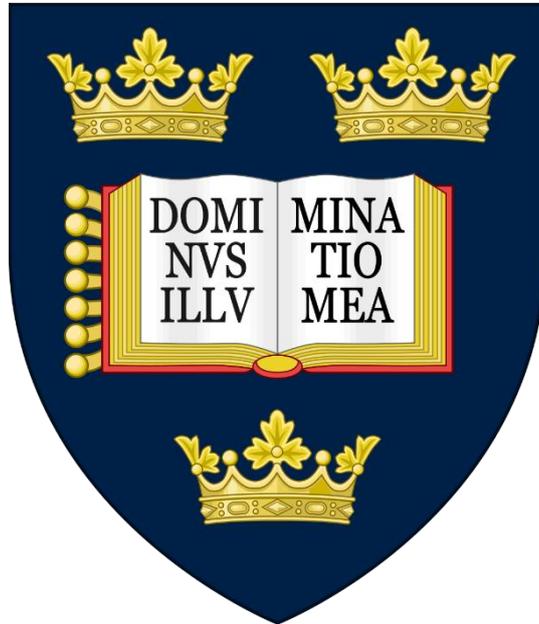


Faces and Places: How Context Influences the Social Effects of Smiles



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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	II
TABLE OF CONTENTS	VI
LIST OF FIGURES	IX
LIST OF TABLES	XI
STATEMENT OF AUTHORSHIP	XII
ABSTRACT.....	1
CHAPTER 1: INTRODUCTION.....	3
GENERAL OVERVIEW OF THE CHAPTER.....	3
SOCIAL INTERACTION	4
Types of Social Communicative Cues	6
Facial Expressions	7
Smiles	12
THE ROLE OF CONTEXT WITHIN SOCIAL INTERACTION	18
Context Effects on Facial Expression Evaluations	19
Theories of Contextual Influence.....	26
Bidirectional Context.....	31
Context and Smile Types	32
Automaticity of Context Effects	34
THE SECOND-PERSON APPROACH.....	36
The Foundations of the Second-Person Approach.....	37
Empirical Second-Person Research	39
OVERVIEW OF THE CURRENT THESIS	40
CHAPTER 2: THE EFFECTS OF SMILES AND SITUATIONAL CONTEXTS ON EXPLICIT PARTICIPANT EVALUATIONS	43
ABSTRACT.....	43
INTRODUCTION	44
Present Research	52
Hypotheses.....	53
STUDY 1	54
Methods	54
Results.....	58
Discussion.....	64
STUDY 2	64
Methods	64
Results.....	65
Discussion.....	72

STUDY 3	73
Methods	74
Results.....	77
GENERAL DISCUSSION	81
CONCLUSION.....	89
CHAPTER 3: THE PSYCHOLOGICAL MECHANISMS UNDERLYING CONSCIOUS FACE-CONTEXT INTEGRATION	90
ABSTRACT.....	90
INTRODUCTION	91
Present Research	94
Hypotheses.....	95
STUDY 4	96
Methods	96
Results.....	101
GENERAL DISCUSSION	109
CONCLUSION.....	114
CHAPTER 4: MORPHOLOGICAL AND CONTEXTUAL CUES AFFECT IMPLICIT APPROACH-AVOIDANCE RESPONSES TO SMILES.....	115
ABSTRACT.....	115
INTRODUCTION	116
Present Research	120
Hypotheses.....	121
STUDY 5	121
Methods	121
Results.....	128
Discussion.....	129
STUDY 6	130
Methods	130
Results.....	132
Discussion.....	133
STUDY 7	135
Methods	136
Results.....	136
Discussion.....	138
STUDY 8	139
Methods	139
Results.....	140
Discussion.....	141
GENERAL DISCUSSION	142

CONCLUSION.....	148
CHAPTER 5: CONTEXT INFLUENCES FACIAL MIMICRY WITHIN VIRTUAL ENVIRONMENTS	149
ABSTRACT.....	149
INTRODUCTION	150
Present Research	156
Hypotheses.....	157
STUDY 9	158
Methods	158
Results.....	165
GENERAL DISCUSSION	186
CONCLUSION.....	193
CHAPTER 6: GENERAL DISCUSSION	194
OVERALL SUMMARY	194
HOW DO MORPHOLOGICAL AND CONTEXTUAL CUES AFFECT EXPLICIT SOCIAL EVALUATIONS OF SMILES AND CONTEXTS?	195
Findings	196
WHAT PSYCHOLOGICAL MECHANISMS INFLUENCE HOW SMILES AND CONTEXTS ARE COMBINED?	197
Findings	197
DO MORPHOLOGICAL AND CONTEXTUAL CUES IMPLICITLY AFFECT SUBSEQUENT BEHAVIOURAL RESPONSES TO SMILES?	198
Findings	199
DO MORPHOLOGICAL AND CONTEXTUAL CUES INFLUENCE SOCIAL RESPONSES IN SCENARIOS MORE EQUIVALENT TO REAL-LIFE SOCIAL INTERACTIONS?.....	199
Findings	200
BROAD THEORETICAL CONSIDERATIONS	200
How Does Context Exert its Influence on Facial Expression Processing?	200
Differences Between Processing Faces Versus Situations.....	204
Moderating Effect of Negative Situations.....	206
Does the SIMS Model Accurately Categorise Smiles?.....	208
VALUE OF CONVERGENT METHODOLOGICAL TECHNIQUES	210
LIMITATIONS.....	212
Participant Representativeness.....	212
Stimulus Validity	214
Lack of Social Complexity	217
OVERALL CONCLUSION	219
REFERENCES.....	220

