is not fulfilled by the relative clause, so it is held and facilitates the processing of the *because*-clause.

- (6) a. Diane *fired* the guy from the London office who was here last month because astoundingly he hired a stripper for the Christmas party.
 b. Diane *fired* the guy from the London office who was embezzling money because astoundingly he hired a stripper for the Christmas party.

2.2. Clause-internal coherence relations

The initial attempt to investigate clause-internal coherence can be traced back to Anscombe (1979), who introduced the phrase “under the description” as a tool in the philosophy of action. The idea is that whether a certain description of an event is true may depend on what happens at other times, leading readers to incorporate appropriate temporal information when interpreting a description to avoid logical inconsistencies. For example, (7) is naturally understood as implying that the woman became a widow after she struck and killed her husband with a knife. The temporal relations in this interpretation also suggest a clause-internal Explanation relation: The woman became a widow because she stabbed her husband.

- (7) The widow stuck a knife into her husband.

Later studies provided further examples showing that coherence relations can be inferred between adjacent nominal segments (e.g., Cohen & Kehler, 2021; Hobbs, 1990, 2010). For instance, in (8), people tend to infer in (8a) that the jogger was hit by a car *when* and *because* she was jogging. In contrast, in (8b), no similar inference arises about the teacher being hit *when* and *because* she was teaching.

- (8) a. The jogger was hit by a car.
b. The teacher was hit by a car.

Similarly, experimental evidence from recent offline comprehension studies demonstrate that attributive adjectives can trigger clause-internal causal inferences, allowing readers to establish Explanation relations between a result state described by the adjective and the event in the main clause (Sasaki & Altshuler, 2022, 2023). For instance, in (9), readers infer that the dog was *injured* because of *being hit by a car*, even though the causal link is implicit and non-obligatory. Their work suggest such clause-internal Explanation inferences are robust in offline comprehension tasks, especially when the attributive adjective is a deverbal one (e.g., *injured*).

- (9) The injured dog was hit by a car.

Further studies in Yao et al. (2024) indicate adjective-driven clause-internal Explanation relations are not always available, as they are constrained by the temporal interpretation of the determiner phrase (DP) containing the adjective. In two comprehension tasks, they found the definite subject *the broken window* in (10a) strongly biases readers toward inferring that the window's broken state resulted from being

struck by the stone. In contrast, the indefinite subject in (10b) and the object DPs in (10c)–(10d) are less likely to elicit this inference. Yao et al. (2024) attribute this asymmetry to the temporal independence of the DP. Specifically, definite subjects (e.g., *the broken window* in (10a)) are preferentially interpreted as discourse topics, which are temporally independent of the main clause event (Herburger, 2000). This independence allows the result state (i.e., *being broken*) to be temporally unbound by the event (i.e., *being struck*), enabling a causal link where the *striking* event causes the *broken* state. By contrast, indefinite or non-subject DPs (e.g., *a broken window* in (10b) or *the/a broken window* in (10c)–(10d)) are interpreted within the scope of the event quantifier (Musn, 1999; Tonhauser, 2020). Their temporal location overlaps with the clausal event, making the causal inference implausible (since the *broken* state would already exist prior to the *striking* event).

- (10) a. The broken window was struck by a stone from the sidewalk next to the building.
- b. A broken window was struck by a stone from the sidewalk next to the building.
- c. Bethany struck the broken window with a stone from the sidewalk next to the building.
- d. Bethany struck a broken window with a stone from the sidewalk next to the building.

2.3. *The current study*

While the studies mentioned above provide evidence that resultative adjectives can guide clause-internal Explanation coherence in offline tasks, no existing studies have

examined clause-internal coherence in online processing. It remains unclear whether the establishment of clause-internal coherence is immediate and anticipatory.

On the one hand, language processing is highly incremental in general. And a considerable number of studies have demonstrated comprehenders can generate expectations for upcoming coherence relations in multi-clause discourse, indicating that the establishment of coherence relations is highly incremental that occurs without delay. On the other hand, clause-internal coherence appears to be more fragile than inter-clause coherence, partly because, as Cohen and Kehler (2021) proposed, the crucial difference between clause-internal coherence and other extra-semantic enrichments, such as implicatures and implicatures, is that the former, unlike the latter, does not rest on a threat to communication.¹ They further argued that coherence relations are obligatory in inter-sentential cases but non-obligatory in clause-internal cases. This is because, in inter-sentential contexts, comprehenders must establish some relevancy relations (i.e., coherence relations) between clauses to maintain discourse coherence. In contrast, in clause-internal cases, the discourse remains coherent even if comprehenders do not establish any implicit coherence relations between segments (e.g., words or phrases). Therefore, the non-obligatory status makes clause-internal coherence comparatively fragile. Moreover, the availability of clause-internal coherence relations has been shown to be highly sensitive to grammatical structure, with subtle changes in syntactic configuration influencing whether such inferences arise (Sasaki & Altshuler, 2023; Yao et al., 2024).

Some experimental results also indicate differences between inter-clausal and intra-clausal coherence. For example, offline comprehension tasks in Sasaki and Altshuler

¹Cohen and Kehler (2021) introduced the term *eliciture* to capture the nature of intra-sentential coherence, which includes coherence between main clauses and relative clauses, such as (5b), as well as clause-internal coherence, such as (10a).

(2023) showed that while attributive adjectives can trigger causal inferences within clauses, these inferences are weaker than those between sentences. Similarly, Yao et al. (2024) found that clause-internal Explanation relations triggered by resultative adjectives are constrained by syntactic factors, suggesting that clause-internal coherence is more fragile than inter-clausal coherence and may largely depend on (morpho)syntax.

The fragility of clause-internal coherence raises an open question: is the processing of clause-internal coherence as immediate and anticipatory as inter-clausal coherence, and does it elicit similar online processing effects in terms of reading time? To address this, the present study investigates the online processing of clause-internal Explanation coherence through a self-paced reading experiment (Experiment 1) and an eye-tracking-while-reading experiment (Experiment 2). The stimuli were adapted from Yao et al. (2024) to manipulate coherence by varying Structure (Passive vs. Active) and Definiteness (Definite vs. Indefinite). If readers are able to establish clause-internal coherence during online processing, we would expect that the condition in which participants can infer Explanation relations in offline judgments would also be processed more easily and rapidly. This facilitation would arise from expectations potentially triggered by resultative adjectives and/or from the general processing advantage associated with causal relations.

3. Experiment 1: Self-paced reading

We conducted a self-paced reading (SPR) task to investigate whether native speakers can infer Explanation relations between resultative adjectives within DPs and the instruments of events that can cause such results during online processing. If the processing of clause-internal coherence is as immediate and anticipatory as inter-clausal coherence, we expect the Explanation relation to facilitate the processing of the instru-

ment. Otherwise, if comprehenders delay committing to a clause-internal Explanation relation until more information becomes available, we would not expect to find any effects.

3.1. *Participants*

We recruited 101 native English speakers (mean age 37.9, age range: 19-71, 61 women) who had a Prolific approval rate of at least 98% from Prolific. Participants were required to complete the task using a desktop to make sure the device can fully support the task. All the participants provided their written informed consent before participating in the experiment and received financial compensation (£5) for their time.

3.2. *Design and materials*

40 experimental items were adapted from the *initial study* in (Yao et al., 2024), as exemplified in Table 1 (The full list of items, raw data and analysis scripts are available at <https://osf.io/fc4mb/>). Each item contained a resultative adjective (e.g., *slippery*) and an instrument of an event that can lead to such a result (e.g., *oil*). Structure (Active vs. Passive) and Definiteness (Definite vs. Indefinite) were changed to manipulate whether comprehenders can infer Explanation relations from the sentence. The noun denoting the instrument served as the critical word (CW) in the study.

Experimental items were distributed across four lists using a Latin Square design, with each item appeared only once per list and in one of the four conditions. They were then intermixed with 80 filler items that were adapted from DeLong et al. (2005) and were similar to the target items in terms of length and complexity. To monitor whether participants were paying attention to the task, one third of the items were followed by an unambiguous yes or no comprehension question, such as *Was the floorboard covered*

Structure	Definiteness	Coherence (Expected)	Sentence
<i>Passive</i>	<i>Definite</i>	Yes	The slippery floorboard got covered with some <u>oil</u> last Tuesday evening.
<i>Passive</i>	<i>Indefinite</i>	No	A slippery floorboard got covered with some <u>oil</u> last Tuesday evening.
<i>Active</i>	<i>Definite</i>	No	Bill covered the slippery floorboard with some <u>oil</u> last Tuesday evening.
<i>Active</i>	<i>Indefinite</i>	No	Bill covered a slippery floorboard with some <u>oil</u> last Tuesday evening.

Table 1. Sample experimental item in the SPR task. The underlined word indicates the CW.

with some water?

3.3. Procedure

Participants completed the word-by-word moving-window SPR task online using PCibex Farm (Schwarz & Zehr, 2021). In each trial, the sentence was initially displayed as a series of dashes, indicating the number of words. Participants pressed the spacebar to reveal each word sequentially, with each new word replacing the previous one. Reading times (RTs) were recorded from the onset of each keypress. To ensure participants were attending to the task, some trials were followed by a simple *yes* or *no* comprehension question, which they answered by pressing ‘F’ (*no*) or ‘J’ (*yes*) on the keyboard. The entire experiment took approximately 20 minutes to complete.

3.4. *Prediction*

We predicted that comprehenders would be able to establish clause-internal Explanation relations immediately and anticipatorily during real-time processing, similar to what has been observed for inter-clausal coherence (e.g., Hoek et al., 2021b; Scholman et al., 2017). If so, this should be reflected in shorter RTs at the CW or on the spillover region in the Passive-Definite condition, where the coherence relation is most strongly supported (Yao et al., 2024), compared to the other conditions.

3.5. *Analysis and results*

Data from two participants were excluded due to low comprehension accuracy (below 70%), resulting in 99 participants included in the final analysis. Additionally, RTs outside the range of 100–2000 ms were considered outliers and removed, accounting for 0.86% of the data.

Table 2 provides an overview of mean reading times (RTs) and standard deviations (SDs) for two words preceding the critical word (CW-2, CW-1), the CW, and three words in the spillover region (CW+1, CW+2, CW+3). The pattern shows that CW-1, CW, CW+1, and CW+2 were read fastest in the Passive-Definite condition.

RTs were analyzed using linear mixed-effects models using the lme4 package (Bates et al., 2014) in R. Structure (Active vs. Passive), Definiteness (Indefinite vs. Definite) and their interaction were coded as fixed effects. Random intercepts and slopes for both fixed effects were included for participants and items, following a maximal random effects structure (Barr et al., 2013). P-values were obtained using the lmerTest package (Kuznetsova et al., 2017), and post-hoc comparisons were conducted using the emmeans package (Lenth et al., 2024).

Figure 1 displays model-estimated reading times (RTs) for each word from CW-2

	CW-2		CW-1		CW		CW+1		CW+2		CW+3	
Condition	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Act-def	377	180	366	164	372	209	374	197	375	193	393	211
Act-indef	378	194	358	173	381	231	376	208	366	174	378	194
Pass-def	370	189	348	151	357	188	361	174	359	162	380	209
Pass-indef	370	180	358	171	367	196	376	208	372	198	396	226

Table 2. An overview of means and SDs of RTs (ms) between CW-2 and CW+3 in the SPR task.

to CW+3 across conditions. We found a significant main effect of Structure at CW-2 (Est = -15.1, SE = 5.8, $t = -2.6$, $p = .012$), CW-1 (Est = -12.8, SE = 5.2, $t = -2.5$, $p = .017$), CW (Est = -17.7, SE = 7.4, $t = -2.4$, $p = .020$), CW+1 (Est = -13.3, SE = 5.9, $t = -2.3$, $p = .027$), and CW+2 (Est = -10.8, SE = 5.2, $t = -2.1$, $p = .044$). A marginal main effect of Definiteness was observed at CW (Est = -10.3, SE = 5.8, $t = -1.8$, $p = .079$). No interaction effects were found at any word position.

Pairwise comparisons revealed that at CW-2, the effect of Structure was significant in the Indefinite conditions (Est = 22.2, $p = .014$) but not in the Definite conditions (Est = 8.0, $p = .25$). At CW-1, the Structure effect was significant in the Definite conditions (Est = 17.36, $p = .008$), but not in the Indefinite conditions (Est = 8.21, $p = .310$). At CW, the Structure effect was marginally significant in both Definite (Est = 15.2, $p = .051$) and Indefinite (Est = 20.2, $p = .060$) conditions.

3.6. Discussion

The results did not align with our predictions. We had expected a processing advantage in the Passive–Definite condition, where clause-internal Explanation relations are most strongly licensed in offline processing (Yao et al., 2024). However, we did not observe any interaction between Structure and Definiteness at the CW or on the spillover

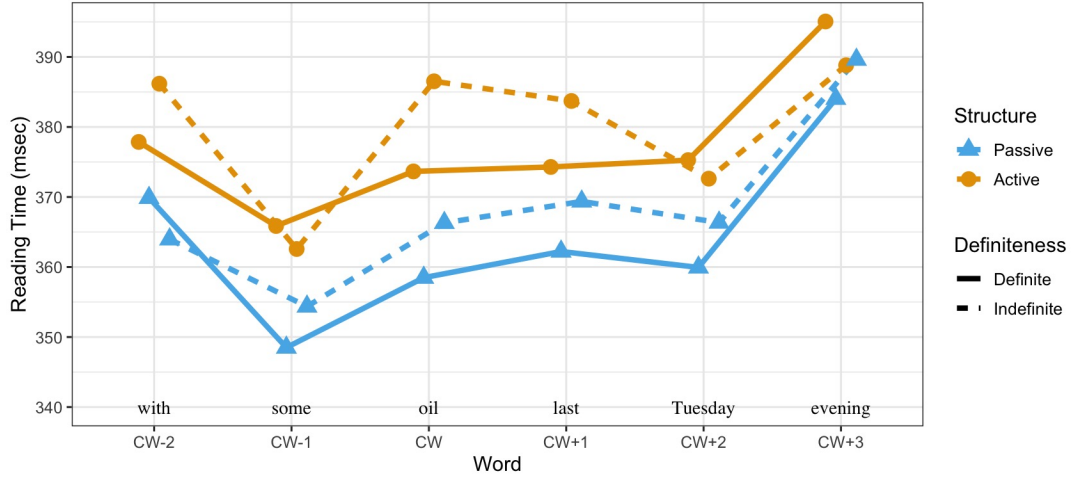


Figure 1. Model Estimated RTs between CW-2 and CW+3 in the SPR task.

region. This suggests that comprehenders may not be able to establish clause-internal Explanation relations during real-time processing.

We observed a main effect of Structure between CW-2 and CW+2, with faster reading times in the Passive conditions compared to the Active conditions. However, it remains unclear whether this facilitation was driven by coherence relations. One possibility is that readers established an Explanation relation between the resultative adjective and the entire prepositional phrase (PP), rather than just the noun denoting the instrument (i.e., the CW), and that they were more likely to establish such relations in the Passive conditions, thereby facilitating the processing. Alternatively, it is also possible that the observed effect is due to structural predictability (Levy, 2008), as prepositions like *with* may be more expected in passive structures, leading to facilitation in the Passive conditions.

Despite the absence of statistically significant interactions, the numerical pattern was consistent with our predictions: the CW and the spillover region were read fastest in the Passive–Definite condition. This trend raises the possibility that the lack of

robust effects may be due to the coarse-grained nature of SPR reading times. Prior research on inter-clausal coherence has reported online effects in later eye-tracking measures, such as total reading time (e.g., Hoek et al., 2021b; Scholman et al., 2017). It is possible that early reading times captured by SPR are not sensitive enough to detect subtle advantages conferred by clause-internal coherence. To investigate this possibility, we conducted an eye-tracking-while-reading study in Experiment 2.

4. Experiment 2: Eye-tracking-while-reading

The goal of Experiment 2 was to investigate whether the results from Experiment 1 were due to the limitations of SPR measures. We used an eye-tracking-while-reading paradigm to further examine whether clause-internal Explanation relations can be established immediately and anticipatorily during online processing.

4.1. *Participants*

24 undergraduate students (14 women) were recruited through the University of Oxford SONA system. All participants were self-reported native English speakers and had normal or corrected-to-normal vision. They took part in exchange for course credit.

4.2. *Design and materials*

The design and materials were similar to those used in Experiment 1. 40 experimental items were adapted from the *follow-up study* in Yao et al. (2024) (The full list of items, raw data and analysis scripts are available at <https://osf.io/fc4mb/>). As in Experiment 1, we manipulated Structure (Active vs. Passive) and Definiteness (Definite vs. Indefinite) to create four conditions for each item. The main difference between

the stimuli in the two experiments was that all resultative adjectives used in this experiment were deverbal (e.g., *broken* in (10)), while adjectives used in Experiment 1 also included some non-deverbals (e.g., *slippery*). Deverbal adjectives have been shown to elicit more robust clause-internal causal inferences than non-deverbals during offline comprehension (Sasaki & Altshuler, 2022, 2023), so we expected this change to enhance the coherence effects in the current study.

In addition, In contrast to Experiment 1, where the CW was a single noun, the critical region in this study was the PP (e.g., *by/with a stone* in (10)), which conveyed the potential cause of the result expressed by the adjective. Experimental items were distributed across four lists using a Latin Square design and randomized with 80 filler items, which were identical to the fillers used in Experiment 1. To encourage participants to read carefully, One third of the items were followed by a *yes* or *no* binary choice comprehension question.