LIST OF FIGURES

Figure 2.1. Examples of smile and context stimuli used in Chapter 2.....	56
Figure 2.2. Interactions between context and smile type for all Study 1 ratings	62
Figure 2.3. Interaction between context and smile type for politeness ratings in Study 1 (including dominance smiles)	63
Figure 2.4. Interactions between context and smile type for all Study 2 ratings	69
Figure 2.5. Interactions between context and smile type for all Study 2 ratings (including dominance smiles).....	71
Figure 2.6. Interaction between context and smile type for invested points in Study 3.....	78
Figure 2.7. Interaction between context and smile type for expected points returned in Study 3	79
Figure 2.8. Interaction between context and smile type for invested points in Study 3 (including dominance smiles)	80
Figure 2.9. Interaction between context and smile type for expected points returned in Study 3 (including dominance smiles)	81
Figure 3.1. Interaction between context and smile type for duration of fixations to the situational context in Study 4	101
Figure 3.2. Interactions between context and smile type for all Study 4 face ratings.....	104
Figure 3.3. Interactions between context and smile type for all Study 4 situation ratings.....	107
Figure 3.4. Interaction between context and smile type for response times in Study 4.....	109
Figure 4.1. Examples of smile-in-context stimuli used in Chapter 4.....	123
Figure 4.2. Interactions between response direction, smile type, and context for Study 5	128
Figure 4.3. Interactions between response direction, smile type, and context for Study 6	133
Figure 4.4. Interactions between response direction, facial emotion, and context for Study 7.....	138
Figure 4.5. Interactions between response direction, smile type, and context for Study 8	141
Figure 5.1. Mean EMG activity across different muscles and smile types in Study 9	165
Figure 5.2. Interaction between context and smile type for joy ratings in Study 9.....	167
Figure 5.3. Interaction between context and smile type for liking ratings in Study 9	169
Figure 5.4. Interaction between context and smile type for acknowledgement ratings in Study 9.....	171
Figure 5.5. Interaction between context and smile type for politeness ratings in Study 9.....	173
Figure 5.6. Interaction between context and smile type for concern ratings in Study 9	175
Figure 5.7. Interaction between context and smile type for condescension ratings in Study 9	177
Figure 5.8. Interaction between context and smile type for Inclusion of the Other in the Self (IOS) ratings in Study 9	179
Figure 5.9. Interaction between context and smile type for mean zygomaticus and orbicularis EMG activity in Study 9	181
Figure 5.10. Interaction between context and smile type for mean corrugator EMG activity in Study 9	183
Figure 5.11. Mediation of the main effect of smile type by Inclusion of the Other in the Self (IOS) ratings in Study 9	184

Figure 5.12. Mediation of the main effect of context by Inclusion of the Other in the Self (IOS) ratings in Study 9 185

LIST OF TABLES

Table 2.1. Comparison of context and smile type effects in Study 1 and Study 2.....	72
Table 5.1. Comparisons across smile types for joy ratings in Study 9	166
Table 5.2. Comparisons across smile types for liking ratings in Study 9	168
Table 5.3. Comparisons across smile types for acknowledgement ratings in Study 9	170
Table 5.4. Comparisons across smile types for politeness ratings in Study 9.....	172
Table 5.5. Comparisons across smile types for concern ratings in Study 9.....	174
Table 5.6. Comparisons across smile types for condescension ratings in Study 9	176
Table 5.7. Comparisons across smile types for Inclusion of the Other in the Self (IOS) ratings in Study 9	178
Table 5.8. Comparisons across smile types for zygomaticus and orbicularis EMG activity in Study 9	180
Table 5.9. Comparisons across smile types for corrugator EMG activity in Study 9.....	182

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Day, S. E., Shore, D. M., & Krumhuber, E. G. (2025). Contextual influences on the perception and interpretation of facial expressions. In D. Chadee & A. Kostic (Eds.), *Body Language Communication* (pp. 81-105). Palgrave Macmillan.
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My co-authors confirm that I have permission to include published/submitted materials in the doctoral thesis.

ABSTRACT

Facial expressions are salient sources of social information. Of all the facial expressions, smiles are perhaps the most important because they occur frequently and have strong but subtle effects on the behaviour of interaction partners. By distinguishing between their social effects, researchers have identified different types of smiles associated with specific patterns of facial muscle activity (i.e. morphology). Nonetheless, a smile's meaning is also affected by the situational context that the smiler is seen within. In the present thesis, I investigated how these morphological and contextual cues combine to impact the social effects of smiles. To begin, in Chapter 2 I assessed how contextual cues affected explicit social evaluations of smiles, as well as how different smile types affected explicit evaluations of situational contexts. This was tested using both rating scales and an economic trust game. I found that context significantly affected explicit social evaluations of smiles. Moreover, explicit evaluations of situational contexts were significantly influenced by the smile type that accompanied them. Next, in Chapter 3 I investigated the psychological mechanisms underlying the integration of smiles with their accompanying situational context by recording both the eye gaze and response time of participants as they rated face-in-context stimuli. I concluded that the integration of smiles and contexts likely depends mostly upon a process of conscious cognitive reinterpretation, if enough time is available for this type of processing. In Chapter 4, I tested the extent to which morphological and contextual information implicitly affected participant's approach-avoidance response speed using a mobile approach-avoidance app. Both morphological and contextual information implicitly affected the speed of subsequent approach-avoidance movements. However, the automatic integration of contextual information depended upon the ambiguity or "source clarity" of the information available. Finally, in Chapter 5 I determined whether the effects of context and smile type could be generalised to more realistic social interaction scenarios. Using virtual reality and

electromyography, I measured the extent to which smiles displayed by virtual avatars were mimicked by participants. My results demonstrated that both smile type and situational context influenced subsequent mimicry within more embedded and embodied social interactions. Taken together, this thesis demonstrates the power and importance of situational context in expression processing. Context can influence the social effects of expressions both implicitly at an early unconscious stage and explicitly at a later conscious stage. However, its influence depends on the ambiguity of the different expressions and different contexts, as well as the demands of the social task.

CHAPTER 1: INTRODUCTION

General Overview of the Chapter

This introductory chapter has four broad sections. The first section describes the role and purpose of facial expressions, with an emphasis on smiles. To begin, I outline the various social cues that convey information during social interactions. I then focus specifically on facial expressions — perhaps the most important of social cues — and describe the different theoretical frameworks that have been used to investigate and understand their functions and meanings. After this, I discuss the role of smiles, including the main systems by which different types of smiles have been classified and differentiated.

In the second section, I discuss the role that context plays in the evaluation and interpretation of facial expressions. I start by describing research into the various contextual factors that have been shown to influence responses to facial expressions. I then describe multiple models that have been proposed to explain how context influences facial expression processing. I end by highlighting various oversights made by researchers interested in context effects, including how context affects evaluations of different smile types.

In the third section, I discuss methodological approaches that have been used to study facial expressions. I start by talking about “third-person” isolation paradigms, which make up the vast majority of studies in this area. I then describe the newer “second-person” approach, which is becoming increasingly prominent within this research area.

Finally, in the fourth section, I discuss how my own research in this thesis relates to the literature reviewed. I then describe the structure of the thesis and give a brief overview of the studies included within each empirical chapter.

Social Interaction

Humans are a social species, and we spend a large amount of our time interacting with other people in social environments. At work, individuals engage with colleagues, subordinates, and supervisors to accomplish their goals. At home, family life is centred upon interaction with one's romantic partner, parents, siblings, and children. Beyond work and family responsibilities, many people opt to spend their leisure time socialising with friends. And outside of these common interaction scenarios, people regularly interact or exchange words with total strangers across a huge variety of everyday scenarios e.g. supermarket cashiers, service staff, fellow commuters, etc.

Given the frequency of social interaction, it is perhaps unsurprising that humans are proficient at conversing and communicating with others. Although no two interactions are the same, most people are able to successfully navigate their interactions by utilising a combination of verbal and nonverbal behaviours, without experiencing particular cognitive difficulty. This suggests that humans make use of psychological mechanisms that make social interaction a cognitively manageable task. Such mechanisms are essential given the value and importance of social interaction for interactants' short- and long-term outcomes. Research highlights that the quality of one's social interactions is predictive of quality of life. This includes the development of social and romantic relationships, mental wellbeing, and even physical health (Holt-Lunstad & Clark, 2014; Umberson & Montez, 2010).

High quality social interactions are associated with positive outcomes, in part because they allow for efficient exchanges of information. On one hand, interaction partners communicate a wealth of information that can be used to guide subsequent decision-making and ultimately lead to the successful achievement of goals. These range from simple choices (e.g. who to chat to at a social event) to more complicated decisions (e.g. whether to trust the investment advice of a financial advisor). Conversely however, social interaction also allows

people to influence the behaviour of others in ways that can be beneficial to themselves. For example, the content of one's speech may encourage or discourage interaction partners from choosing a certain course of action. Likewise, at a more implicit level, various factors including one's tone of voice or accompanying facial expressions may be used to subtly alter the behaviour of other people.