4.3. Procedure

Before the experiment began, participants completed a brief dominant eye test. They were asked to form a small triangular opening with their hands, then align this opening with a fixed spot on the wall. The eye that maintained alignment when the participants alternately closed each eye was recorded as the dominant eye. The eye-tracker was then calibrated to this eye.

Participants' eye movements were recorded using the SR Research EyeLink 1000 system with a chin rest, at a sampling rate of 1000 Hz. Viewing was binocular, but only the dominant eye was tracked (right eye for 11 participants). The experiment began with four practice trials to familiarize participants with the task. The main experiment was divided into two blocks, with a short break provided between them to

reduce fatigue. A standard nine-point calibration was performed at the beginning of the experiment, after the mid-experiment break, and whenever measurement accuracy appeared insufficient.

Participants were instructed to read each passage at a natural pace. Each trial began with a fixation dot appearing at the position of the first word of the sentence to ensure appropriate launch-site positioning before sentence presentation. Participants were instructed to read at a natural pace. At the end of each item, they were asked to fixate on a dot in the upper-right corner of the screen. Following this, either an end-of-trial instruction or a comprehension question appeared. For comprehension questions, participants responded by pressing the F key (*no*) or the J key (*yes*) on the keyboard. The next trial began automatically after a response. If no question followed, participants were instructed to press any key to proceed.

4.4. Prediction

The prediction for Experiment 2 was similar to that of Experiment 1. We expected to observe faster processing at the PP and/or spillover regions in the Passive–Definite condition. Given that no such processing advantage was observed in the SPR task, and that previous studies on coherence relations have reported online effects in later eye-tracking measures, we anticipated that any advantage would be most evident in re-reading time or total reading time.

4.5. Analysis and results

Data were cleaned using Eyelink Data Viewer program. Fixations shorter than 80 ms were merged with nearby fixations or removed.

All participants demonstrated high comprehension question accuracy ($>75\%$), with

a mean accuracy of 88%. No participants were excluded from the analysis. However, approximately one third of the data from one participant was lost due to technical issues.

We analyzed the PP and the spill-over region in each experimental item, see (11):

- (11) a. The/a broken window was struck [by a stone]_{PP} [from the]_{spillover} side-walk next to the building.
- b. Bethany struck the/a broken window [with a stone]_{PP} [from the]_{spillover} sidewalk next to the building.

For each region, we analyzed four reading time measures, mainly based on Hoek et al. (2021a):

- First pass time: The sum of fixation duration in a region from the first time it's entered until the eyes leave it in either direction. It reflects the initial processing difficulty of a region (Rayner, 1998).
- Go-past time (also known as regression path duration): The sum of fixation duration from when the current region is first fixated until the eyes enter the next region on the right. It is also associated with immediate processing difficulty, reflecting difficulty resolving ambiguity or integrating meaning (Rayner, 1998).
- Re-reading time: The sum of fixations made in a region after the reader has already left it once (i.e., any returns to the region). It reflects later-stage processing, including reanalysis or re-integration of prior text (Rayner, 1998).
- Total reading time: The sum of all fixations in a region, including regressions. It reflects overall processing load, but mixes early and late processing (Liversedge et al., 1998; Rayner, 1998).

6.2. Clause-internal Explanation fails in online processing

We analyzed the data using linear mixed effects regression models with maximal random effects (Barr et al., 2013) using the lme4 package (Bates et al., 2014) in R, with fixed effects for Structure, Definiteness and their interaction, as well as random effects of participants and items.

Table 3 shows the mean reading times and SDs for each reading time measure per condition on the PP and the spillover region. Regression models didn't show any significant effect of Structure, Definiteness or their interaction on any of the reading time measures on these two regions ($ps > .05$). Model estimated reading times for each condition are reported in the appendix.

	PP							
	First pass time		Go-past time		Re-reading time		Total reading time	
	M	SD	M	SD	M	SD	M	SD
Active-Definite	436	225	560	424	215	350	651	415
Active-Indefinite	453	240	632	703	250	367	702	421
Passive-Definite	439	261	542	412	193	307	632	395
Passive-Indefinite	459	239	561	427	223	346	682	424

	Spillover							
	First pass time		Go-past time		Re-reading time		Total reading time	
	M	SD	M	SD	M	SD	M	SD
Active-Definite	286	154	371	355	114	199	400	246
Active-Indefinite	301	181	354	279	119	197	420	259
Passive-Definite	286	172	333	216	108	182	394	256
Passive-Indefinite	265	131	333	240	118	202	382	243

Table 3. Mean reading times and standard deviations per measure and region in the eye-tracking-while-reading task.

4.6. Discussion

The results of Experiment 2 did not support our predictions. We found no evidence of a processing advantage for the Passive–Definite condition, where clause-internal Explanation relations are most strongly licensed in offline comprehension (Yao et al., 2024), even in later eye-movement measures. This suggests that comprehenders may not be able to establish clause-internal Explanation relations in real-time.

Notably, the main effect of Structure observed between CW-2 and CW+2 in Experiment 1 did not replicate in the current study. This discrepancy may be attributed to different processing strategies elicited by the two tasks. In the SPR task, participants were required to read the sentence word-by-word, which may have encouraged more deliberate, incremental integration of each word into the unfolding sentence structure. In contrast, the eye-tracking-while-reading task allowed for more natural reading patterns, in which readers could skip words, make regressions, and allocate attention more flexibly. If the main effect of Structure in Experiment 1 was driven by structural predictability, as discussed in the previous section, it is possible that the eye-tracking task did not elicit the effect as robustly as the SPR task.

5. General discussion

This study investigated whether comprehenders can establish clause-internal Explanation relations during online processing, focusing on the effects of Structure (Active vs. Passive) and Definiteness (Definite vs. Indefinite) on the processing of clause-internal Explanation relations triggered by resultative adjectives. Through one SPR task (Experiment 1) and one eye-tracking-while-reading task (Experiment 2), we examined whether the Passive–Definite condition, which most strongly licenses a clause-internal

coherence relation in offline comprehension (Yao et al., 2024), would confer an online processing advantage due to expectations potentially triggered by resultative adjectives and/or the general processing advantage associated with causal relations.

In both studies, we didn't observe any predicted interaction between Structure and Definiteness. This suggests that comprehenders may not readily establish clause-internal Explanation relations during real-time processing. One possibility is that the establishment of such relations is more fragile than inter-clausal coherence relations and, as a result, the establishment of clause-internal coherence relations may not be as immediate and anticipatory as inter-clausal coherence relations. Instead, comprehenders may delay committing to a clause-internal Explanation relation until additional information becomes available. This interpretation aligns with the findings of Yao et al. (2024), who showed that the construction of clause-internal coherence relations is largely dependent on (morpho)syntactic cues.

Although the current results suggest that the establishment of clause-internal relations may not be facilitated by causal expectations, and not be as highly incremental as inter-clausal relations, it would be premature to conclude that such processing is not incremental at all. Consider a sequence of discourse units π_1, π_2, π_3 and so on. Do comprehender build the relations between π_1 and π_2 at the moment they reach π_2 , or only after they finish π_2 (i.e., when they begin π_3)? Both can be regarded as incremental, but the former represents an earlier stage of incrementality, while the latter reflects a later, more integrative stage. In inter-clausal cases such as (5b), where the event of *being praised* corresponds to π_1 and *making a lot of money* to π_2 , faster reading times indicate that readers anticipate an Explanation relation even before reaching π_2 , and then confirm it as soon as they encounter π_2 . In our clause-internal case (e.g., (10a)), where *being broken* is π_1 and *being struck with a stone* is π_2 , the absence of

a facilitation effect merely indicates that readers did not form such expectations and did not establish the Explanation relation at that early stage. However, if readers were to build the relation upon processing a subsequent event π_3 , this would still be considered as incremental. Our experimental design cannot capture these incrementality. Future research could use stimuli which include some disambiguating cue to cancel inferences, such as “The injured man was hit by a car on his way to the clinic to treat a sprained ankle” to further examine the nuanced time course of coherence relation establishment.

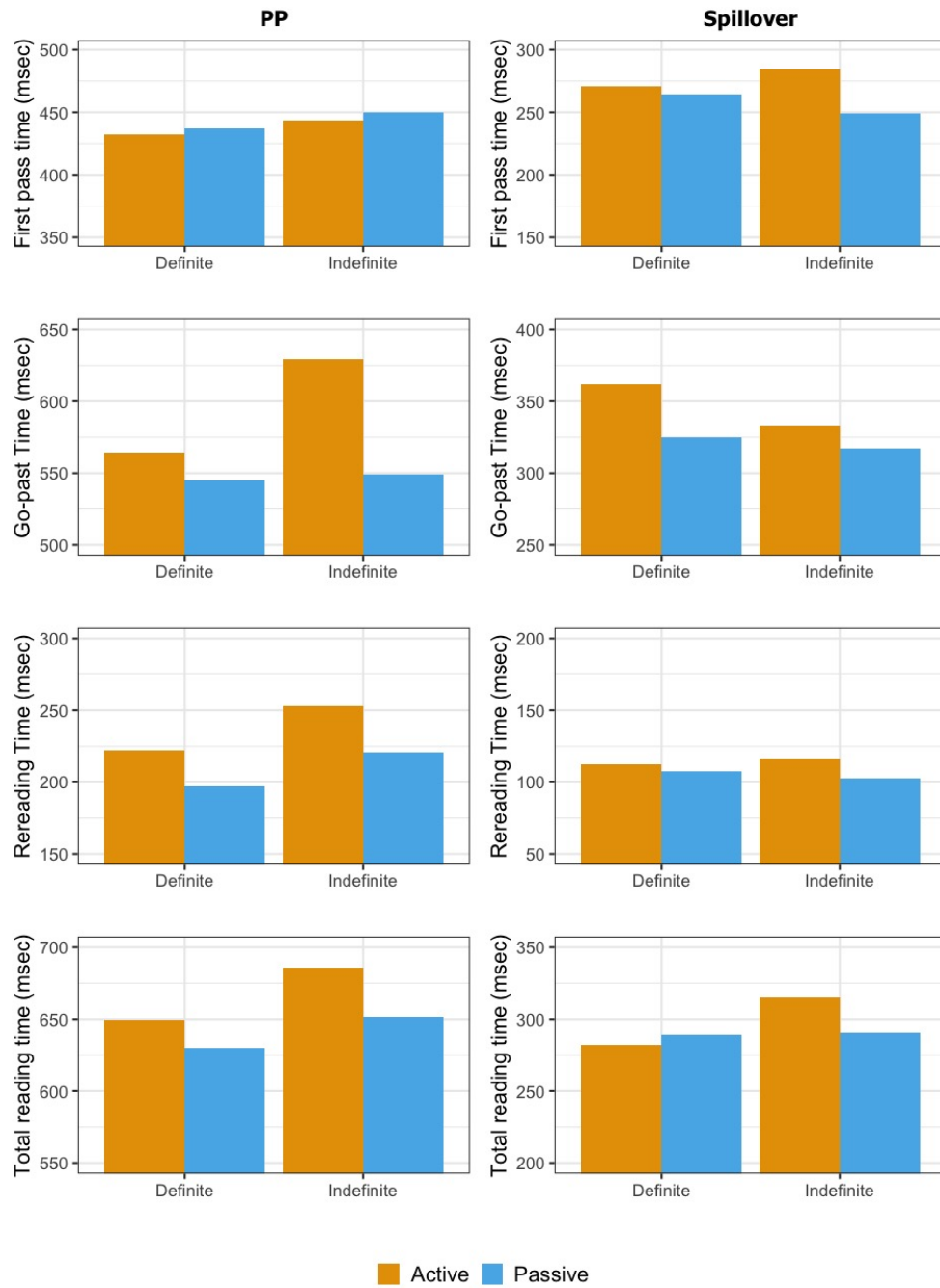
In Experiment 1, we observed a main effect of Structure, with faster reading times in the Passive conditions relative to the Active conditions. However, this effect was not localized to the CW or its immediate spillover region, but was observed in a broader window (i.e., CW-2 to CW+2). Notably, this effect did not replicate in Experiment 2, which employed a more naturalistic reading paradigm. This suggests that the Structure effect in Experiment 1 may not reflect facilitation from coherence-based inference but could instead be attributed to structural predictability effects (Levy, 2008).

An alternative explanation for the lack of significant interaction effects in both experiments is that the manipulations of Definiteness and Structure may not have been strong enough to influence online processing. That is, although these factors have been shown to shape offline causal interpretations, their effects may not be robust or immediate enough to impact real-time comprehension. Future studies may explore whether stronger manipulations, or additional contextual support, are needed to elicit online sensitivity to clause-internal Explanation relations.

6. Conclusion

To summarize, while it has been previously shown that inter-clausal coherence relations can be established immediately and anticipatorily during online processing, our findings suggest that clause-internal coherence relations may not be processed in the same way. Instead, comprehenders may adopt a more conservative strategy, delaying the establishment of such relations until additional linguistic cues become available. These findings indicate that comprehenders may not be able to establish clause-internal Explanation in online processing, highlighting a potential asymmetry between the online processing of clause-internal and inter-clausal coherence relations. This work contributes to the growing body of research on coherence processing. Future work could further investigate the time course of clause-internal coherence relation establishment with more natural discourse and more fine-grained design.

Appendix: Model Estimated RTs in Experiment 2



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7 General discussion

7.1 Incrementality of discourse processing

A fundamental question in discourse processing concerns the extent to which comprehenders process discourse incrementally. Do they build discourse coherence incrementally and immediately, or do they leave it underspecified until more information becomes available?

The findings from this thesis shed new light on this question by investigating how readers establish inter-clausal and intra-clausal Explanation relations in discourse processing. Article 1 and Article 2 studied the establishment of inter-clausal Explanation relations, demonstrating that comprehenders form expectations for upcoming inter-clausal Explanation relations based on IC verbs, with these expectations being modulated by structural factors such as relative clauses and the RFC. These findings suggest that readers build inter-clausal Explanation relations immediately and anticipatorily, aligning with previous research on predictive discourse processing (e.g., Hoek et al., 2021a,b; Kehler and Rohde, 2017).

However, Articles 3 and 4 investigated clause-internal Explanation relations and revealed a different pattern. While Article 3 demonstrated that comprehenders can establish clause-internal Explanation relations in offline tasks when guided by resultative adjectives, Article 4 found no evidence for immediate establishment of such relations during online processing. This suggests that during online discourse processing, clause-internal Explanation relations may not be established as immediately and anticipatorily as inter-clausal Explanation relations.

Together, these findings demonstrate that incrementality in discourse processing is

not uniform across all types of coherence relations. Though, as I discussed in Article 4, the lack of facilitation effects in online processing is still not sufficient to indicate fully non-incremental processing mechanisms, it does suggest that the processing of clause-internal Explanation relations may be less highly incremental than that of intra-clausal Explanation relations. The asymmetry observed between inter-clausal and intra-clausal Explanation relations may reflect intrinsic differences in their discourse status, which aligns with previous research suggesting that inter-clausal Explanation relations tend to be stronger and more robust than intra-clausal ones (Cohen and Kehler, 2021; Sasaki and Altshuler, 2022, 2023). Consistent with this view, Article 3 in this project also shows that intra-clausal Explanation relations are often fragile and more likely to be constrained by morphosyntactic information. In particular, while resultative adjectives can guide clause-internal Explanation relations, their establishment depends on nominal temporal interpretations that are affected by grammatical cues such as definiteness and subjecthood, making them less readily constructed from lexical-semantic information (e.g., resultative adjectives) alone.

In addition, another potential factor that may contribute to this asymmetry is the strength of available cues; that is, IC verbs might be stronger than resultative adjectives as cues for Explanation relations. Sasaki and Altshuler found that inter-clausal Explanation relations raised by prenominal adjectives are stronger than intra-clausal Explanation relations raised by prenominal adjectives in offline processing. However, there is no direct comparison between inter-clausal Explanation relations raised by resultative adjectives and those raised by IC verbs, leaving open the possibility that resultative adjectives are inherently weaker cues for coherence processing.

However, a very recent study by Sasaki et al. (2025b) reports that readers can incrementally construct clause-internal Explanation relations guided by deverbal nouns. In a maze study, the underlined noun was processed more quickly in (61-a), where an Explanation relation is available, than in (61-b). The discrepancy between Sasaki et al. (2025b)’s findings and ours may stem from methodological differences or properties of the stimuli; for instance, as they discussed, the effects may be due to verb–noun collocation.

tion frequencies. Nonetheless, evidence for the real-time establishment of clause-internal Explanation relations remains very limited. It is possible that some types of Explanation relations can be constructed more incrementally than others, but the relevant conditions are not yet well understood. Further research is therefore needed.

- (61) a. Alice congratulated two winners.
 b. Alice congratulated two readers.

More broadly, these findings highlight the need for discourse processing models to incorporate flexibility in the timing of coherence construction. Rather than assuming a uniformly incremental and predictive, or a uniformly delayed mechanism, a comprehensive discourse processing model should account for variability driven by the type of coherence relation and/or the strength of available cues.

7.2 RFC in the QUD framework

This project involves both SDRT and QUD frameworks. Specifically, Article 1 analyses IC-driven expectations within the QUD framework, while Article 2 found that the RFC, which is a key component of the SDRT framework, constrains long-distance discourse expectations. An underlying question is whether we can operate the RFC within the QUD framework, or more broadly, whether SDRT and QUD frameworks are compatible.