Previous research has investigated the factors that contribute to successful interactions. For example, increased frequency of smiling and eye contact is typically associated with higher interaction quality (Hall et al., 2005; Spezio et al., 2007). Similarly, interpersonal synchrony and bodily/facial mimicry are also predictors of positive interactions (Bourgeois & Hess, 2008; Heerey & Crossley, 2013; Langfeld, 1918). In contrast, the absence of many of these behaviours is often observed in clinical populations who often struggle with social interaction e.g. people with autism (Stone & Gerrans, 2006).

Although we have some idea about the factors that contribute towards successful social interactions, our understanding of this phenomena is far from complete. Within any interaction, individuals must both interpret and transmit a vast array of social cues. These cues must be perceived and processed in order to develop a coherent understanding of the intentions of interaction partners, which in turn guides subsequent social responses. Moreover, social cues always overlap within social interactions and may interact with one another in non-additive ways that must be deciphered. For instance, a serious statement accompanied by a wink and a knowing smile is more likely to be interpreted as sarcastic or untrue by an interaction partner than the same statement without those additional cues. A selection of such social cues is discussed in the following section, many of which remain under-researched and poorly understood.

Types of Social Communicative Cues

Perhaps the most obvious type of communicative cue present during most social interactions is spoken language. Speech allows for communication of ideas, beliefs, emotions, instructions, statements of intent, etc, in a way that is explicit and (mostly) semantically unambiguous. However, the ease of using of spoken language also confers a notable downside for social interactions. Specifically, in comparison to most “nonverbal” social cues, language can be more easily manipulated by the communicator so as not to reflect true underlying cognitions or emotions. As a result, it has been proposed that alternative social cues are more honest or “leaky” than spoken language (Blanck & Rosenthal, 1982; DePaulo & Rosenthal, 1979), and therefore retain a high informational value, despite being more difficult to accurately interpret.

For example, in addition to the explicit semantic content of speech, vocalisations also convey other less obvious and less controllable sources of socially relevant information, including acoustic cues such as tone and amplitude. These can be neatly categorised under the umbrella term “vocal affect”. Vocal affect has been shown to guide social processing and decision-making across multiple situations and paradigms (Scherer, 1986; 1988), including the attribution of affective dimensions (Bergmann et al., 1988; Ladd et al., 1985), speaker intentions (Searle, 1986), and internal states (Scherer et al., 1984). Notably, in the latter study, judgements of an interactant’s cognitive and affective states (e.g. politeness, patience, reproachfulness) were far less detailed when based upon verbal content alone (participants read a transcript of the conversation) compared to ratings provided by participants who had listened to an audio recording of the conversation. This finding remained true even when the auditory stimulus was altered to become semantically unintelligible. Such observations highlight the quality of information provided by nonverbal cues, above and beyond the semantic content of language.

Another important source of nonverbal information often present during social interaction are one's body language and gestures. Once more, these signals are seemingly more difficult to manipulate and regulate than spoken language. Yet again however, extensive evidence has shown that people can use these cues to make various emotional judgements. For example, people can recognise emotions from body posture (e.g., Atkinson et al., 2004, Coulson, 2004), arm movements (Pollick et al., 2001), and whole-body movements (e.g., Atkinson et al., 2004, de Meijer, 1989, Dittrich et al., 1996), even when facial and vocal information is removed. Moreover, body language and gestures are often used in tight conjunction with spoken language. Beattie and Shovelton authored a series of papers which outlined the complementary and facilitative functions of gestures for disambiguating various types of verbal information (Beattie & Shovelton, 1999a; 1999b; 2000; 2002).

Facial Expressions

Whilst the value of vocal affect and body language in socio-emotional processing is not disputed, the most informative and frequently utilised nonverbal social cues within interpersonal interactions are derived from faces. A large body of literature suggests that humans process faces in a specialised manner in comparison to other objects, as illustrated by a robust “face inversion effect” (Valentine, 1988) and a clear attentional bias towards the face area when viewing naturalistic scenes (Fletcher-Watson et al., 2008). Such specialism is likely associated with the huge volume of socially relevant dispositional information conveyed by the face, including identity, sex, race, attractiveness, health, etc. Moreover, static features of faces can be used to make a range of personality judgements, along dimensions including competence (Todorov, 2005), likability (Willis & Todorov, 2006), trustworthiness (Bar et al., 2006), and power (Hassin & Trope, 2000). Nonetheless, whilst static features of the face are undoubtedly highly informative, it is the dynamic movements of faces — i.e. “facial expressions” — that are particularly prominent and salient sources of information for

guiding subsequent decision-making within social interactions. Unlike static facial features, dynamic facial movements can reveal the current intentions or emotions of a person *as they change across time*.

The importance of facial expressions cannot be underestimated. They communicate information quickly and efficiently, and influence observers' interpretations of other people's personality and behaviour. For example, individuals displaying happy expressions tend to be seen as high in trait affiliation, whereas individuals with angry expressions are perceived as low in trait affiliation (e.g. Bar et al., 2006; Harker & Keltner, 2001; Knutson, 1996; Montepare & Dobish, 2003; Todorov et al., 2009). Furthermore, facial expressions can also substantially alter behaviour-based inferences about other people. Ames and Johar (2009) presented participants with scenes featuring either prosocial or harmful behaviours, carried out by targets showing either positive or negative affective displays. Intriguingly, when the target displayed a positive expression, participants' evaluations of their character were more in-line with their behaviour. In contrast, when the target showed a negative display, participants' inferences about the person were less associated with the actual behaviour performed. This suggests that facial expressions inform an observer about the intentions of the expresser, which in turn alters our understanding of their actions.

Similarly, facial expressions also allow observers to form predictions about the outcome of a social interaction. When an interaction partner smiles, an observer typically expects a positive social outcome, whereas frowns lead observers to anticipate negative outcomes (Kringelbach & Rolls, 2003). Perhaps because of this, some expressions like smiles are known to facilitate prosocial contact between people, even from infancy (e.g. Bowlby, 1958).

Nonetheless, the exact type of information conveyed by facial expressions has been the subject of an intense debate within affective science, spanning several decades. On one hand, the traditional “Basic Emotion” approach to affective science (e.g. Ekman et al., 1969; Ekman & Friesen, 1971) focused upon the view that facial expressions typically represent a faithful readout of an underlying emotional state. These specific facial configurations are supposedly triggered alongside emotion-specific patterns of autonomic and neural activity, as part of a broad and innate “emotion program”. Ekman and colleagues conceded that facial expressions can deviate from representing discrete emotions when culture-specific regulatory “display rules” are deployed (i.e. expressions are suppressed or exaggerated depending upon the cultural norms associated with specific situations). However, the Basic Emotions perspective undoubtedly emphasised a key role for facial expressions in representing discrete underlying emotional states (Buck, 1994; Ekman, 1992).

In contrast, the socio-functionalist “Behavioural Ecology” approach (Carroll & Russell, 1996; Fridlund, 1991a; 1994) instead proposes that facial expressions communicate information about an expresser’s social motives and intentions rather than their underlying internal emotions per se. This confers the added adaptive advantage of a more direct influence upon the social environment and the behaviours of others, which in turn enables the expresser to achieve their social goals more efficiently. Hence, facial expressions are conceived of as flexible tools for social influence and are not caused by the internal mental or emotional states that may covary with them. Under this externalist conceptualisation of facial expressions, it could be argued that the face is not actually “expressing” anything. For instance, rather than reflecting the discrete underlying emotion of sadness (as Basic Emotion theorists would contend), pouting may instead communicate that the expresser wants comfort or reassurance, and therefore has the ultimate purpose of recruiting the protection and support of a social partner.

Support for the functionalist view has been derived from multiple empirical studies. Notably, one line of research has shown that classic prototypical examples of facial expressions are not often produced when their supposed corresponding emotion is experienced (see Duran & Fernandez-Dols, 2021, for review). For example, Reisenzein et al. (2006) conducted a series of eight experiments which found that the prototypical surprise expression was displayed by a maximum of just 25% of participants even as they reported experiencing that specific emotion. Similarly, Matsumoto et al. (2009) showed that spontaneously produced facial expressions were accurately identified as their respective emotion at a far lower rate than studies which presented participants with posed facial expressions. This suggests that spontaneous emotional expressions rarely match the prototypes proposed by Ekman and colleagues.

Meanwhile, a complementary line of research has determined that facial expressions are regularly interpreted with regards to their social motives, as behavioural ecologists would predict. For example, Crivelli et al. (2016) observed that adolescents from the Trobriander tribe in Papua New Guinea most often labelled certain prototypical facial expressions according to their predicted intention (e.g. rejection) rather than the hypothesised basic emotion (disgust). Similar findings have been observed in African, Amazonian, and Pacific societies (Gendron et al., 2018). Therefore, certain preliterate groups may not interpret facial movements as Western cultures do, which suggests that emotional facial expressions are not universal, as Ekman would contend.

The behavioural ecology view is also supported by evidence that facial expressions are produced at time points more consistent with the purpose of conveying social messages rather than reflecting underlying affective states. A classic study by Kraut and Johnston (1979) found that ten-pin bowlers tended to produce smiles not when they made strikes, but instead when they turned around to face their fellow competitors watching on. This implies

that facial displays are deployed when an audience is most available rather than when the emotion (i.e. happiness) peaks. More recently, Schützwohl and Reisenzein (2012) videoed the moment when participants left a psychology testing lab to unexpectedly encounter a bright green room, rather than the stark grey hallway they had entered through minutes earlier. As expected, facial expressivity was greater when the participant was with friends than when with strangers or alone. Once again, this suggests a social rather than emotional purpose of facial expressions.