As demonstrated in Article 2, the RFC shows psychological reality through its measurable effects on real-time processing. This suggests that the RFC may extend beyond the SDRT framework as a more general principle, and could potentially be integrated into the QUD framework. For example, one limitation of the QUD framework is that it remains unclear which questions are available for resolution at any given stage of discourse processing, and the RFC could provide a principled solution to this problem. Specifically, if we analyse IC-driven effects within the QUD framework, Article 2 can be reinterpreted as investigating whether the RFC affects the availability of “why” questions raised by IC verbs for resolution after an intervening sentence. The results indicate that the RFC can

work as a structural constraint within the QUD framework, determining which QUDs remain accessible for discourse continuation.

More broadly, the compatibility between SDRT and the QUD framework has been debated in the theoretical literature. For example, Hunter and Abrusán (2015) argue that a direct mapping between SDRT’s coherence relations and QUDs is not possible, primarily because SDRT organises discourse units via structural constraints such as the RFC, whereas the QUD model organises questions via intentional, strategy-based relations. More recently, however, Lee (2024) proposes a systematic procedure for reconstructing QUDs and shows that coherence relations can correspond to relations among QUDs when the subquestion structure is properly identified. This emerging line of work suggests that SDRT and QUD may be productively integrated.

Given this theoretical landscape, I tend to consider SDRT and the QUD framework as complementary frameworks that both address discourse coherence but with different emphases. Rather than seeking a one-to-one correspondence between SDRT’s coherence relations and QUDs, my interest lies in how the two frameworks complement each other - structurally in the case of SDRT, and pragmatically in the case of the QUD framework. As mentioned in Section 2.1.1.2, the SDRT framework was proposed as a formal tool to analyse discourse structure and coherence, and with the RFC as its key component, it makes testable predictions about discourse attachment (e.g., Asher and Lascarides, 2003; Mann and Thompson, 1988; Thompson and Mann, 1987; Webber, 1988). In contrast, the QUD framework was not originally designed specifically for discourse coherence, though it can also account for coherence phenomena by predicting that a discourse is coherent only when each subsequent sentence addresses the questions raised in the preceding discourse (e.g., Benz and Jasinskaja, 2017; Kehler and Rohde, 2017; Lee, 2024; Onea, 2016).

Compared to the SDRT framework, predictions made by QUD-based approaches are pragmatically grounded rather than structurally-based. Though SDRT and QUD frameworks make similar predictions in most cases, they can diverge in certain contexts where pragmatic and structural factors point toward different analyses. For example, consider the resolution of the propositional anaphora *that* in (62-c). According to the RFC within

the SDRT framework, *that* could refer to either “did two things” or “visited my wife’s grave”, as both propositions are structurally accessible. However, there is a strong intuitive preference to attach (62-c) to (62-b), with *that* most naturally referring to “visited my wife’s grave”. This preference can be captured by a QUD-based approach, which would argue that the proposition “did two things” in (62-a) establishes a discourse goal by raising a QUD such as *What two things did the speaker do on their seventy-fifth birthday?* Under this analysis, (62-b) provides a partial answer to this question but doesn’t close this question, making (62-a) a less accessible referent for the anaphoric expression in (62-c).

- (62)
- a. I did two things on my seventy-fifth birthday.
 - b. I visited my wife’s grave.
 - c. That took a long time.

To conclude, SDRT and QUD both view discourse as hierarchically structured rather than linear or random. The QUD framework excels at capturing pragmatic factors that drive discourse coherence, while the SDRT framework provides precise structural predictions. Many examples in this thesis have shown that the establishment of coherence relations is not merely a result of either discourse structure or pragmatic knowledge alone; neither approach fully captures the complexity of discourse comprehension in isolation. Therefore, integrating structural constraints like the RFC into the QUD framework may offer a more comprehensive account of discourse coherence. A challenge for such an integration, however, is that defining the RFC requires identifying subordinating and coordinating relations, but there is relatively little consensus in the QUD literature about how the distinction between subordinating and coordinating relations is reflected in QUD structure (see Lee (2024) for some discussions). Addressing this gap is a crucial step for developing a convergent model of discourse coherence, as well as a model of discourse processing where both bottom-up structural constraints and top-down pragmatic expectations jointly shape comprehension.

7.3 A few words on methods

In this project, I used moving window self-paced reading (SPR) and eye-tracking-while-reading tasks to measure online processing. The linking hypothesis is that the amount of time that readers allocate on a given region of a sentence or discourse reflects the processing difficulty of this region (e.g., Just and Carpenter, 1980; Rayner, 1998; Yoshida, 2023). SPR has often been regarded as a cheaper and more convenient substitute for eye-tracking-while-reading, which is one of the reasons I mainly used SPR in this project.²⁶ Despite the higher noise levels and potential spill-over effects associated with SPR, it has functioned as a reliable method in this project. In particular, I did not observe significant spillover effects in the region-by-region analyses of my SPR studies (Articles 1 and 2). One possible reason is that the segmentation was carried out on a region-by-region basis, so that processing difficulty was more likely to be resolved within the same region rather than spreading to subsequent ones.

Another online reading measurement that can take place remotely is the maze task (Boyce et al., 2020; Forster et al., 2009; Witzel et al., 2012). In maze tasks, participants are instructed to make a forced choice at each word between a sensible continuation and a distractor. The distractor is either a real word that was anomalous given the current sentence context (G(rammaticality)-maze) or a pseudoword (L(exicality)-maze). Maze studies have been found to yield comparable effect sizes to eye-tracking and to be more sensitive than SPR (e.g., Forster et al., 2009; Witzel et al., 2012). However, maze tasks were difficult to implement because generating distractors manually was labour-intensive. This limitation was addressed by A(uto)-maze (Boyce et al., 2020), where distractors are high-surprisal real words that are automatically generated by language models. During the pandemic lockdowns, maze tasks have been used in many incremental language processing studies (e.g., Boyce and Levy, 2023; Heuser and Gibson, 2023; Husband, 2022).

A-maze was also a plausible method for this project, and a recent study using this

²⁶ I started this project during the COVID-19 pandemic, which made in-person and lab-based eye-tracking less accessible.

paradigm reported that readers incrementally construct clause-internal Explanation relations in real-time (Sasaki et al., 2025b), which is different from the findings of Article 4 in this thesis, making the method especially appealing. However, I did not actually use A-maze for two concerns. First, my study required region-by-region analysis to capture coherence effects that span multiple words, whereas A-maze provides word-by-word measurements. While it is common practice in eye-tracking studies to sum up word-by-word reading times to create region-based measures, it remains unclear whether summed A-maze reaction times are comparable to region-by-region SPR measurements. Second, participants in maze tasks may behave differently than in natural reading, as the task forces participants to process text word-by-word while simultaneously making forced choices at each step. Therefore, the linking hypothesis behind maze tasks remains unclear. While there are some studies comparing SPR and A-maze in discourse processing and, in most cases, A-maze effects are larger than SPR effects (e.g., Boyce and Levy, 2023; Duff, 2023), some research found SPR effects that were not replicated in A-maze, which may indicate reduced attention to preceding context in A-maze tasks (Duff, 2023). While this does not necessarily constitute a disadvantage, more comparison studies between A-maze and other incremental processing methods are required to gain a comprehensive understanding of maze tasks and establish them as a more widely-applicable tool for discourse research.

7.4 Directions for future work

While this project has investigated the establishment of Explanation relations in discourse processing across some contexts, there are still some limitations that may be explored in future studies.

First, although the present project is framed in terms of causal relations, given their importance in discourse coherence and human cognition, this thesis has focused exclusively on implicit Explanation relations, a specific subtype within the broader causal domain. It therefore remains unclear whether the findings reported here generalize to other types of causal relations, such as Result relations. One challenge in investigating Result relations in predictive processing is that, as I have discussed in Section 2.3.1, unlike Ex-

planation relations triggered by IC verbs, there is no similarly reliable cue to generate expectations for Result relations. That also means there is no clear point at which we can assume that comprehenders raise a Result-related question, making QUD-based analysis of Result relations are more ad hoc and less testable. If we adopt the causality-by-default hypothesis (e.g., Sanders et al., 1992, 1993), Result relations may arise as a default expectation in comprehension. Yet such a default expectation is likely to operate at a very high level, and thus may not be constrained by factors such as linguistic structure.

Taken together, these considerations raise the possibility that the processing profile of Result relations differs fundamentally from that of Explanation relations. In this sense, Result relations may mark a potential boundary condition for the incremental QUD framework proposed in Article 1, and perhaps for QUD-based models of discourse processing more broadly. Future research should therefore investigate whether and how Result relations can be captured within a QUD-based approach, and what modifications to current models are necessary to accommodate their distinctive status.

Second, the current study (Article 1 and Article 2) used IC verbs as cues for Explanation expectations. As discussed in §2.3.2, this approach leaves several open questions for future research. One promising direction is to conduct norming studies on IC verbs that directly examine coherence biases. Existing large-scale norming studies of IC verbs have primarily focused on coreference biases (e.g., Ferstl et al., 2011; Hartshorne and Snedeker, 2013; Hartshorne et al., 2012), whereas comparable norming data for coherence biases remain relatively scarce. Establishing such norms would help clarify the relationship between verbs' coreference biases and their tendencies to elicit specific coherence relations in discourse. In addition, following common practice in discourse processing studies, I treated IC versus non-IC verbs as a categorical factor and selected IC verbs based on previous studies. While this approach has yielded reliable results, the distribution of IC bias may vary continuously across verbs (e.g., Ferstl et al., 2011; Garvey and Caramazza, 1974; Semin and Fiedler, 1991). Future research could therefore explore modelling IC bias as a continuous factor.

Third, Articles 3 and 4 in the current study represent just the beginning of research

into clause-internal coherence. Recent years have witnessed a growing body of studies on clause-internal coherence phenomena across different linguistic contexts. In addition to clause-internal coherence relations triggered by adjectives, some other types of clause-internal coherence relations have been observed but haven't been investigated systematically. Recent studies have investigated clause-internal coherence raised by nouns. For example, readers were found to be able to infer clause-internal Explanation relations between verbs and nouns, such as between *congratulated* and *winner* in (63) during off-line processing, results from a maze study suggest readers can also do so immediately in online processing (Sasaki et al., 2025a). While these online processing findings appear to contradict the results of Article 4, which found no evidence for immediate establishment of clause-internal relations in online processing, this potential discrepancy highlights the need for further research to investigate whether different types of clause-internal cues or contextual factors exhibit distinct processing profiles, or whether methodological differences account for the conflicting results.

(63) Alice congratulated a winner. (Sasaki and Altshuler, 2025)

Lastly, the current findings are based on English discourse processing, but the establishment of coherence relations may vary significantly across languages due to factors such as differences in linguistic structure, discourse markers and culture (e.g., Knott and Sanders, 1998; Le Guen et al., 2015; Sanders and Stukker, 2012; Taboada, 2009). For example, some languages tend to use less explicit connectives than English (e.g., Mandarin, Japanese and some Indigenous languages of the Americas such as Navajo and Quechua (e.g., Weber, 1989; Willie and Jelinek, 2014)). An open question is whether in these languages, comprehenders rely more heavily on implicit inference mechanisms to establish coherence relations, potentially leading to different processing strategies compared to English speakers. Conversely, other languages, such as Korean and German, tend to provide more explicit morphological and syntactic means for marking discourse relations compared to English. It remains to be investigated whether speakers of these languages have more difficulties in processing implicit coherence relations.

8 Conclusion

The current work set out to investigate the establishment of implicit Explanation relations, a subtype of causal relations, in discourse processing. Prior studies have demonstrated that local linguistic cues, such as IC verbs, can guide comprehenders to infer and expect Explanation relations in discourse processing. However, significant questions remained about what linguistic elements constrain implicit Explanation relations, how comprehenders infer such relations across different discourse contexts, and where in the linguistic structure these relations can be established. This thesis addressed these gaps through experimental methods and formal semantic analysis.

One main finding in this thesis is that IC-driven Explanation relations can be constrained by structural embedding. While the IC verbs are a well-established source of causal biases in discourse processing, I found that IC-driven inferences and expectations cannot project to a higher clause. Specifically, when an IC verb occurs inside a relative clause, it does not give rise to expectations that guide the processing of the main clause. This is arguably because while IC verbs uniformly raise “why” questions, these questions can only generate QUDs that enhance offline causal inference rates and guide online causal discourse expectations to material that is at the same or lower structural level. I interpreted these results as evidence within an incremental QUD model, which captures the the interplays between structural constraints and QUD dynamics in generating real-time discourse expectations. Moreover, I found that IC-driven Explanation expectations are constrained by the RFC. Specifically, IC-driven expectations can be maintained across subordinating intervening units but are blocked by coordinating units. These results provide new evidence for the RFC’s central role in online discourse processing and offer insights into how readers anticipate and structure upcoming discourse.

Furthermore, this work expanded the domain of coherence relations by exploring clause-internal Explanation relations triggered by resultative adjectives. Offline studies showed that while readers can use resultative adjectives to establish Explanation relations within a clause, such inferences are fragile. I found that comprehenders can obtain Explanation inferences only when the adjective appears in a definite subject. This is arguably because only definite DPs that serve as subjects tend to function as sentence topics and can be interpreted outside the scope of an event quantifier, thereby allowing the temporal location of the resultative state to be placed after the event described by the verb. In addition, one SPR study and one eye-tracking-while-reading study showed that readers are not able to establish clause-internal Explanation relations during real-time processing, suggesting that the establishment of such relations may not be immediate and anticipatory. Instead, under the current manipulations, readers appear to delay committing to a clause-internal Explanation relation until additional information becomes available. However, these studies reported in this thesis examined only one type of clause-internal coherence and relied on a specific experimental manipulation, leaving open the question of how general these findings are across other types of clause-internal relations and manipulations. Further research is therefore needed to clarify whether and how other types of clause-internal coherence can be established during online processing.

Together, these findings lead to three key conclusions. First, inter-clausal Explanation relations are established predictively during real-time processing, indicating a highly incremental pattern of discourse comprehension. Comprehenders can generate discourse expectations about upcoming Explanation relations, guided by cues such as IC verbs, and such expectations are constrained by structural embedding (e.g., relative clause) and discourse structure (e.g., the RFC). Second, Explanation relations can be established within a clause, guided by cues such as resultative adjectives in offline processing. However, their establishment is more fragile and does not occur immediately during real-time comprehension, indicating a less incremental pattern in the establishment of clause-internal coherence relations. Third, the establishment of implicit Explanation relations is shaped by a dynamic interplay of lexical semantics, (morpho)syntactic constraints, and discourse

structure. These findings advance our understanding of discourse processing by shedding new light on how and when readers establish implicit Explanation relations during discourse comprehension.

A Experimental items for Article 1

Experiment 1

- Comprehension task
- Conditions: Verb type {IC, non-IC} $\times$ Verb position {main clause, RC}
- 24 experimental items

1. (a) **Verb type:** IC; **Verb position:** RC.

Andrew looked over the crowd that had assembled in the company lounge.
The woman who he admired had built a successful career in sales. She arrived
at the conference room just in time for her next meeting.

(b) **Verb type:** IC; **Verb position:** main clause.

Andrew looked over the crowd that had assembled in the company lounge. He
admired the woman who had built a successful career in sales. She arrived at
the conference room just in time for her next meeting.

(c) **Verb type:** non-IC; **Verb position:** RC.

Andrew looked over the crowd that had assembled in the company lounge.
The woman who he talked to had built a successful career in sales. She arrived
at the conference room just in time for her next meeting.

(d) **Verb type:** non-IC; **Verb position:** main clause.

Andrew looked over the crowd that had assembled in the company lounge. He
talked to the woman who had built a successful career in sales. She arrived at
the conference room just in time for her next meeting.

Question: Did Andrew admire the woman because she had built a successful career in sales?

2. (a) **Verb type:** IC; **Verb position:** RC.

Last week, George attended a huge career event, where he met a lot of new people. The woman who he pitied had lost four jobs within a year. She was trying to find a new job at the event.

- (b) **Verb type:** IC; **Verb position:** main clause.

Last week, George attended a huge career event, where he met a lot of new people. He pitied the woman who had lost four jobs within a year. She was trying to find a new job at the event.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Last week, George attended a huge career event, where he met a lot of new people. The woman who he talked to had lost four jobs within a year. She was trying to find a new job at the event.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Last week, George attended a huge career event, where he met a lot of new people. He talked to the woman who had lost four jobs within a year. She was trying to find a new job at the event.

Question: Did George pity the woman because she had lost four jobs within a year?

3. (a) **Verb type:** IC; **Verb position:** RC.

Jenny walked through the hallway to check on the daily goings-on around the office. The guy who she priased made a lot of money for the company. He is a friendly employee who has been working for this company for ten years.

- (b) **Verb type:** IC; **Verb position:** main clause.

Jenny walked through the hallway to check on the daily goings-on around the office. She praised the guy who made a lot of money for the company. He is a friendly employee who has been working for this company for ten years.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Jenny walked through the hallway to check on the daily goings-on around the office. The guy who she joked with made a lot of money for the company. He is a friendly employee who has been working for this company for ten years.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Jenny walked through the hallway to check on the daily goings-on around the office. She joked with the guy who made a lot of money for the company. He is a friendly employee who has been working for this company for ten years.

Question: Did Jenny praise the guy because he made a lot of money for the company?

4. (a) **Verb type:** IC; **Verb position:** RC.

Charlotte was almost ready to close the weekly company assembly. The guy who she fired had been 30 minutes late to the meeting. He is new to this company several months ago.

- (b) **Verb type:** IC; **Verb position:** main clause.

Charlotte was almost ready to close the weekly company assembly. She fired the guy who had been 30 minutes late to the meeting. He is new to this company several months ago.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Charlotte was almost ready to close the weekly company assembly. The guy who she joked with had been 30 minutes late to the meeting. He is new to this company several months ago.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Charlotte was almost ready to close the weekly company assembly. She joked with the guy who had been 30 minutes late to the meeting. He is new to this company several months ago.