On the other hand, opposing the central tenet of behavioural ecology theory, Ekman et al. (1990) argued that facial expressions often occur when people are alone, contradicting the idea that they act as social signals. However, in response, Fridlund (1991b) claimed that solitary facial expressions may instead be produced for the benefit of an “implicit audience”, including imagined humans, real non-humans, distant humans, and nearby objects. Moreover, to support the idea that facial expressiveness is correlated with sociality, Fridlund made participants watch humorous film clips in four conditions with various levels of sociality, either: (1) alone, (2) alone but with the belief that there was a friend nearby who was distracted, (3) alone but with the belief that a friend was viewing the same video in another room, or (4) with a friend present and visible. Using electromyography (EMG) to record facial muscle activity, Fridlund found that participant’s smiling frequency correlated strongly with the sociality of viewing — not with the reported emotion. This suggests a more social rather than emotional function of these expressions.

In sum, the behavioural ecology account seems to offer a parsimonious explanation for variability in facial expression displays, both across situations and across cultures. Consequently, this externalist functionalist approach has been gaining increasing influence within the field of affective science.

Smiles

Smiles are especially important facial expressions for a range of reasons. First, they occur at a high frequency within social interactions (Heerey & Kring, 2007; Hess & Bourgeois, 2010) and are therefore likely the most ubiquitous facial expression other than the neutral display. In addition, smiles are more effective at grabbing the attention of observers relative to neutral or negative faces (Campos et al., 2015) and tend to activate reward areas of the brain (e.g. Chang et al., 2014), which suggests a processing bias towards this type of expression. Furthermore, smiles also have a large effect on inferences made about the expresser across a variety of personality traits, which is particularly important when making first impressions (Senft et al., 2016).

Finally, smiles also have strong effects on the behaviour of perceivers. Within an experimental context, Shore and Heerey (2011) showed that participants were willing to forego a monetary reward in exchange for a “genuine” smile. Similarly, Scharlemann et al. (2001) showed that smiles influence a partner’s decision-making, as they elicit more co-operation during a one-shot variant of the classic investor-trustee economic game (Berg et al., 1995). Likewise, research in more ecological contexts has found that smiles have considerable influence over real-world outcomes, ranging from relatively low-level decisions such as how much to tip a waitress in a cocktail bar (Tidd & Lockard, 1978), to high-consequence decisions like voting preference (Mullen et al., 1986) and criminal sentencing severity (LaFrance & Hecht, 1995). Martin et al. (2017) argue that smiles are particularly effective as communicative tools for regulating and influencing the social environment, because they are subtle and unobtrusive and therefore achieve their goals with “a minimum disruption of interpersonal equilibrium” (p. 866).

The functionalist perspective described above has informed the development of a new typology of smiles, which moves beyond traditional distinctions proposed by Basic Emotion

theorists. Traditionally, the dominance of the Basic Emotion framework within affective science encouraged a relatively simplistic categorisation of different smile types, largely based upon observations made by the nineteenth-century neurologist Duchenne of Boulogne. Whilst all smiles necessarily require the activation of the *zygomaticus major* muscle (which upturns one or both corners of the mouth), Duchenne (1862) claimed that “genuine” smiles — supposedly elicited by the true experience of a positive emotion — were characterised by the contraction of the *orbicularis oculi* muscle, which creates a phenomenon widely known as “crow’s feet” around the corner of the eyes. Such smiles were viewed as innate and reflex-like. In contrast, Duchenne argued that “polite” or “fake” smiles — which supposedly occur without the experience of an underlying positive emotion — were characterised by the absence of contraction in this muscle. Fittingly, these separate smile variants are now commonly referred to as Duchenne and non-Duchenne smiles respectively.

Duchenne’s early classification was repopularised more than a century later by eminent Basic Emotions theorists (e.g. Ekman et al., 1990), who interpreted these two categories as consistent with their distinction between (1) expressions reflecting a true underlying emotion (i.e. happiness) and (2) dissimulative expressions influenced by display rules. Since then, a body of evidence has supported such a distinction, by seemingly showing that contraction of the *orbicularis oculi* occurs only when smiles are accompanied by true experience of happiness (Ekman et al., 1988; 1990; Ekman & Friesen, 1982). Consequently, this smile typology has become well established within affective science, and has been used by a multitude of studies which have aimed to assess the relative display rates, influences, and interpretations of such smiles across various participant groups (e.g. Boraston et al., 2008; Frank et al., 1993; Johnston et al., 2010; Manera et al., 2011; Perron et al., 2017; Shore & Heerey, 2011).

Nevertheless, the emergence of the Behavioural Ecology framework has led researchers to challenge the distinction between Duchenne and non-Duchenne smiles. At a theoretical level, it has been argued that Duchenne's original classification implicitly constrained later empirical work by encouraging researchers to focus on whether a smiler is experiencing genuine positive emotions or not, rather than assessing whether smiles transmit other types of information e.g. social motives (Gunnery & Ruben, 2015). Regardless, recent emotion-focused research has posed significant empirical problems for the classic Duchenne versus non-Duchenne classification, as studies have shown that a considerable minority of people can in fact produce Duchenne smiles (i.e. they can contract the orbicularis oculi) purposefully and non-spontaneously, without experiencing underlying happy emotions (Gunnery et al., 2012; Krumhuber & Manstead, 2009). Conversely, it has also been suggested that the "genuine versus fake" framework is limited in scope, as humans have been observed to smile whilst experiencing a much larger range of emotions (e.g. embarrassment, discomfort, pride) across a range of different social contexts (Ansfield, 2007; Keltner, 1995; Kunz et al., 2009, Tracy & Matsumoto; 2008). Notably, Landis (1924) created a face stimulus set by photographing volunteers' spontaneous expressions as they experienced a series of affective stimuli (e.g. gruesome/pornographic images, unexpected gunshots, and severe electric shocks), culminating with the instruction to decapitate a live rat with a butcher's knife. The most common expression produced by volunteers was a smile, even during extremely unpleasant experiences. It seems unlikely that many of these smiles were either "genuine" or "fake" per se. Instead, they likely have an entirely different social meaning.

Consequently, researchers have recently proposed a new social-functional typology based upon the contrasting social goals and functions of different smile types rather than the genuineness of the expression relative to the underlying emotion (Niedenthal et al., 2010). Specifically, the Simulation of Smiles (SIMS) Model divides smiles into three categories,

each serving a different basic human need that arises within the social environment.

Respectively, these needs are:

1. Reinforcing desired behaviours
2. Forming and maintaining social bonds
3. Negotiating social hierarchies

First, the “Reward Smile” is proposed to help reinforce desired behaviours in the perceiver. This hypothesised function is supported by research which shows that some smiles are particularly effective at reinforcing favourable outcomes in decision-making and social learning tasks (Heerey, 2014; Shore & Heerey, 2011). These findings are complemented by neural evidence which shows that more “genuine looking” smiles activate classic reward areas of the brain (McLellan et al., 2012). Consequently, it is theorised that viewing reward smiles induces positive affect in the perceiver, which then functions to encourage repetition of the behaviour that elicited the reward smile from one’s social partner to begin with, via reinforcement learning. Reward smiles are associated with a set of morphological features that include symmetrical activation of *zygomaticus major*, dimples, and raised eyebrows (Rychlowska et al., 2017).

Second, the “Affiliation Smile” is proposed to aid the formation and maintenance of mutually beneficial social bonds, by conveying an openness to establishing or reestablishing positive relations with a social partner. This contrasts with the classic view of non-reward smiles as potentially “fake” or misleading. Instead, Martin et al. (2017) argue that such smiles can be produced spontaneously irrespective of whether they arise from underlying positive affect. Such a proposition is supported by reference to apparent “greeting smiles” expressed by babies to strangers, which are not dissimulative, but do not reflect an internal happiness state either (Fox & Davidson, 1988). Affiliation smiles may also indicate appeasement or

embarrassment (Keltner, 1995; Hess et al., 2002). Notably, the former meaning corresponds with the function of the bared-teeth display in non-human primates, which usually serves to communicate non-threat or submission in most primate species (van Hooff, 1972; Waller & Dunbar, 2005) and hence encourages social co-operation rather than competition.

Researchers suspect that the human smile expression has evolved from such bared-teeth displays (van Hooff, 1972). Unlike reward smiles, affiliation smiles are associated with activation of the lip pressor and chin raiser action units (Rychlowska et al., 2017).

Finally, the third smile type proposed by Niedenthal et al. (2010) is the “Dominance Smile”, which is proposed to assert superiority over other social interactants. Although first described by Darwin (1872), this smile category deviates the most from Duchenne’s classic typology and has multiple potential uses. Within hierarchical structures, the dominance smile plays a key role in status negotiation, by either aiding challenges to higher-status hierarchy members or facilitating the suppression lower-status members. This occurs because — in contrast to the other smile types — dominance smiles do not tend to signal positive or prosocial intentions, but instead reflect relations that are asymmetrical in nature. This outcome is typically desired by the expresser but not the receiver. Furthermore, outside of social hierarchical contexts, dominance smiles may also be employed in order to distance oneself from a member of one’s own social group who has done something worthy of disapproval. Like affiliation smiles, dominance smiles are assumed to occur spontaneously and without the need for positive underlying affect. In fact, these smiles have been associated with non-positively-valenced feelings, including threat (Tipples et al., 2002). Nevertheless, despite frequently taking on antisocial intentions, Martin et al. (2017) hypothesise that dominance smiles may be effective at reducing physical violence during social interactions because they are more subtle and less threatening than other possible facial expressions that could be produced in such situations (e.g. prototypical anger or disgust displays). Dominance

smiles are typically associated with asymmetrical activation of *zygomaticus major*, which leads to an upturn in just one corner of the mouth (Rychlowska et al., 2017). Likewise, Rychlowska et al. (2017) argued that other action units previously associated with disgust may also characterise dominance smiles e.g. nose wrinkler and lip raiser.