Question: Did Charlotte fire the guy because he had been 30 minutes late to the meeting?

5. (a) **Verb type:** IC; **Verb position:** RC.

James walked into the busy lecture hall. The girl who he congratulated had won the writing contest. She was a middle school student dreaming to be a writer in the future.

- (b) **Verb type:** IC; **Verb position:** main clause.

James walked into the busy lecture hall. He congratulated the girl who had won the writing contest. She was a middle school student dreaming to be a writer in the future.

- (c) **Verb type:** non-IC; **Verb position:** RC.

James walked into the busy lecture hall. The girl who he waved at had won the writing contest. She was a middle school student dreaming to be a writer in the future.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

James walked into the busy lecture hall. He waved at the girl who had won the writing contest. She was a middle school student dreaming to be a writer in the future.

Question: Did James congratulate the girl because she had won the writing contest?

6. (a) **Verb type:** IC; **Verb position:** RC.

Yesterday, Kyle went to the city center to watch the marathon with his friends. The girl who he criticized had quit half-way through the race. It was the first time the girl participated in a marathon.

- (b) **Verb type:** IC; **Verb position:** main clause.

Yesterday, Kyle went to the city center to watch the marathon with his friends. He criticized the girl who had quit half-way through the race. It was the first time the girl participated in a marathon.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Yesterday, Kyle went to the city center to watch the marathon with his friends.

The girl who he waved at had quit half-way through the race. It was the first time the girl participated in a marathon.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Yesterday, Kyle went to the city center to watch the marathon with his friends. He waved at the girl who had quit half-way through the race. It was the first time the girl participated in a marathon.

Question: Did Kyle criticize the girl because she had quit half-way through the race?

7. (a) **Verb type:** IC; **Verb position:** RC.

We entered our apartment building and headed up the stairs. The neighbor who we thanked had brought over a fruit basket. The fruit basket was filled with fresh fruits and it was a delightful surprise to my birthday.

- (b) **Verb type:** IC; **Verb position:** main clause.

We entered our apartment building and headed up the stairs. We thanked the neighbor who had brought over a fruit basket. The fruit basket was filled with fresh fruits and it was a delightful surprise to my birthday.

- (c) **Verb type:** non-IC; **Verb position:** RC.

We entered our apartment building and headed up the stairs. The neighbor who we greeted had brought over a fruit basket. The fruit basket was filled with fresh fruits and it was a delightful surprise to my birthday.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

We entered our apartment building and headed up the stairs. We greeted the neighbor who had brought over a fruit basket. The fruit basket was filled with fresh fruits and it was a delightful surprise to my birthday.

Question: Did we thank the neighbor because they had brought over a fruit basket?

8. (a) **Verb type:** IC; **Verb position:** RC.

As we left the house, we told our son to join us at the neighborhood picnic

soon. The neighbor who we ignored had dropped our newly inherited vase. The vase was bought decades ago from a workshop in France.

- (b) **Verb type:** IC; **Verb position:** main clause.

As we left the house, we told our son to join us at the neighborhood picnic soon. We ignored the neighbor who had dropped our newly inherited vase. The vase was bought decades ago from a workshop in France.

- (c) **Verb type:** non-IC; **Verb position:** RC.

As we left the house, we told our son to join us at the neighborhood picnic soon. The neighbor who we greeted had dropped our newly inherited vase. The vase was bought decades ago from a workshop in France.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

As we left the house, we told our son to join us at the neighborhood picnic soon. We greeted the neighbor who had dropped our newly inherited vase. The vase was bought decades ago from a workshop in France.

Question: Did we ignore the neighbor because they dropped our newly inherited vase?

9. (a) **Verb type:** IC; **Verb position:** RC.

Having just finished marking the exams, I walked into the classroom. The girl who I complimented had gotten a perfect test score. She is the smartest and most diligent student in the class.

- (b) **Verb type:** IC; **Verb position:** main clause.

Having just finished marking the exams, I walked into the classroom. I complimented the girl who had gotten a perfect test score. She is the smartest and most diligent student in the class.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Having just finished marking the exams, I walked into the classroom. The girl who I saw had gotten a perfect test score. She is the smartest and most diligent student in the class.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Having just finished marking the exams, I walked into the classroom. I saw the girl who had gotten a perfect test score. She is the smartest and most diligent student in the class.

Question: Did I compliment the girl because she had gotten a perfect test score?

10. (a) **Verb type:** IC; **Verb position:** RC.

Carrying a huge bowl of potato chips, I entered the room where the birthday party was taking place. The girl who I scolded had thrown a pair of scissors. Luckily, she didn't hurt anybody.

- (b) **Verb type:** IC; **Verb position:** main clause.

Carrying a huge bowl of potato chips, I entered the room where the birthday party was taking place. I scolded the girl who had thrown a pair of scissors. Luckily, she didn't hurt anybody.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Carrying a huge bowl of potato chips, I entered the room where the birthday party was taking place. The girl who I saw had thrown a pair of scissors. Luckily, she didn't hurt anybody.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Carrying a huge bowl of potato chips, I entered the room where the birthday party was taking place. I saw the girl who had thrown a pair of scissors. Luckily, she didn't hurt anybody.

Question: Did I scold the girl because she had thrown a pair of scissors?

11. (a) **Verb type:** IC; **Verb position:** RC.

During her visit to Morningside Hospital, Emma got to meet almost the entire hospital staff. The doctor who she trusted had received a prestigious award. Every staff in the hospital respect this doctor.

- (b) **Verb type:** IC; **Verb position:** main clause.

During her visit to Morningside Hospital, Emma got to meet almost the entire

hospital staff. She trusted the doctor who had received a prestigious award.
Every staff in the hospital respect this doctor.

- (c) **Verb type:** non-IC; **Verb position:** RC.

During her visit to Morningside Hospital, Emma got to meet almost the entire hospital staff. The doctor who she knew had received a prestigious award.
Every staff in the hospital respect this doctor.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

During her visit to Morningside Hospital, Emma got to meet almost the entire hospital staff. She knew the doctor who had received a prestigious award.
Every staff in the hospital respect this doctor.

Question: Did Emma trust the doctor because he had received a prestigious award?

12. (a) **Verb type:** IC; **Verb position:** RC.

Natalie had to go to the hospital soon to have her cast removed. The doctor who she distrusted had messed up the procedure last time. The mistake the doctor made last time almost made Natalie lose her arm.

- (b) **Verb type:** IC; **Verb position:** main clause.

Natalie had to go to the hospital soon to have her cast removed. She distrusted the doctor who had messed up the procedure last time. The mistake the doctor made last time almost made Natalie lose her arm.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Natalie had to go to the hospital soon to have her cast removed. The doctor who she knew had messed up the procedure last time. The mistake the doctor made last time almost made Natalie lose her arm.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Natalie had to go to the hospital soon to have her cast removed. She knew the doctor who had messed up the procedure last time. The mistake the doctor made last time almost made Natalie lose her arm.

Question: Did Natalie distrust the doctor because he had messed up the procedure last time?

13. (a) **Verb type:** IC; **Verb position:** RC.

Aaron kept in touch with most of his mother's seven sisters. The aunt who he respected worked for Doctors without Borders. She had devoted herself to the career after graduating from medical school.

- (b) **Verb type:** IC; **Verb position:** main clause.

Aaron kept in touch with most of his mother's seven sisters. He respected the aunt who worked for Doctors without Borders. She had devoted herself to the career after graduating from medical school.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Aaron kept in touch with most of his mother's seven sisters. The aunt who he carpooled with worked for Doctors without Borders. She had devoted herself to the career after graduating from medical school.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Aaron kept in touch with most of his mother's seven sisters. He carpooled with the aunt who worked for Doctors without Borders. She had devoted herself to the career after graduating from medical school.

Question: Did Aaron respect his aunt because she worked for Doctors without Borders?

14. (a) **Verb type:** IC; **Verb position:** RC.

Oliver had to attend his family reunion every single year. The aunt who he condemned had punched her care-taker on several occasions. There was one time the aunt punched her care-taker in the nose.

- (b) **Verb type:** IC; **Verb position:** main clause.

Oliver had to attend his family reunion every single year. He condemned the aunt who had punched her care-taker on several occasions. There was one time the aunt punched her care-taker in the nose.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Oliver had to attend his family reunion every single year. The aunt who he carpooled with had punched her care-taker on several occasions. There was one time the aunt punched her care-taker in the nose.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Oliver had to attend his family reunion every single year. He carpooled with the aunt who had punched her care-taker on several occasions. There was one time the aunt punched her care-taker in the nose.

Question: Did Oliver condemn his aunt because she had punched her care-taker on several occasions?

15. (a) **Verb type:** IC; **Verb position:** RC.

Ms. Roberts entered the classroom. The boy who she rewarded had volunteered to sweep the floor. It was the third time that the boy volunteered to clean up the classroom.

- (b) **Verb type:** IC; **Verb position:** main clause.

Ms. Roberts entered the classroom. She rewarded the boy who had volunteered to sweep the floor. It was the third time that the boy volunteered to clean up the classroom.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Ms. Roberts entered the classroom. The boy who she recognized had volunteered to sweep the floor. It was the third time that the boy volunteered to clean up the classroom.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Ms. Roberts entered the classroom. She recognized the boy who had volunteered to sweep the floor. It was the third time that the boy volunteered to clean up the classroom.

Question: Did Ms. Roberts reward the boy because he had volunteered to sweep the floor?

16. (a) **Verb type:** IC; **Verb position:** RC.

Ms. Walker was called into one of her colleague's classrooms. The boy who she punished had stolen a pencil case. He has apologized and promised not to do it again.

- (b) **Verb type:** IC; **Verb position:** main clause.

Ms. Walker was called into one of her colleague's classrooms. She punished the boy who had stolen a pencil case. He has apologized and promised not to do it again.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Ms. Walker was called into one of her colleague's classrooms. The boy who she recognized had stolen a pencil case. He has apologized and promised not to do it again.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Ms. Walker was called into one of her colleague's classrooms. She recognized the boy who had stolen a pencil case. He has apologized and promised not to do it again.

Question: Did Ms. Walker punish the boy because he had stolen a pencil case?

17. (a) **Verb type:** IC; **Verb position:** RC.

Ginny opened the door to let in three of her father's brothers. The uncle who she love always bought amazing presents. This time he brought Ginny a piece of butterfly amber.

- (b) **Verb type:** IC; **Verb position:** main clause.

Ginny opened the door to let in three of her father's brothers. She loved the uncle who always bought amazing presents. This time he brought Ginny a piece of butterfly amber.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Ginny opened the door to let in three of her father's brothers. The uncle who she resembled always bought amazing presents. This time he brought Ginny a

piece of butterfly amber.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Ginny opened the door to let in three of her father's brothers. She resembled the uncle who always bought amazing presents. This time he brought Ginny a piece of butterfly amber.

Question: Did Ginny love her uncle because he always bought amazing presents?

18. (a) **Verb type:** IC; **Verb position:** RC.

At dinner, Suzie told her best friend about her family members. The uncle who she hated forgot about her 30th birthday party. They haven't seen each other for many years.

- (b) **Verb type:** IC; **Verb position:** main clause.

At dinner, Suzie told her best friend about her family members. She hated the uncle who forgot about her 30th birthday party. They haven't seen each other for many years.

- (c) **Verb type:** non-IC; **Verb position:** RC.

At dinner, Suzie told her best friend about her family members. The uncle who she resembled forgot about her 30th birthday party. They haven't seen each other for many years.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

At dinner, Suzie told her best friend about her family members. She resembled the uncle who forgot about her 30th birthday party. They haven't seen each other for many years.

Question: Did Suzie hate her uncle because he forgot about her 30th birthday party?

19. (a) **Verb type:** IC; **Verb position:** RC.

Caroline attended an election rally in her home state. The congressman who she applauded passed the bipartisan bill. It was a momentous occasion marked a significant step towards positive change.

- (b) **Verb type:** IC; **Verb position:** main clause.

Caroline attended an election rally in her home state. She applauded the congressman who passed the bipartisan bill. It was a momentous occasion marked a significant step towards positive change.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Caroline attended an election rally in her home state. The congressman who she ran into passed the bipartisan bill. It was a momentous occasion marked a significant step towards positive change.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Caroline attended an election rally in her home state. She ran into the congressman who passed the bipartisan bill. It was a momentous occasion marked a significant step towards positive change.

Question: Did Caroline applaud the congressman because he passed the bipartisan bill?

20. (a) **Verb type:** IC; **Verb position:** RC.

On her trip to Washington D.C., Tara spent a lot of time around politicians. The congressman who she reassured lost the most recent election. On the last day, Tara saw the Vice-President walking out of a restaurant.

- (b) **Verb type:** IC; **Verb position:** main clause.

On her trip to Washington D.C., Tara spent a lot of time around politicians. She reassured the congressman who lost the most recent election. On the last day, Tara saw the Vice-President walking out of a restaurant.

- (c) **Verb type:** non-IC; **Verb position:** RC.

On her trip to Washington D.C., Tara spent a lot of time around politicians. The congressman who she ran into lost the most recent election. On the last day, Tara saw the Vice-President walking out of a restaurant.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

On her trip to Washington D.C., Tara spent a lot of time around politicians.

She ran into the congressman who lost the most recent election. On the last day, Tara saw the Vice-President walking out of a restaurant.

Question: Did Tara reassure the congressman because he lost the most recent election?

21. (a) **Verb type:** IC; **Verb position:** RC.

Jake looked out of the airplane window and noticed they were already flying over the Atlantic Ocean. The stewardess who he envied got to stay in Paris for the weekend. The sight of the vast expanse of blue stretching out beneath him filled him with excitement.

- (b) **Verb type:** IC; **Verb position:** main clause.

Jake looked out of the airplane window and noticed they were already flying over the Atlantic Ocean. He envied the stewardess who got to stay in Paris for the weekend. The sight of the vast expanse of blue stretching out beneath him filled him with excitement.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Jake looked out of the airplane window and noticed they were already flying over the Atlantic Ocean. The stewardess who he talked to got to stay in Paris for the weekend. The sight of the vast expanse of blue stretching out beneath him filled him with excitement.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Jake looked out of the airplane window and noticed they were already flying over the Atlantic Ocean. He talked to the stewardess who got to stay in Paris for the weekend. The sight of the vast expanse of blue stretching out beneath him filled him with excitement.

Question: Did Jake envy the stewardess because she got to stay in Paris for the weekend?

22. (a) **Verb type:** IC; **Verb position:** RC.

After dropping off his suitcase and passing through security, Geoff headed for

the gate. The stewardess who he ridiculed crashed the drink cart into the wall.
The accident she made caused the plane to be delayed for half an hour.

- (b) **Verb type:** IC; **Verb position:** main clause.

After dropping off his suitcase and passing through security, Geoff headed for the gate. He ridiculed the stewardess who crashed the drink cart into the wall.
The accident she made caused the plane to be delayed for half an hour.

- (c) **Verb type:** non-IC; **Verb position:** RC.

After dropping off his suitcase and passing through security, Geoff headed for the gate. The stewardess who he talked to crashed the drink cart into the wall.
The accident she made caused the plane to be delayed for half an hour.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

After dropping off his suitcase and passing through security, Geoff headed for the gate. He talked to the stewardess who crashed the drink cart into the wall.
The accident she made caused the plane to be delayed for half an hour.

Question: Did Geoff ridicule the stewardess because she crashed the drink cart into the wall?

23. (a) **Verb type:** IC; **Verb position:** RC.

At the annual charity event, Mrs. Miller talked freely about her relationship with her staff. The gardener who she valued took special care of her tulips.
These tulips bloom each spring with vibrant colors.

- (b) **Verb type:** IC; **Verb position:** main clause.

At the annual charity event, Mrs. Miller talked freely about her relationship with her staff. She valued the gardener who took special care of her tulips.
These tulips bloom each spring with vibrant colors.

- (c) **Verb type:** non-IC; **Verb position:** RC.

At the annual charity event, Mrs. Miller talked freely about her relationship with her staff. The gardener who she gossiped with took special care of her tulips. These tulips bloom each spring with vibrant colors.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

At the annual charity event, Mrs. Miller talked freely about her relationship with her staff. She gossiped with the gardener who took special care of her tulips. These tulips bloom each spring with vibrant colors.

Question: Did Mrs. Miller value the gardener because he took special care of her tulips?

24. (a) **Verb type:** IC; **Verb position:** RC.

Lady Thompson was hosting an afternoon of bridge while her landscaping crew worked in the garden. The gardener who she loathed always traipsed his muddy shoes through the house. Every time after the gardener walked through the house, Lady Thompson would find muddy footprints on her pristine marble floors.

- (b) **Verb type:** IC; **Verb position:** main clause.

Lady Thompson was hosting an afternoon of bridge while her landscaping crew worked in the garden. She loathed the gardener who always traipsed his muddy shoes through the house. Every time after the gardener walked through the house, Lady Thompson would find muddy footprints on her pristine marble floors.

- (c) **Verb type:** non-IC; **Verb position:** RC.

Lady Thompson was hosting an afternoon of bridge while her landscaping crew worked in the garden. The gardener who she gossiped with always traipsed his muddy shoes through the house. Every time after the gardener walked through the house, Lady Thompson would find muddy footprints on her pristine marble floors.

- (d) **Verb type:** non-IC; **Verb position:** main clause.

Lady Thompson was hosting an afternoon of bridge while her landscaping crew worked in the garden. She gossiped with the gardener who always traipsed his muddy shoes through the house. Every time after the gardener walked through

the house, Lady Thompson would find muddy footprints on her pristine marble floors.

Question: Did Lady Thompson loath the gardener because he always traipsed his muddy shoes through the house?

Experiment 2

- Region-by-region self-paced reading task
 - 24 experimental items and four conditions in this task were the same as those in Experiment 1
 - Each experimental item was divided into six regions; e.g.,
 - (i) Andrew looked over the crowd that * had assembled in the company lounge. *
He {talked to/admired} the woman who * had built a successful career in sales.
* She arrived at the conference room * just in time for her next meeting.
 - (ii) Andrew looked over the crowd that * had assembled in the company lounge. *
The woman who he {talked to/admired} * had built a successful career in sales.
* She arrived at the conference room * just in time for her next meeting.
- Asterisks marks boundaries. The underlined part is the critical region.

B Experimental items for Article 2

Self-paced reading task

- Conditions: Verb type {IC, non-IC} × Intervening sentence {subordination, coordination}
- 36 experimental items
- Sentence-by-sentence self-paced reading. The underlined part is the target sentence.

1. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Bill manages many international employees. This morning he talked to Jenny.
Jenny then walked into her office. She had been embezzling money for years.
It was big news for everyone.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Bill manages many international employees. This morning he talked to Jenny.
Jenny is Austrian. She had been embezzling money for years. It was big news
for everyone.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Bill manages many international employees. This morning he fired Jenny.
Jenny then walked into her office. She had been embezzling money for years.
It was big news for everyone.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Bill manages many international employees. This morning he fired Jenny.
Jenny is Austrian. She had been embezzling money for years. It was big news
for everyone.

Question: Had Bill been embezzling money for years?

2. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Everyone in the company attended the quarterly review meeting. Lucy praised Bob at the beginning of the meeting. Bob then sat down. He had made a lot of money for the company. People guessed he would get a promotion soon.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Everyone in the company attended the quarterly review meeting. Lucy praised Bob at the beginning of the meeting. Bob was a new employee. He had made a lot of money for the company. People guessed he would get a promotion soon.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Everyone in the company attended the quarterly review meeting. Lucy chatted with Bob at the beginning of the meeting. Bob then sat down. He had made a lot of money for the company. People guessed he would get a promotion soon.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Everyone in the company attended the quarterly review meeting. Lucy chatted with Bob at the beginning of the meeting. Bob was a new employee. He had made a lot of money for the company. People guessed he would get a promotion soon.

3. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Andrew was sitting in the classroom with Amy. He studied with Amy. Amy is his classmate. She had just failed an exam. She was very upset about it.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Andrew was sitting in the classroom with Amy. He comforted Amy. Amy then borrowed a pen from him. She had just failed an exam. She was very upset about it.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Andrew was sitting in the classroom with Amy. He comforted Amy. Amy is his classmate. She had just failed an exam. She was very upset about it.

- (d) **Verb type:** non-IC; **Intervening sentence:** coordination.

Andrew was sitting in the classroom with Amy. He studied with Amy. Amy then borrowed a pen from him. She had just failed an exam. She was very upset about it.

4. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mary hang out with several friends at the party yesterday. She hugged Jay. Jay then went to the restroom. He had slipped while going down the stairs. But luckily, he was not injured.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mary hang out with several friends at the party yesterday. She hugged Jay. Jay is from the same city as her. He had slipped while going down the stairs. But luckily, he was not injured.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Mary hang out with several friends at the party yesterday. She laughed at Jay. Jay is from the same city as her. He had slipped while going down the stairs. But luckily, he was not injured.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Mary hang out with several friends at the party yesterday. She laughed at Jay. Jay then went to the restroom. He had slipped while going down the stairs. But luckily, he was not injured.

Question: Did Mary went to a party yesterday?

5. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Joseph was very excited to be seeing so many of his favorite artists. He congratulated Lily. Lily then stood up. She had won a prestigious prize. Joseph was happy for her.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Joseph was very excited to be seeing so many of his favorite artists. He joked

with Lily. Lily is a British musician. She had won a prestigious prize. Joseph was happy for her.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Joseph was very excited to be seeing so many of his favorite artists. He joked with Lily. Lily then stood up. She had won a prestigious prize. Joseph was happy for her.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Joseph was very excited to be seeing so many of his favorite artists. He congratulated Lily. Lily is a British musician. She had won a prestigious prize. Joseph was happy for her.

6. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Rachel was sitting in the living room. She criticized Paul. Paul then left the house. He always smoked in the bedroom. He ultimately promised that he would not do it again.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Rachel was sitting in the living room. She smiled at Paul. Paul was her new housemate. He always smoked in the bedroom. He ultimately promised that he would not do it again.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Rachel was sitting in the living room. She criticized Paul. Paul was her new housemate. He always smoked in the bedroom. He ultimately promised that he would not do it again.

- (d) **Verb type:** non-IC; **Intervening sentence:** coordination.

Rachel was sitting in the living room. She smiled at Paul. Paul then left the house. He always smoked in the bedroom. He ultimately promised that he would not do it again.

Question: Did Paul smoke?

7. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Smith moved into a new house yesterday. He gossiped with Betty after a long day of moving in. Betty then went home. She had helped him with moving furniture. Mr Smith was grateful for it.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Smith moved into a new house yesterday. He thanked Betty after a long day of moving in. Betty is his new neighbor. She had helped him with moving furniture. Mr Smith was grateful for it.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Smith moved into a new house yesterday. He gossiped with Betty after a long day of moving in. Betty is his new neighbor. She had helped him with moving furniture. Mr Smith was grateful for it.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Smith moved into a new house yesterday. He thanked Betty after a long day of moving in. Betty then went home. She had helped him with moving furniture. Mr Smith was grateful for it.

8. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Lily attended a class reunion this week. She saw Tom during the reunion. Tom then got himself some coffee. He bullied Lily a lot in school. Lily thought he should apologize to her.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Lily attended a class reunion this week. She saw Tom during the reunion. Tom was her deskmate. He bullied Lily a lot in school. Lily thought he should apologize to her.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Lily attended a class reunion this week. She ignored Tom during the reunion. Tom was her deskmate. He bullied Lily a lot in school. Lily thought he should apologize to her.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Lily attended a class reunion this week. She ignored Tom during the reunion. Tom then got himself some coffee. He bullied Lily a lot in school. Lily thought he should apologize to her.

9. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Kim has many penpals. He complimented Ashely in a recent letter. Ashely is his youngest penpal. She had won the first prize in a writing contest. It was a big achievement for her.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Kim has many penpals. He wrote to Ashely in a recent letter. Ashely then replied to him. She had won the first prize in a writing contest. It was a big achievement for her.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Kim has many penpals. He complimented Ashely in a recent letter. Ashely then replied to him. She had won the first prize in a writing contest. It was a big achievement for her.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Kim has many penpals. He wrote to Ashely in a recent letter. Ashely is his youngest penpal. She had won the first prize in a writing contest. It was a big achievement for her.

10. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ms Roberts is having a tough time teaching Year Three this year. Yesterday, she stood near Bill. Bill is one of her students. He had thrown a pair of scissors in the classroom. Luckily, no one had been hurt.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Ms Roberts is having a tough time teaching Year Three this year. Yesterday, she scolded Bill. Bill is one of her students. He had thrown a pair of scissors in the classroom. Luckily, no one had been hurt.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ms Roberts is having a tough time teaching Year Three this year. Yesterday, she stood near Bill. Bill then went to the cafeteria. He had thrown a pair of scissors in the classroom. Luckily, no one had been hurt.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Ms Roberts is having a tough time teaching Year Three this year. Yesterday, she scolded Bill. Bill then went to the cafeteria. He had thrown a pair of scissors in the classroom. Luckily, no one had been hurt.

11. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr White is a primary school teacher. Last week, he played with Jane. Jane then left to get some water. She had stolen a pen from her deskmate. She felt guilty about it.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr White is a primary school teacher. Last week, he played with Jane. Jane is a fifth year student. She had stolen a pen from her deskmate. She felt guilty about it.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Mr White is a primary school teacher. Last week, he penalized Jane. Jane then left to get some water. She had stolen a pen from her deskmate. She felt guilty about it.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Mr White is a primary school teacher. Last week, he penalized Jane. Jane is a fifth year student. She had stolen a pen from her deskmate. She felt guilty about it.

Question: Is Mr White a teacher?

12. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

The auditorium was filled with people. Ms Green bumped into Ben after the performance. Ben then walked out. He had behaved himself during today's performance. Ms Green was proud of him.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

The auditorium was filled with people. Ms Green rewarded Ben after the performance. Ben is the second chair violinist. He had behaved himself during today's performance. Ms Green was proud of him.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

The auditorium was filled with people. Ms Green rewarded Ben after the performance. Ben then walked out. He had behaved himself during today's performance. Ms Green was proud of him.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

The auditorium was filled with people. Ms Green bumped into Ben after the performance. Ben is the second chair violinist. He had behaved himself during today's performance. Ms Green was proud of him.

13. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Johnson was caught up in some family drama. He talked to Luna. Luna is his niece. She had verbally abused her little sister this morning. Everyone was shocked by her words.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Johnson was caught up in some family drama. He condemned Luna. Luna is his niece. She had verbally abused her little sister this morning. Everyone was shocked by her words.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Johnson was caught up in some family drama. He condemned Luna. Luna then ran away from home. She had verbally abused her little sister this morning. Everyone was shocked by her words.

- (d) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Johnson was caught up in some family drama. He talked to Luna. Luna then ran away from home. She had verbally abused her little sister this morning. Everyone was shocked by her words.

14. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ms Walker worked in the same department with William. She met William at the end of the day. William was new to the company. He was worried about meeting the project deadline. He couldn't even fall asleep because of it.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ms Walker worked in the same department with William. She met William at the end of the day. William then left the office. He was worried about meeting the project deadline. He couldn't even fall asleep because of it.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Ms Walker worked in the same department with William. She reassured William at the end of the day. William then left the office. He was worried about meeting the project deadline. He couldn't even fall asleep because of it.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Ms Walker worked in the same department with William. She reassured William at the end of the day. William was new to the company. He was worried about meeting the project deadline. He couldn't even fall asleep because of it.

Question: Were Ms Walker and William colleagues?

15. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

The client appreciation party organizers were busy in the hall. Paul sat next to Daisy. Daisy then left the party. She had forgotten to send out the invitations to several important clients. She felt embarrassed and guilty.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

The client appreciation party organizers were busy in the hall. Paul blamed Daisy in the corner of the hall. Daisy then left the party. She had forgotten to send out the invitations to several important clients. She felt embarrassed and guilty.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

The client appreciation party organizers were busy in the hall. Paul blamed

Daisy. Daisy was acting as maternity cover. She had forgotten to send out the invitations to several important clients. She felt embarrassed and guilty.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

The client appreciation party organizers were busy in the hall. Paul sat next to Daisy. Daisy was acting as maternity cover. She had forgotten to send out the invitations to several important clients. She felt embarrassed and guilty.

16. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Sally is a policewoman. She visited Jack yesterday. Jack is a local resident. He had been selling drugs in the block for years. Most of the local residents despise him.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Sally is a policewoman. She arrested Jack yesterday. Jack then contacted his lawyers. He had been selling drugs in the block for years. Most of the local residents despise him.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Sally is a policewoman. She visited Jack yesterday. Jack then contacted his lawyers. He had been selling drugs in the block for years. Most of the local residents despise him.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Sally is a policewoman. She arrested Jack yesterday. Jack is a local resident. He had been selling drugs in the block for years. Most of the local residents despise him.

Question: Do local residents like Jack?

17. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Lee was helping the football team off the bus. He ran into Grace on the step. Grace then goodbyed to him. She had been badly hurt. Everyone was worried about her.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Lee was helping the football team off the bus. He carried Grace down the steps. Grace is the manager of the team. She had been badly hurt. Everyone was worried about her.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Lee was helping the football team off the bus. He carried Grace down the steps. Grace then goodbyed to him. She had been badly hurt. Everyone was worried about her.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Lee was helping the football team off the bus. He ran into Grace on the step. Grace is the manager of the team. She had been badly hurt. Everyone was worried about her.

18. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ava attended a symposium yesterday. She spoke to Mr Paulson during the coffee break. Mr Paulson is a famous pianist. He had tripped as he walked onto the stage. Everyone was surprised by the incident.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Ava attended a symposium yesterday. She mocked Mr Paulson during the coffee break. Mr Paulson then sat down. He had tripped as he walked onto the stage. Everyone was surprised by the incident.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ava attended a symposium yesterday. She spoke to Mr Paulson during the coffee break. Mr Paulson then sat down. He had tripped as he walked onto the stage. Everyone was surprised by the incident.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Ava attended a symposium yesterday. She mocked Mr Paulson during the coffee break. Mr Paulson is a famous diplomat. He had tripped as he walked onto the stage. Everyone was surprised by the incident.

19. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Lady Hill is leading a charity fund for children. Last month, she fired Freddie. Freddie had been in the the team for five years. He had been caught stealing from the charity fund. He disappointed everyone.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Lady Hill is leading a charity fund for children. Last month, she emailed Freddie. Freddie then messaged her. He had been caught stealing from the charity fund. He disappointed everyone.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

Lady Hill is leading a charity fund for children. Last month, she emailed Freddie. Freddie had been in the the team for five years. He had been caught stealing from the charity fund. He disappointed everyone.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Lady Hill is leading a charity fund for children. Last month, she fired Freddie. Freddie then messaged her. He had been caught stealing from the charity fund. He disappointed everyone.

Question: Was Freddie an honest staff?

20. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Brown was hosting a global company meeting. He praised Evelyn during the break. Evelyn is based in London. She had produced an extraordinary report for the meeting. She might even get a promotion because of it.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Brown was hosting a global company meeting. He praised Evelyn during the break. Evelyn then took her seat. She had produced an extraordinary report for the meeting. She might even get a promotion because of it.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Brown was hosting a global company meeting. He chatted with Evelyn during the break. Evelyn then took her seat. She had produced an extraordinary

report for the meeting. She might even get a promotion because of it.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Brown was hosting a global company meeting. He chatted with Evelyn during the break. Evelyn is based in London. She had produced an extraordinary report for the meeting. She might even get a promotion because of it.

21. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Mrs Wood was waiting for Mr Wood at home. She comforted Mr Wood when he arrived. Mr Wood then went to sleep. He had just lost his mother. He was deeply saddened.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mrs Wood was waiting for Mr Wood at home. She hugged Mr Wood when he arrived. Mr Wood then went to sleep. He had just lost his mother. He was deeply saddened.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Mrs Wood was waiting for Mr Wood at home. She comforted Mr Wood when he arrived. Mr Wood had just traveled back from the hospital. He had just lost his mother. He was deeply saddened.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mrs Wood was waiting for Mr Wood at home. She hugged Mr Wood when he arrived. Mr Wood had just traveled back from the hospital. He had just lost his mother. He was deeply saddened.

22. (a) **Verb type:** IC; **Intervening sentence:** subordination.

It was a busy morning on set. Mr Jones laughed at Victoria. Victoria is an actress. She was wearing two different shoes by mistake. She was embarrassed.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

It was a busy morning on set. Mr Jones met Victoria. Victoria then went to work. She was wearing two different shoes by mistake. She was embarrassed.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

It was a busy morning on set. Mr Jones laughed at Victoria. Victoria then went to work. She was wearing two different shoes by mistake. She was embarrassed.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

It was a busy morning on set. Mr Jones met Victoria. Victoria is an actress. She was wearing two different shoes by mistake. She was embarrassed.

Question: Was Mr Jones embarrassed?

23. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Linda saw several students outside a theater. She congratulated Roy. Roy is a hard-working student. He had graduated with distinction. It was a huge achievement.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Linda saw several students outside a theater. She congratulated Roy. Roy then walked into the theater. He had graduated with distinction. It was a huge achievement.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Linda saw several students outside a theater. She joked with Roy. Roy then walked into the theater. He had graduated with distinction. It was a huge achievement.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Linda saw several students outside a theater. She joked with Roy. Roy is a hard-working student. He had graduated with distinction. It was a huge achievement.

24. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

There was a marathon race last weekend. Geoff smiled at Natalie after the race. Natalie then got herself some water. She was the last one to finish the race. But she had tried her best.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

There was a marathon race last weekend. Geoff criticized Natalie after the race. Natalie was covered in sweat. She was the last one to finish the race. But she had tried her best.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

There was a marathon race last weekend. Geoff smiled at Natalie after the race. Natalie covered in sweat. She was the last one to finish the race. But she had tried her best.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

There was a marathon race last weekend. Geoff criticized Natalie after the race. Natalie then got herself some water. She was the last one to finish the race. But she had tried her best.

Question: Did Geoff quit halfway through the race?

25. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ms Johnson has been interested in investment recently. This afternoon, she gossiped with Victor. Victor then went to work. He had told her about an amazing investment opportunity. Victor is such a nice person.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ms Johnson has been interested in investment recently. This afternoon, she gossiped with Victor. Victor is a business analyst. He had told her about an amazing investment opportunity. Victor is such a nice person.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Ms Johnson has been interested in investment recently. This afternoon, she thanked Victor. Victor then went to work. He had told her about an amazing investment opportunity. Victor is such a nice person.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Ms Johnson has been interested in investment recently. This afternoon, she thanked Victor. Victor is a business analyst. He had told her about an amazing

investment opportunity. Victor is such a nice person.

26. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mike and Nina were enrolled in the same course. Mike studied with Nina after the course. Nina is his old acquaintance. She had been spreading rumors about him. These rumors bothered Mike a lot.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Mike and Nina were enrolled in the same course. Mike ignored Nina after the course. Nina then left the classroom. She had been spreading rumors about him. These rumors bothered Mike a lot.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Mike and Nina were enrolled in the same course. Mike ignored Nina after the course. Nina is his old acquaintance. She had been spreading rumors about him. These rumors bothered Mike a lot.

- (d) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mike and Nina were enrolled in the same course. Mike studied with Nina after the course. Nina then left the classroom. She had been spreading rumors about him. These rumors bothered Mike a lot.

Question: Did Mike ignore the rumors?

27. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Ms Wong was doing her morning emails to her employees. She complimented Arthur in one email. Arthur had just joined the company recently. He had done an outstanding job on his project. He deserved the compliment.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ms Wong was doing her morning emails to her employees. She wrote to Arthur in one email. Arthur then replied to her. He had done an outstanding job on his project. He deserved the compliment.

- (c) **Verb type:** IC; **Intervening sentence:** coordination.

Ms Wong was doing her morning emails to her employees. She complimented

Arthur in one email. Arthor then replied to her. He had done an outstanding job on his project. He deserved the compliment.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ms Wong was doing her morning emails to her employees. She wrote to Arthur in one email. Arthor had just joined the company recently. He had done an outstanding job on his project. He deserved the compliment.

28. (a) **Verb type:** non-IC; **Intervening sentence:** subordination.

It was about time for lunch. Charles stood near Ava. Ava is in his team. She failed to complete her assigned tasks on time. She apologized and promised to make up for it.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

It was about time for lunch. Charles stood near Ava. Ava then went to the hall. She failed to complete her assigned tasks on time. She apologized and promised to make up for it.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

It was about time for lunch. Charles scolded Ava. Ava is in his team. She failed to complete her assigned tasks on time. She apologized and promised to make up for it.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

It was about time for lunch. Charles scolded Ava. Ava then went to the hall. She failed to complete her assigned tasks on time. She apologized and promised to make up for it.

Question: Did Ava complete his assigned task in advance?

29. (a) **Verb type:** IC; **Intervening sentence:** coordination.

The class had just ended. Ms Moore had penalized Thomas. Thomas then went home. He had cheated on the in-class quiz. He was regretful about his behavior.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

The class had just ended. Ms Moore played with Thomas. Thomas then went home. He had cheated on the in-class quiz. He was regretful about his behavior.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

The class had just ended. Ms Moore played with Thomas. Thomas is a second year student. He had cheated on the in-class quiz. He was regretful about his behavior.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

The class had just ended. Ms Moore had penalized Thomas. Thomas is a second year student. He cheated on the in-class quiz. He was regretful about his behavior.

30. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Mr Hall was returning exam papers to his students. He rewarded Isabella. Isabella then stood up. She had achieved the highest score in the class. She is a talented student.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Mr Hall was returning exam papers to his students. He bumped into Isabella's desk. Isabella then stood up. She had achieved the highest score in the class. She is a talented student.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

Mr Hall was returning exam papers to his students. He rewarded Isabella. Isabella is one of his students. She had achieved the highest score in the class. She is a talented student.

- (d) **Verb type:** non-IC; **Intervening sentence:** subordination.

Mr Hall was returning exam papers to his students. He bumped into Isabella's desk. Isabella is one of his students. She had achieved the highest score in the class. She is a talented student.

31. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Ms Miller works at a local company. This morning, she condemned George. George is an old employee. He had hired a stripper for the company party. It was very offensive to other colleagues.

- (b) **Verb type:** IC; **Intervening sentence:** coordination.

Ms Miller works at a local company. This morning, she condemned George. George then walked into his office. He had hired a stripper for the company party. It was very offensive to other colleagues.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

Ms Miller works at a local company. This morning, she emailed George. George is an old employee. He had hired a stripper for the company party. It was very offensive to other colleagues.

- (d) **Verb type:** non-IC; **Intervening sentence:** coordination.

Ms Miller works at a local company. This morning, she emailed George. George then walked into his office. He had hired a stripper for the company party. It was very offensive to other colleagues.

32. (a) **Verb type:** IC; **Intervening sentence:** coordination.

The office buzzed with activity as colleagues moved in and out. Theodore reassured Clara. Clara then walked into the boardroom. She had been feeling anxious about her upcoming presentation. It is an important presentation for her.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

The office buzzed with activity as colleagues moved in and out. Theodore visited Clara. Clara is a new staff. She had been feeling anxious about her upcoming presentation. It is an important presentation for her.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

The office buzzed with activity as colleagues moved in and out. Theodore visited Clara. Clara then walked into the boardroom. She had been feeling anxious about her upcoming presentation. It is an important presentation for

her.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

The office buzzed with activity as colleagues moved in and out. Theodore reassured Clara. Clara is a new staff. She had been feeling anxious about her upcoming presentation. It is an important presentation for her.

33. (a) **Verb type:** IC; **Intervening sentence:** coordination.

Charlotte was meeting her project group in a café. Before they started, she blamed Lucas. Lucas then ordered some coffee. He had forgotten to complete his part of the group project. He was very sorry for that.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

Charlotte was meeting her project group in a café. Before they started, she sat next to Lucas. Lucas was working with her. He had forgotten to complete his part of the group project. He was very sorry for that.

- (c) **Verb type:** non-IC; **Intervening sentence:** coordination.

Charlotte was meeting her project group in a café. Before they started, she sat next to Lucas. Lucas then ordered some coffee. He had forgotten to complete his part of the group project. He was very sorry for that.

- (d) **Verb type:** IC; **Intervening sentence:** subordination.

Charlotte was meeting her project group in a café. Before they started, she blamed Lucas. Lucas was working with her. He had forgotten to complete his part of the group project. He was very sorry for that.

34. (a) **Verb type:** IC; **Intervening sentence:** subordination.

Officer Anderson was patrolling the streets. He arrested Alexa outside a store. Alexa is a teenager. She had been caught shoplifting by the cashier. But the store owner decided not to press charges.

- (b) **Verb type:** non-IC; **Intervening sentence:** coordination.

Officer Anderson was patrolling the streets. He saw Alexa outside a store.

Alexa then asked for some water. She had been caught shoplifting by the cashier. But the store owner decided not to press charges.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

Officer Anderson was patrolling the streets. He saw Alexa outside a store. Alexa is a teenager. She had been caught shoplifting from a nearby store by the cashier. But the store owner decided not to press charges.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Officer Anderson was patrolling the streets. He arrested Alexa outside a store. Alexa then asked for some water. She had been caught shoplifting by the cashier. But the store owner decided not to press charges.

35. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

The students were very excited about recess. Sue ran into Aaron on the playground. Aaron then played in the sandbox. He had twisted his ankle while playing soccer. He couldn't walk on his own.

- (b) **Verb type:** non-IC; **Intervening sentence:** subordination.

The students were very excited about recess. Sue ran into Aaron on the playground. Aaron is a young athlete. He had twisted his ankle while playing soccer. He couldn't walk on his own.

- (c) **Verb type:** IC; **Intervening sentence:** subordination.

The students were very excited about recess. Sue carried Aaron into the playground. Aaron is a young athlete. He had twisted his ankle while playing soccer. He couldn't walk on his own.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

The students were very excited about recess. Sue carried Aaron into the playground. Aaron then played in the sandbox. He had twisted his ankle while playing soccer. He couldn't walk on his own.

36. (a) **Verb type:** non-IC; **Intervening sentence:** coordination.

Oscar attended a rehearsal last night which included a number of people he

knew. He spoke to Ada during the break. Ada then stood up. She had forgotten the lyrics to one of her songs. However, few people noticed her mistake.

- (b) **Verb type:** IC; **Intervening sentence:** subordination.

Oscar attended a rehearsal last night which included a number of people he knew. He mocked Ada during the break. Ada is a singer. She had forgotten the lyrics to one of her songs. However, few people noticed her mistake.

- (c) **Verb type:** non-IC; **Intervening sentence:** subordination.

Oscar attended a rehearsal last night which included a number of people he knew. He spoke to Ada during the break. Ada is a singer. She had forgotten the lyrics to one of her songs. However, few people noticed her mistake.

- (d) **Verb type:** IC; **Intervening sentence:** coordination.

Oscar attended a rehearsal last night which included a number of people he knew. He mocked Ada during the break. Ada then sat down. She had forgotten the lyrics to one of her songs. However, few people noticed her mistake.

C Experimental items for Article 3

Experiment 1

- Comprehension task
- Conditions Structure {Active, Passive} $\times$ Article {Definite, Indefinite}
- 40 experimental items

1. (a) **Structure:** Active; **Article:** Definite.

Anna hit the drenched man with a water balloon outside the old yellow house.

- (b) **Structure:** Active; **Article:** Indefinite.

Anna hit a drenched man with a water balloon outside the old yellow house.

- (c) **Structure:** Passive; **Article:** Definite.

The drenched man got hit with a water balloon outside the old yellow house.

- (d) **Structure:** Passive; **Article:** Indefinite.

A drenched man got hit with a water balloon outside the old yellow house.

Question: Was the man drenched because of the water balloon?

2. (a) **Structure:** Active; **Article:** Definite.

Was the window broken because of the stone?

- (b) **Structure:** Active; **Article:** Indefinite.

Was the window broken because of the stone?

- (c) **Structure:** Passive; **Article:** Definite.

Was the window broken because of the stone?

- (d) **Structure:** Passive; **Article:** Indefinite.

Was the window broken because of the stone?

Question: Was the window broken because of the stone?

3. (a) **Structure:** Active; **Article:** Definite.

The assailant cut the bleeding man with a knife in the local park.

- (b) **Structure:** Active; **Article:** Indefinite.

The assailant cut a bleeding man with a knife in the local park.

- (c) **Structure:** Passive; **Article:** Definite.

The bleeding man got cut by a knife in the local park.

- (d) **Structure:** Passive; **Article:** Indefinite.

A bleeding man got cut by a knife in the local park.

Question: Was the man bleeding because of the knife?

4. (a) **Structure:** Active; **Article:** Definite.

Bill covered the slippery floorboard with some oil last Tuesday afternoon.

- (b) **Structure:** Active; **Article:** Indefinite.

Bill covered a slippery floorboard with some oil last Tuesday afternoon.

- (c) **Structure:** Passive; **Article:** Definite.

The slippery floorboard got covered with some oil last Tuesday afternoon.

- (d) **Structure:** Passive; **Article:** Indefinite.

A slippery floorboard got covered with some oil last Tuesday afternoon.

Question: Was the floorboard slippery because of the oil?

5. (a) **Structure:** Active; **Article:** Definite.

Andy punctured the flat tyre with a nail this morning accidentally.

- (b) **Structure:** Active; **Article:** Indefinite.

Andy punctured a flat tyre with a nail this morning accidentally.

- (c) **Structure:** Passive; **Article:** Definite.

The flat tyre got punctured by a nail this morning accidentally.

- (d) **Structure:** Passive; **Article:** Indefinite.

A flat tyre got punctured by a nail this morning accidentally.

Question: Was the tyre flat because of the nail?

6. (a) **Structure:** Active; **Article:** Definite.

Amy sprayed the damp lawn with some water before the sunrise.

- (b) **Structure:** Active; **Article:** Indefinite.

Amy sprayed a damp lawn with some water before the sunrise.

- (c) **Structure:** Passive; **Article:** Definite.

The damp lawn got sprayed with some water before the sunrise.

- (d) **Structure:** Passive; **Article:** Indefinite.

A damp lawn got sprayed with some water before the sunrise.

Question: Was the lawn damp because of the water?

7. (a) **Structure:** Active; **Article:** Definite.

Ben sterilized the clean pool with some bleaching powder this morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Ben sterilized a clean pool with some bleaching powder this morning.

- (c) **Structure:** Passive; **Article:** Definite.

The clean pool got sterilized with some bleaching powder this morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

A clean pool got sterilized with some bleaching powder this morning.

Question: Was the pool clean because of the bleaching powder?

8. (a) **Structure:** Active; **Article:** Definite.

Antony seasoned the spicy chicken nugget with some paprika bought from a famous restaurant.

- (b) **Structure:** Active; **Article:** Indefinite.

Antony seasoned a spicy chicken nugget with some paprika bought from a famous restaurant.

- (c) **Structure:** Passive; **Article:** Definite.

The spicy chicken nugget got seasoned with some paprika bought from a famous restaurant.

- (d) **Structure:** Passive; **Article:** Indefinite.

A spicy chicken nugget got seasoned with some paprika bought from a famous restaurant.

Question: Was the chicken nugget spicy because of the paprika?

9. (a) **Structure:** Active; **Article:** Definite.

Betty spread the sweet waffle with some jam made by fresh berries.

- (b) **Structure:** Active; **Article:** Indefinite.

Betty spread a sweet waffle with some jam made by fresh berries.

- (c) **Structure:** Passive; **Article:** Definite.

The sweet waffle got spread with some jam made by fresh berries.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sweet waffle got spread with some jam made by fresh berries.

Question: Was the waffle sweet because of the jam?

10. (a) **Structure:** Active; **Article:** Definite.

Bruce lashed the frightened horse with a whip heavily on its back.

- (b) **Structure:** Active; **Article:** Indefinite.

Bruce lashed a frightened horse with a whip heavily on its back.

- (c) **Structure:** Passive; **Article:** Definite.

The frightened horse got lashed by a whip heavily on its back.

- (d) **Structure:** Passive; **Article:** Indefinite.

A frightened horse got lashed by a whip heavily on its back.

Question: Was the horse frightened because of the whip?

11. (a) **Structure:** Active; **Article:** Definite.

The black soil nourished the growing tree with fertilizers for the whole year.

- (b) **Structure:** Active; **Article:** Indefinite.

The black soil nourished a growing tree with fertilizers for the whole year.

- (c) **Structure:** Passive; **Article:** Definite.

The growing tree got nourished with fertilizers for the whole year.

- (d) **Structure:** Passive; **Article:** Indefinite.

A growing tree got nourished with fertilizers for the whole year.

Question: Was the tree growing because of the fertilizers?

12. (a) **Structure:** Active; **Article:** Definite.

Bella roasted the cooked fish in an oven before the party.

- (b) **Structure:** Active; **Article:** Indefinite.

Bella roasted a cooked fish in an oven before the party.

- (c) **Structure:** Passive; **Article:** Definite.

The cooked fish was roasted in an oven before the party.

- (d) **Structure:** Passive; **Article:** Indefinite.

A cooked fish was roasted in an oven before the party.

Question: Was the fish cooked because of the oven?

13. (a) **Structure:** Active; **Article:** Definite.

Bob touched the contaminated needle with a dirty finger in the hospital.

- (b) **Structure:** Active; **Article:** Indefinite.

Bob touched a contaminated needle with a dirty finger in the hospital.

- (c) **Structure:** Passive; **Article:** Definite.

The contaminated needle was touched with a dirty finger in the hospital.

- (d) **Structure:** Passive; **Article:** Indefinite.

A contaminated needle was touched with a dirty finger in the hospital.

Question: Was the needle contaminated because of the dirty finger?

14. (a) **Structure:** Active; **Article:** Definite.

The cleaner polished the smooth tabletop with the sandpaper yesterday in the afternoon.

- (b) **Structure:** Active; **Article:** Indefinite.

The cleaner polished a smooth tabletop with the sandpaper yesterday in the afternoon.

- (c) **Structure:** Passive; **Article:** Definite.

The smooth tabletop got polished with the sandpaper yesterday in the afternoon.

- (d) **Structure:** Passive; **Article:** Indefinite.

A smooth tabletop got polished with the sandpaper yesterday in the afternoon.

Question: Was the tabletop smooth because of the sandpaper?

15. (a) **Structure:** Active; **Article:** Definite.

Jessica entertained the drunk man with beers after the exciting football game.

- (b) **Structure:** Active; **Article:** Indefinite.

Jessica entertained a drunk man with beers after the exciting football game.

- (c) **Structure:** Passive; **Article:** Definite.

The drunk man was entertained with beers after the exciting football game.

- (d) **Structure:** Passive; **Article:** Indefinite.

A drunk man was entertained with beers after the exciting football game.

Question: Was the man drunk because of the beers?

16. (a) **Structure:** Active; **Article:** Definite.

Cindy put the frozen fish in a freezer in the large kitchen.

- (b) **Structure:** Active; **Article:** Indefinite.

Cindy put a frozen fish in a freezer in the large kitchen.

- (c) **Structure:** Passive; **Article:** Definite.

The frozen fish was put in a freezer in the large kitchen.

- (d) **Structure:** Passive; **Article:** Indefinite.

A frozen fish was put in a freezer in the large kitchen.

Question: Was the fish frozen because of the freezer?

17. (a) **Structure:** Active; **Article:** Definite.

Brandon amused the smiling baby with a toy in the small lovely garden.

- (b) **Structure:** Active; **Article:** Indefinite.

Brandon amused a smiling baby with a toy in the small lovely garden.

- (c) **Structure:** Passive; **Article:** Definite.

The smiling baby was amused with a toy in the small lovely garden.

- (d) **Structure:** Passive; **Article:** Indefinite.

A smiling baby was amused with a toy in the small lovely garden.

Question: Was the baby smiling because of the toy?

18. (a) **Structure:** Active; **Article:** Definite.

Briant washed the clean mug with detergent and put it on the shelf.

- (b) **Structure:** Active; **Article:** Indefinite.

Briant washed a clean mug with detergent and put it on the shelf.

- (c) **Structure:** Passive; **Article:** Definite.

The clean mug was washed with detergent and put it on the shelf.

- (d) **Structure:** Passive; **Article:** Indefinite.

A clean mug was washed with detergent and put it on the shelf.

Question: Was the mug clean because of the detergent?

19. (a) **Structure:** Active; **Article:** Definite.

A call from the police devastated the distressed man with the bad news half an hour ago.

- (b) **Structure:** Active; **Article:** Indefinite.

A call from the police devastated a distressed man with the bad news half an hour ago.

- (c) **Structure:** Passive; **Article:** Definite.

The distressed man was devastated by the bad news half an hour ago.

- (d) **Structure:** Passive; **Article:** Indefinite.

A distressed man was devastated by the bad news half an hour ago.

Question: Was the man distressed because of the bad news?

20. (a) **Structure:** Active; **Article:** Definite.

The raw egg infected the sick man with a virus yesterday in a restaurant.

- (b) **Structure:** Active; **Article:** Indefinite.

The raw egg infected a sick man with a virus yesterday in a restaurant.

- (c) **Structure:** Passive; **Article:** Definite.

The sick man got infected by a virus yesterday in a restaurant.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sick man got infected by a virus yesterday in a restaurant.

Question: Was the man sick because of the virus?

21. (a) **Structure:** Active; **Article:** Definite.

Cathy balled the sheet of crumpled paper in her fist tightly and angrily.

- (b) **Structure:** Active; **Article:** Indefinite.

Cathy balled a sheet of crumpled paper in her fist tightly and angrily.

- (c) **Structure:** Passive; **Article:** Definite.

The sheet of crumpled paper was balled in her fist tightly and angrily.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sheet of crumpled paper was balled in her fist tightly and angrily.

Question: Was the sheet of paper crumpled because of the fist?

22. (a) **Structure:** Active; **Article:** Definite.

Diana decorated the red wall with paint outside the building.

- (b) **Structure:** Active; **Article:** Indefinite.

Diana decorated a red wall with paint outside the building.

- (c) **Structure:** Passive; **Article:** Definite.

The red wall got decorated with paint outside the building.

- (d) **Structure:** Passive; **Article:** Indefinite.

A red wall got decorated with paint outside the building.

Question: Was the wall red because of the paint?

23. (a) **Structure:** Active; **Article:** Definite.

Eric hit the wounded man with a sword in the video game yesterday.

- (b) **Structure:** Active; **Article:** Indefinite.

Eric hit a wounded man with a sword in the video game yesterday.

- (c) **Structure:** Passive; **Article:** Definite.

The wounded man was hit by a sword in the video game yesterday.

- (d) **Structure:** Passive; **Article:** Indefinite.

A wounded man was hit by a sword in the video game yesterday.

Question: Was the man wounded because of the sword?

24. (a) **Structure:** Active; **Article:** Definite.

The robber attacked the injured man with a gun in a remote district last night.

- (b) **Structure:** Active; **Article:** Indefinite.

The robber attacked an injured man with a gun in a remote district last night.

- (c) **Structure:** Passive; **Article:** Definite.

The injured man got attacked with a gun in a remote district last night.

- (d) **Structure:** Passive; **Article:** Indefinite.

An injured man got attacked with a gun in a remote district last night.

Question: Was the man injured because of the gun?

25. (a) **Structure:** Active; **Article:** Definite.

The bad weather trapped the delayed flight with the storm in the cold mid-night.

- (b) **Structure:** Active; **Article:** Indefinite.

The bad weather trapped a delayed flight with the storm in the cold midnight.

- (c) **Structure:** Passive; **Article:** Definite.

The delayed flight got trapped with the storm in the cold midnight.

- (d) **Structure:** Passive; **Article:** Indefinite.

A delayed flight got trapped with the storm in the cold midnight.

Question: Was the flight delayed because of the storm?

26. (a) **Structure:** Active; **Article:** Definite.

Emma crushed the minced garlic clove with the blade before the main course was ready.

- (b) **Structure:** Active; **Article:** Indefinite.

Emma crushed a minced garlic clove with the blade before the main course was ready.

- (c) **Structure:** Passive; **Article:** Definite.

The minced garlic clove was crushed by the blade before the main course was ready.

- (d) **Structure:** Passive; **Article:** Indefinite.

A minced garlic clove was crushed by the blade before the main course was ready.

Question: Was the garlic clove minced because of the blade?

27. (a) **Structure:** Active; **Article:** Definite.

Eden frightened the crying girl with a scary photo last Friday in a dimly lit room.

- (b) **Structure:** Active; **Article:** Indefinite.

Eden frightened a crying girl with a scary photo last Friday in a dimly lit room.

- (c) **Structure:** Passive; **Article:** Definite.

The crying girl got frightened with a scary photo last Friday in a dimly lit room.

- (d) **Structure:** Passive; **Article:** Indefinite.

A crying girl got frightened with a scary photo last Friday in a dimly lit room.

Question: Was the girl crying because of the scary photo?

28. (a) **Structure:** Active; **Article:** Definite.

Bill provoked the raging bull with a red rag on Tuesday on this farm.

- (b) **Structure:** Active; **Article:** Indefinite.

Bill provoked a raging bull with a red rag on Tuesday on this farm.

- (c) **Structure:** Passive; **Article:** Definite.

The raging bull got provoked by a red rag on Tuesday on this farm.

- (d) **Structure:** Passive; **Article:** Indefinite.

A raging bull got provoked by a red rag on Tuesday on this farm.

Question: Was the bull raging because of the red rag?

29. (a) **Structure:** Active; **Article:** Definite.

Gina fried the plate of crispy bacon by the pan for breakfast this morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Gina fried a plate of crispy bacon by the pan for breakfast this morning.

- (c) **Structure:** Passive; **Article:** Definite.

The plate of crispy bacon was fried by the pan for breakfast this morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

A plate of crispy bacon was fried by the pan for breakfast this morning.

Question: Was the plate of bacon crispy because of the pan?

30. (a) **Structure:** Active; **Article:** Definite.

Gwen presented the happy girl with the gift prepared for her on Christmas Eve.

- (b) **Structure:** Active; **Article:** Indefinite.

Gwen presented a happy girl with the gift prepared for her on Christmas Eve.

- (c) **Structure:** Passive; **Article:** Definite.

The happy girl was presented the gift prepared for her on Christmas Eve.

- (d) **Structure:** Passive; **Article:** Indefinite.

A happy girl was presented the gift prepared for her on Christmas Eve.

Question: Was the girl happy because of the gift?

31. (a) **Structure:** Active; **Article:** Definite.

The teacher gave the upset student a failed grade one day before the summer vacation.

- (b) **Structure:** Active; **Article:** Indefinite.

The teacher gave an upset student a failed grade one day before the summer vacation.

- (c) **Structure:** Passive; **Article:** Definite.

The upset student was given a failed grade one day before the summer vacation.

- (d) **Structure:** Passive; **Article:** Indefinite.

An upset student was given a failed grade one day before the summer vacation.

Question: Was the student upset because of the failed grade?

32. (a) **Structure:** Active; **Article:** Definite.

Sue woke the annoyed banker with rings at 10PM last weekend.

- (b) **Structure:** Active; **Article:** Indefinite.

Sue woke an annoyed banker with rings at 10PM last weekend.

- (c) **Structure:** Passive; **Article:** Definite.

The annoyed banker was woken by rings at 10PM last weekend.

- (d) **Structure:** Passive; **Article:** Indefinite.

An annoyed banker was woken by rings at 10PM last weekend.

Question: Was the banker annoyed because of the rings?

33. (a) **Structure:** Active; **Article:** Definite.

Helen cooked the sour cabbage with vinegar for guests in the kitchen.

- (b) **Structure:** Active; **Article:** Indefinite.

Helen cooked a sour cabbage with vinegar for guests in the kitchen.

- (c) **Structure:** Passive; **Article:** Definite.

The sour cabbage was cooked with vinegar for guests in the kitchen.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sour cabbage was cooked with vinegar for guests in the kitchen.

Question: Was the cabbage sour because of the vinegar?

34. (a) **Structure:** Active; **Article:** Definite.

Hannah baked the sweet cake with maple syrup for this huge celebration yesterday.

- (b) **Structure:** Active; **Article:** Indefinite.

Hannah baked a sweet cake with maple syrup for this huge celebration yesterday.

- (c) **Structure:** Passive; **Article:** Definite.

The sweet cake was baked with maple syrup for this huge celebration yesterday.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sweet cake was baked with maple syrup for this huge celebration yesterday.

Question: Was the cake sweet because of the maple syrup?

35. (a) **Structure:** Active; **Article:** Definite.

Susan washed the faded T-shirt with bleaching powder in the old washing machine.

- (b) **Structure:** Active; **Article:** Indefinite.

Susan washed a faded T-shirt with bleaching powder in the old washing machine.

- (c) **Structure:** Passive; **Article:** Definite.

The faded T-shirt was washed with bleaching powder in the old washing machine.

- (d) **Structure:** Passive; **Article:** Indefinite.

A faded T-shirt was washed with bleaching powder in the old washing machine.

Question: Was the T-shirt faded because of the bleaching powder?

36. (a) **Structure:** Active; **Article:** Definite.

Henry smudged the dirty tissue with some dirt on Friday in the corner of the meeting room.

- (b) **Structure:** Active; **Article:** Indefinite.

Henry smudged a dirty tissue with some dirt on Friday in the corner of the meeting room.

- (c) **Structure:** Passive; **Article:** Definite.

The dirty tissue got smudged with some dirt on Friday in the corner of the meeting room.

- (d) **Structure:** Passive; **Article:** Indefinite.

A dirty tissue got smudged with some dirt on Friday in the corner of the meeting room.

Question: Was the tissue dirty because of the dirt?

37. (a) **Structure:** Active; **Article:** Definite.

Iris comforted the relaxed dog with music in the Sunday afternoon in the living room.

- (b) **Structure:** Active; **Article:** Indefinite.

Iris comforted a relaxed dog with music in the Sunday afternoon in the living room.

- (c) **Structure:** Passive; **Article:** Definite.

The relaxed dog was comforted with music in the relaxing afternoon in the

living room.

- (d) **Structure:** Passive; **Article:** Indefinite.

A relaxed dog was comforted with music in the relaxing afternoon in the living room.

Question: Was the dog relaxed because of the music?

38. (a) **Structure:** Active; **Article:** Definite.

Ivy touched the burning candle with a match when it became dark and cold.

- (b) **Structure:** Active; **Article:** Indefinite.

Ivy touched a burning candle with a match when it became dark and cold.

- (c) **Structure:** Passive; **Article:** Definite.

The burning candle got touched by a match when it became dark and cold.

- (d) **Structure:** Passive; **Article:** Indefinite.

A burning candle got touched by a match when it became dark and cold.

Question: Was the candle burning because of the match?

39. (a) **Structure:** Active; **Article:** Definite.

Irene heated the boiled egg with hot water for breakfast on Monday morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Irene heated a boiled egg with hot water for breakfast on Monday morning.

- (c) **Structure:** Passive; **Article:** Definite.

The boiled egg was heated with hot water for breakfast on Monday morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

A boiled egg was heated with hot water for breakfast on Monday morning.

Question: Was the egg boiled because of the hot water?

40. (a) **Structure:** Active; **Article:** Definite.

Freddy stuffed the heavy suitcase with clothes before the flight took off.

- (b) **Structure:** Active; **Article:** Indefinite.

Freddy stuffed a heavy suitcase with clothes before the flight took off.

- (c) **Structure:** Passive; **Article:** Definite.

The heavy suitcase got stuffed with clothes before the flight took off.

- (d) **Structure:** Passive; **Article:** Indefinite.

A heavy suitcase got stuffed with clothes before the flight took off.

Question: Was the suitcase heavy because of the clothes?

Experiment 2

- Comprehension task
- Conditions Structure {Active, Passive} $\times$ Article {Definite, Indefinite}
- 40 experimental items

1. (a) **Structure:** Active; **Article:** Definite.

Bethany struck the broken window with a stone from the sidewalk next to the building.

- (b) **Structure:** Active; **Article:** Indefinite.

Bethany struck a broken window with a stone from the sidewalk next to the building.

- (c) **Structure:** Passive; **Article:** Definite.

The broken window got struck with a stone from the sidewalk next to the building.

- (d) **Structure:** Passive; **Article:** Indefinite.

A broken window got struck with a stone from the sidewalk next to the building.

Question: Do you think the window became broken because it got struck by the stone?

2. (a) **Structure:** Active; **Article:** Definite.

The artist coated the glazed pot with some enamel in a local art studio last week.

- (b) **Structure:** Active; **Article:** Indefinite.

The artisit coated a glazed pot with some enamel in a local art studio last week.

- (c) **Structure:** Passive; **Article:** Definite.

The glazed pot got coated with some enamel in a local art studio last week.

- (d) **Structure:** Passive; **Article:** Indefinite.

A glazed pot got coated with some enamel in a local art studio last week.

Question: Do you think the pot became glazed because it was coated with the enamel?

3. (a) **Structure:** Active; **Article:** Definite.

Jessica entertained the intoxicated man with some beers after the exciting football game in a bar.

- (b) **Structure:** Active; **Article:** Indefinite.

Jessica entertained an intoxicated man with some beers after the exciting football game in a bar.

- (c) **Structure:** Passive; **Article:** Definite.

The intoxicated man was entertained with some beers after the exciting football game in a bar.

- (d) **Structure:** Passive; **Article:** Indefinite.

An intoxicated man was entertained with some beers after the exciting football game in a bar.

Question: Do you think the man became intoxicated because he was enterained with the beers?

4. (a) **Structure:** Active; **Article:** Definite.

Eric struck the wounded player with a sword in a video game yesterday.

- (b) **Structure:** Active; **Article:** Indefinite.

Eric struck a wounded player with a sword in a video game yesterday.

- (c) **Structure:** Passive; **Article:** Definite.

The wounded player got struck with a sword in a video game yesterday.

- (d) **Structure:** Passive; **Article:** Indefinite.

A wounded player got struck with a sword in a video game yesterday.

Question: Do you think the player became wounded because he got struck by the sword?

5. (a) **Structure:** Active; **Article:** Definite.

Peter hit the injured dog with a car on a busy street earlier this morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Peter hit an injured dog with a car on a busy street earlier this morning.

- (c) **Structure:** Passive; **Article:** Definite.

The injured dog got hit with a car on a busy street earlier this morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

An injured dog got hit with a car on a busy street earlier this morning.

Question: Do you think the dog became injured because it got hit by the car?

6. (a) **Structure:** Active; **Article:** Definite.

The jealous queen assassinated the poisoned princess with a cobra in the film which was popular last year.

- (b) **Structure:** Active; **Article:** Indefinite.

The jealous queen assassinated a poisoned princess with a cobra in the film which was popular last year.

- (c) **Structure:** Passive; **Article:** Definite.

The poisoned princess got assassinated with a cobra in the film which was popular last year.

- (d) **Structure:** Passive; **Article:** Indefinite.

A poisoned princess got assassinated with a cobra in the film which was popular last year.

Question: Do you think the princess became poisoned because she got assassinated with the cobra?

7. (a) **Structure:** Active; **Article:** Definite.

Emma treated the inflamed wound with some expired ointment at home a few days ago.

- (b) **Structure:** Active; **Article:** Indefinite.

Emma treated an inflamed wound with some expired ointment at home a few days ago.

- (c) **Structure:** Passive; **Article:** Definite.

The inflamed wound was treated with some expired ointment at home a few days ago.

- (d) **Structure:** Passive; **Article:** Indefinite.

An inflamed wound was treated with some expired ointment at home a few days ago.

Question: Do you think the wound became inflamed because it was treated with the expired ointment?

8. (a) **Structure:** Active; **Article:** Definite.

Ivy cooked the steamed patato with a microwave in the restaurant before the dinner.

- (b) **Structure:** Active; **Article:** Indefinite.

Ivy cooked a steamed patato with a microwave in the restaurant before the dinner.

- (c) **Structure:** Passive; **Article:** Definite.

The steamed patato was cooked with a microwave in the restaurant before the dinner.

- (d) **Structure:** Passive; **Article:** Indefinite.

A steamed patato was cooked with a microwave in the restaurant before the dinner.

Question: Do you think the potato became steamed because it was cooked with the microwave?

9. (a) **Structure:** Active; **Article:** Definite.

Tina cut the damaged painting with a razor blade during the heist in a museum.

- (b) **Structure:** Active; **Article:** Indefinite.

Tina cut a damaged painting with a razor blade during the heist in a museum.

- (c) **Structure:** Passive; **Article:** Indefinite.

The damaged painting was cut with a razor blade during the heist in a museum.

- (d) **Structure:** Passive; **Article:** Indefinite.

A damaged painting was cut with a razor blade during the heist in a museum.

Question: Do you think the painting became damaged because it was cut with the razor blade?

10. (a) **Structure:** Active; **Article:** Definite.

Jenney smashed the cracked wall with a sledge hammer outside the building in the morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Jenney smashed a cracked wall with an sledge hammer outside the building in the morning.

- (c) **Structure:** Passive; **Article:** Definite.

The cracked wall was smashed with a sledge hammer outside the building in the morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

A cracked wall was smashed with a sledge hammer outside the building in the morning.

Question: Do you think the wall became cracked because it was smashed with the sledge hammer?

11. (a) **Structure:** Active; **Article:** Definite.

Sam served the nauseated costumer with some uncooked meat from the kitchen by accident.

- (b) **Structure:** Active; **Article:** Indefinite.

Sam served a nauseated costumer with some uncooked meat from the kitchen by accident.

- (c) **Structure:** Passive; **Article:** Definite.

The nauseated costumer was served with some uncooked meat from the kitchen by accident.

- (d) **Structure:** Passive; **Article:** Indefinite.

A nauseated costumer was served with some uncooked meat from the kitchen by accident.

Question: Do you think the costumer became nauseated because he was served with the uncooked meat?

12. (a) **Structure:** Active; **Article:** Definite.

Ben assaulted the injured man with a knife in a remote district last night.

- (b) **Structure:** Active; **Article:** Indefinite.

Ben assaulted an injured man with a knife in a remote district last night.

- (c) **Structure:** Passive; **Article:** Definite.

The injured man was assaulted with a knife in a remote district last night.

- (d) **Structure:** Passive; **Article:** Indefinite.

An injured man was assaulted with a knife in a remote district last night.

Question: Do you think the man became injured because he was assaulted with the knife?

13. (a) **Structure:** Active; **Article:** Definite.

The company filled the polluted pond with some trash and nobody noticed.

- (b) **Structure:** Active; **Article:** Indefinite.

The company filled a polluted pond with some trash and nobody noticed.

- (c) **Structure:** Passive; **Article:** Definite.

The polluted pond was filled with some trash and nobody noticed.

- (d) **Structure:** Passive; **Article:** Indefinite.

A polluted pond was filled with some trash and nobody noticed.

Question: Do you think the pond became polluted because it was filled with the trash?

14. (a) **Structure:** Active; **Article:** Definite.

John cooked the seasoned steak with some pepper in the new kitchen to treat guests.

- (b) **Structure:** Active; **Article:** Indefinite.

John cooked a seasoned steak with some pepper in the new kitchen to treat guests.

- (c) **Structure:** Passive; **Article:** Definite.

The seasoned steak was cooked with some pepper in the new kitchen to treat guests.

- (d) **Structure:** Passive; **Article:** Indefinite.

A seasoned steak was cooked with some pepper in the new kitchen to treat guests.

Question: Do you think the steak became seasoned because it was cooked with the pepper?

15. (a) **Structure:** Active; **Article:** Definite.

Travellers filled the clogged canal with some boats in the morning during the summer break.

- (b) **Structure:** Active; **Article:** Indefinite.

Travellers filled a clogged canal with some boats in the morning during the

summer break.

- (c) **Structure:** Passive; **Article:** Definite.

The clogged canal was filled with some boats in the morning during the summer break.

- (d) **Structure:** Passive; **Article:** Indefinite.

A clogged canal was filled with some boats in the morning during the summer break.

Question: Do you think the canal became clogged because it was filled with the boats?

16. (a) **Structure:** Active; **Article:** Definite.

Cathy dried the crumpled blouse with a tumble dryer while the wash machine was still working.

- (b) **Structure:** Active; **Article:** Indefinite.

Cathy dried a crumpled blouse with a tumble dryer while the wash machine was still working.

- (c) **Structure:** Passive; **Article:** Definite.

The crumpled blouse was dried with a tumble dryer while the wash machine was still working.

- (d) **Structure:** Passive; **Article:** Indefinite.

A crumpled blouse was washed with a tumble dryer while the wash machine was still working.

Question: Do you think the blouse became crumpled because it was dried with the tumble dryer?

17. (a) **Structure:** Active; **Article:** Definite.

Communters blocked the crowded road with an accident in the city centre this morning.

- (b) **Structure:** Active; **Article:** Indefinite.

Communters blocked a crowded road with an accident in the city centre this morning.

- (c) **Structure:** Passive; **Article:** Definite.

The crowded road was blocked with an accident in the city centre this morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

A crowded road was blocked with an accident in the city centre this morning.

Question: Do you think the road became crowded because it was blocked with the accident?

18. (a) **Structure:** Active; **Article:** Definite.

Annabelle struck the wounded player with a flying disc after the game on the lawn.

- (b) **Structure:** Active; **Article:** Indefinite.

Annabelle struck a wounded player with a flying disc after the game on the lawn.

- (c) **Structure:** Passive; **Article:** Definite.

The wounded player got struck by a flying disc after the game on the lawn.

- (d) **Structure:** Passive; **Article:** Indefinite.

A wounded player got struck by a flying disc after the game on the lawn.

Question: Do you think the player became wounded because he got hit with the flying disc?

19. (a) **Structure:** Active; **Article:** Definite.

Lily smashed the broken finger with the door in the midnight hours by accident.

- (b) **Structure:** Active; **Article:** Indefinite.

Lily smashed a broken finger with the door in the midnight hours by accident.

- (c) **Structure:** Passive; **Article:** Definite.

The broken finger got smashed with the door in the midnight hours by accident.

- (d) **Structure:** Passive; **Article:** Indefinite.

A broken finger got smashed with the door in the midnight hours by accident.

Question: Do you think the finger became broken because it got smashed with the door?

20. (a) **Structure:** Active; **Article:** Definite.

The housemaid cleaned the polished tabletop with some sandpaper yesterday after dinner.

- (b) **Structure:** Active; **Article:** Indefinite.

The housemaid cleaned a polished tabletop with some sandpaper yesterday after dinner.

- (c) **Structure:** Passive; **Article:** Definite.

The polished tabletop was cleaned with some sandpaper yesterday after dinner.

- (d) **Structure:** Passive; **Article:** Indefinite.

A polished tabletop was cleaned with some sandpaper yesterday after dinner.

Question: Do you think the tabletop became polished because it was cleaned with the sandpaper?

21. (a) **Structure:** Active; **Article:** Definite.

Anna hit the drenched man with a water balloon outside the old house in the afternoon.

- (b) **Structure:** Active; **Article:** Indefinite.

Anna hit a drenched man with a water balloon outside the old house in the afternoon.

- (c) **Structure:** Passive; **Article:** Definite.

The drenched man got hit with a water balloon outside the old house in the afternoon.

- (d) **Structure:** Passive; **Article:** Indefinite.

A drenched man got hit with a water balloon outside the old house in the

afternoon.

Question: Do you think the man became drenched because he got hit with the water balloon?

22. (a) **Structure:** Active; **Article:** Definite.

Bob touched the contaminated needle with a dirty rag in the hospital and the nurse was worried.

- (b) **Structure:** Active; **Article:** Indefinite.

Bob touched a contaminated needle with a dirty rag in the hospital and the nurse was worried.

- (c) **Structure:** Passive; **Article:** Definite.

The contaminated needle was touched with a dirty rag in the hospital and the nurse was worried.

- (d) **Structure:** Passive; **Article:** Indefinite.

A contaminated needle was touched with a dirty rag in the hospital and the nurse was worried.

Question: Do you think the needle became contaminated because it was touched with the dirty rag?

23. (a) **Structure:** Active; **Article:** Definite.

Bella grilled the cooked fillet with some charcoal before the party in the garden.

- (b) **Structure:** Active; **Article:** Indefinite.

Bella grilled a cooked fillet with some charcoal before the party in the garden.

- (c) **Structure:** Passive; **Article:** Definite.

The cooked fillet was grilled with some charcoal before the party in the garden.

- (d) **Structure:** Passive; **Article:** Indefinite.

A cooked fillet was grilled with some charcoal before the party in the garden.

Question: Do you think the fish fillet became cooked because it was roasted with the charcoal?

24. (a) **Structure:** Active; **Article:** Definite.

Susan washed the faded shirt with some bleach in the old washing machine that was bought ten years ago.

- (b) **Structure:** Active; **Article:** Indefinite.

Susan washed a faded shirt with some bleach in the old washing machine that was bought ten years ago.

- (c) **Structure:** Passive; **Article:** Definite.

The faded shirt was washed with some bleach in the old washing machine that was bought ten years ago.

- (d) **Structure:** Passive; **Article:** Indefinite.

A faded shirt was washed with some bleach in the old washing machine that was bought ten years ago.

Question: Do you think the shirt became faded because it was washed with the bleach?

25. (a) **Structure:** Active; **Article:** Definite.

A passing car splashed the soiled dress with some mud on a rainy morning in July.

- (b) **Structure:** Active; **Article:** Indefinite.

A passing car splashed a soiled dress with some mud on a rainy morning in July.

- (c) **Structure:** Passive; **Article:** Definite.

The soiled dress was splashed with some mud during on a rainy morning in July.

- (d) **Structure:** Passive; **Article:** Indefinite.

A soiled dress was splashed with some mud during on a rainy morning in July.

Question: Do you think the dress became soiled because it was splashed with the mud?

26. (a) **Structure:** Active; **Article:** Definite.

Andrew adjusted the bent rod with the pliers in a family workshop before the new year.

- (b) **Structure:** Active; **Article:** Indefinite.

Andrew adjusted a bent rod with the pliers in a family workshop before the new year.

- (c) **Structure:** Passive; **Article:** Definite.

The bent rod was adjusted with the pliers in a family workshop before the new year.

- (d) **Structure:** Passive; **Article:** Indefinite.

A bent rod was produced with the pliers in a family workshop before the new year.

Question: Do you think the rod became bent because it was adjusted with the pliers?

27. (a) **Structure:** Active; **Article:** Definite.

Ben struck the punctured tyre with a nail on the roadside in the evening.

- (b) **Structure:** Active; **Article:** Indefinite.

Ben struck a punctured tyre with a nail on the roadside in the evening.

- (c) **Structure:** Passive; **Article:** Definite.

The punctured tyre was struck with a nail on the roadside in the evening.

- (d) **Structure:** Passive; **Article:** Indefinite.

A punctured tyre was struck with a nail on the roadside in the evening.

Question: Do you think the tyre became punctured because it was struck with the nail?

28. (a) **Structure:** Active; **Article:** Definite.

Incense streaked the blackened altar with some residue during the religious ceremony.

- (b) **Structure:** Active; **Article:** Indefinite.

Incense streaked a blackened altar with some residue during the religious ceremony.

- (c) **Structure:** Passive; **Article:** Definite.

The blackened altar was streaked with some residue during the religious ceremony.

- (d) **Structure:** Passive; **Article:** Indefinite.

A blackened altar was streaked with some residue during the religious ceremony.

Question: Do you think the altar became blackened because it was streaked with the residue?

29. (a) **Structure:** Active; **Article:** Definite.

Lez hit the dented tank with a grenade in a fierce battle during the war.

- (b) **Structure:** Active; **Article:** Indefinite.

Lez hit a dented tank with a grenade in a fierce battle during the war.

- (c) **Structure:** Passive; **Article:** Definite.

The dented tank got hit with a grenade in a fierce battle during the war.

- (d) **Structure:** Passive; **Article:** Indefinite.

A dented tank got hit with a grenade in a fierce battle during the war.

Question: Do you think the tank became dented because it got hit with the grenade?

30. (a) **Structure:** Active; **Article:** Definite.

Betty put the melted chocolate bar in a warm pocket during the cold night in the winter.

- (b) **Structure:** Active; **Article:** Indefinite.

Betty put a melted chocolate bar in a warm pocket during the cold night in the winter.

- (c) **Structure:** Passive; **Article:** Definite.

The melted chocolate bar was put in a warm pocket during the cold night in the winter.

- (d) **Structure:** Passive; **Article:** Indefinite.

A melted chocolate bar was put in a warm pocket during the cold night in the winter.

Question: Do you think the chocolate bar became melted because it was put in the warm pocket?

31. (a) **Structure:** Active; **Article:** Definite.

The boy rubbed the infected eye with a dirty hand by accident in the morning.

- (b) **Structure:** Active; **Article:** Indefinite.

The boy rubbed an infected eye with a dirty hand by accident in the morning.

- (c) **Structure:** Passive; **Article:** Definite.

The infected eye was rubbed with a dirty hand by accident in the morning.

- (d) **Structure:** Passive; **Article:** Indefinite.

An infected eye was rubbed with a dirty hand by accident in the morning.

Question: Do you think the eye became infected because it was rubbed with the dirty hand?

32. (a) **Structure:** Active; **Article:** Definite.

Linda covered the defaced wall with some paint after the protests on the bridge.

- (b) **Structure:** Active; **Article:** Indefinite.

Linda covered a defaced wall with some paint after the protests on the bridge.

- (c) **Structure:** Passive; **Article:** Definite.

The defaced wall was cover with some paint after the protests on the bridge.

- (d) **Structure:** Passive; **Article:** Indefinite.

A defaced wall was cover with some paint after the protests on the bridge.

Question: Do you think the wall became defaced because it was covered with the paint?

33. (a) **Structure:** Active; **Article:** Definite.

Sherry covered the emblished dress with many crystals before the ceremony to make it shinning.

- (b) **Structure:** Active; **Article:** Indefinite.

Sherry covered an emblished dress with many crystals before the ceremony to make it shinning.

- (c) **Structure:** Passive; **Article:** Definite.

The emblished dress was covered with many crystals before the ceremony to make it shinning.

- (d) **Structure:** Passive; **Article:** Indefinite.

An emblished dress was covered with many crystals before the ceremony to make it shinning.

Question: Do you think the dress became emblished because it was covered with the crystals?

34. (a) **Structure:** Active; **Article:** Definite.

Leonard filled the scented room with fresh roses in the old castle for the wedding.

- (b) **Structure:** Active; **Article:** Indefinite.

Leonard filled a scented room with fresh roses in the old castle for the wedding.

- (c) **Structure:** Passive; **Article:** Definite.

The scented room was filled with fresh roses in the old castle for the wedding.

- (d) **Structure:** Passive; **Article:** Indefinite.

A scented room was filled with fresh roses in the old castle for the wedding.

Question: Do you think the room became scented because it was filled with the fresh roses?

35. (a) **Structure:** Active; **Article:** Definite.

The government surrounded the trapped vehicle with the police on the highway after the murder.

- (b) **Structure:** Active; **Article:** Indefinite.

The government surrounded a trapped vehicle with the police cars on the highway after the murder.

- (c) **Structure:** Passive; **Article:** Definite.

The trapped vehicle was surrounded with the police on the highway after the murder.

- (d) **Structure:** Passive; **Article:** Indefinite.

A trapped vehicle was surrounded with the police on the highway after the murder.

Question: Do you think the vehicle became trapped because it was surrounded with the police?

36. (a) **Structure:** Active; **Article:** Definite.

Helen prepared the smashed avocado with a muddler this morning for breakfast.

- (b) **Structure:** Active; **Article:** Indefinite.

Helen prepared a smashed avocado with a muddler this morning for breakfast.

- (c) **Structure:** Passive; **Article:** Definite.

The smashed avocado was prepared with a muddler this morning for breakfast.

- (d) **Structure:** Passive; **Article:** Indefinite.

A smashed avocado was prepared with a muddler this morning for breakfast.

Question: Do you think the avocado became smashed because it was prepared with the muddler?

37. (a) **Structure:** Active; **Article:** Definite.

Darcy covered the pickled onion with some vinegar in a large bowl for use.

- (b) **Structure:** Active; **Article:** Indefinite.

Darcy covered a pickled onion with some vinegar in a large bowl for use.

- (c) **Structure:** Passive; **Article:** Definite.

The pickled onion was covered with some vinegar in a large bowl for use.

- (d) **Structure:** Passive; **Article:** Indefinite.

A pickled onion was covered with some vinegar in a large bowl for use.

Question: Do you think the onion became pickled because it was covered with the vinegar?

38. (a) **Structure:** Active; **Article:** Definite.

Kevin rubbed the sharpened knife with a whetstone last weekend in the workshop.

- (b) **Structure:** Active; **Article:** Indefinite.

Kevin rubbed a sharpened knife with a whetstone last weekend in the workshop.

- (c) **Structure:** Passive; **Article:** Definite.

The sharpened knife was rubbed with a whetstone last weekend in the workshop.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sharpened knife was rubbed with a whetstone last weekend in the workshop.

Question: Do you think the knife became sharpened because it was rubbed with the whetstone?

39. (a) **Structure:** Active; **Article:** Definite.

The chef cooked the sweated radish with some sugar to attract kids who don't like vegetables.

- (b) **Structure:** Active; **Article:** Indefinite.

The chef cooked a sweated radish with some sugar to attract kids who don't like vegetables.

- (c) **Structure:** Passive; **Article:** Definite.

The sweetened radish was cooked with some sugar to attract kids who don't like vegetables.

- (d) **Structure:** Passive; **Article:** Indefinite.

A sweetened radish was cooked with some sugar to attract kids who don't like vegetables.

Question: Do you think the radish became sweetened because it was cooked with the sugar?

40. (a) **Structure:** Active; **Article:** Definite.

Lee sprayed the humidified room with some water half an hour ago and now the room is empty.

- (b) **Structure:** Active; **Article:** Indefinite.

Lee sprayed a humidified room with some water half an hour ago and now the room is empty.

- (c) **Structure:** Passive; **Article:** Definite.

The humidified room was sprayed with some water half an hour ago and now the room is empty.

- (d) **Structure:** Passive; **Article:** Indefinite.

A humidified room was sprayed with some water half an hour ago and now the room is empty.

Question: Do you think the room became humidified because it was sprayed with the water?

D Experimental items for Article 4

Experiment 1

- Word-by-word self-paced reading task
- 40 experimental items and four conditions in this task were the same as those in Experiment 1, Article 3.
- Critical word is the noun denoting the instrument; e.g.,
 - (i) {The/a} slippery floorboard got covered with some oil last Tuesday evening.
 - (ii) Billed covered {the/a} slippery floorboard with some oil last Tuesday evening.

Experiment 2

- Eye-tracking-while-reading task
- 40 experimental items and four conditions in this task were the same as those in Experiment 2, Article 3.
- Critical region is the prepositional phrase; e.g.,
 - (i) {The/a} broken window was struck [by a stone]*critical* [from the]*spillover* sidewalk next to the building.
 - (ii) Bethany struck {the/a} broken window [with a stone]*critical* [from the]*spillover* sidewalk next to the building.

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