Before this thesis, only a small number of papers had investigated how SIMS smiles are processed and evaluated (Martin et al., 2018; 2021; Rychlowska et al., 2017; 2021). Rychlowska et al. (2017) determined the morphological features of each smile type and confirmed that these smiles are perceived to convey separate social messages. This latter finding was replicated by Martin et al. (2018), who also found that SIMS smiles displayed by purported audience members had distinctive physiological effects on the autonomic activity of participants who had unexpectedly been selected to give a speech. Furthermore, these smiles also affect how the behaviour of the smiler is evaluated. Specifically, Rychlowska et al. (2021) showed that the deployment of these smiles by a partner differentially affected perceptions of their desire to repair a damaged interpersonal relationship and restore trust following untrustworthy behaviour. Finally, Martin et al. (2021) found that these smiles were anticipated to be encountered in different social contexts and induced different levels of trust during economic games.

Given the recency of SIMS smile classification and its origins from the emerging Behavioural Ecology approach, I argue that these smile types are both important for social interaction *and* under-researched. As a result, the studies in this thesis aimed to understand and compare how reward, affiliation, and dominance smiles — defined according to their respective morphologies — are evaluated and responded to. In particular, I investigated implicit / automatic responses to these different smile types, and how context alters their meaning. In addition, many of my dependent measures were inspired by the purported functions of these smiles.

The Role of Context within Social Interaction

Given their importance to social interactions, a wealth of research has explored the effects and meanings of facial expressions. However, much of this empirical work is limited because it lacks ecological validity. In particular, most research has utilised static photographs of posed, prototypical facial expressions, in accordance with the traditional Basic Emotion view that expressions are automatically recognised (Izard, 1994). This approach is common in social psychological research (e.g. Righart & de Gelder, 2008a; 2008b), as well as in cognitive neuroscience (e.g. Breiter et al., 1996; Phillips et al., 1997; Sprengelmeyer et al., 1998) and clinical psychology (e.g. Kohler et al., 2010). Nonetheless, in everyday interactions facial expressions are not static, posed, or prototypical. Instead, they are dynamic displays, and rarely conform to prototypes (e.g. Reisenzein et al., 2006). This restricts the extent to which many empirical findings can be generalised from the lab to the real world.

Perhaps just as importantly, the prototypical static expressions presented to participants are also limited ecologically because they typically fail to include any accompanying contextual information (i.e. information present other than the face). This approach reflects the Basic Emotions view that affect perception is a feedforward “pattern matching” process, with contextual information integrated into face processing only after the facial is identified (e.g. Vuilleumier & Pourtois, 2007). The exclusion of such context in the overwhelming majority of face perception studies is problematic, given that the faces of others are always encountered within some sort of context during everyday interactions, including situational, vocal, bodily, and dispositional information. In fact, as described in the following section, an extensive body of research has found that contextual information has a significant influence on facial expression interpretation (e.g. Aviezer et al., 2008a; 2008b; 2017; Masuda et al., 2008; 2012; Mui et al., 2020; Namba et al., 2020).

Context Effects on Facial Expression Evaluations

Well-established principles of perception stemming back to Helmholtz (1867) suggest that top-down contextual variables are likely to influence how facial expressions are perceived and evaluated. Empirically, a multitude of research supports this idea, with evidence across a range of different context manipulations (for review, see Gendron et al., 2013; Wieser & Brosch, 2012). Indeed, the first major literature review into this area neatly summarised the idea that context is fundamental to facial expression evaluation, stating that “all in all, one wonders about the significance of studies of the recognition of ‘facial expressions of emotions’, in isolation of context” (Bruner & Tagiuri, 1954, p. 638).

Most of the research into context effects on face processing has explored factors relating to the expresser. This includes eye gaze, body language, other people, sensory stimuli, and the situation the expresser is in.

Eye Gaze

Starting within the face itself, contextual information can be derived from the expresser’s gaze, which consistently influences both the accuracy and reported intensity of perceived emotional expressions. Eye gaze effects appear to vary depending upon the emotion displayed, as angry expressions typically appear more intense and more recognisable when eyes are directed towards — rather than averted away from — the observer, whereas the opposite pattern has been described for fearful faces (Adams, 2003; Adams & Kleck, 2005). Intuitively, this suggests that the focus of an expresser’s attention — as indexed by eye gaze — provides information about the meaning of their expression.

Body Language

Extensive literature has shown that the physical array in which the face is perceived in — referred to by Gendron et al., (2013) as “stimulus-based context” — influences facial expression perception. Notably, much of this work has examined the role of body language.

As described by Darwin (1872), a person’s face and body are part of an integrated whole, both physically and functionally. Therefore, the affect signalled by one is likely to be informative about the affect signalled by the other. To this end, research extending back to Kline and Johanssen (1935) has found that emotion identification is enhanced when emotional facial expressions are displayed with a congruent body posture or gesture. These authors presented participants with photos of an actress posing 20 different facial displays, either in full (with shoulders and upper torso visible) or cropped with all non-facial information removed. Emotion recognition accuracy was higher in the full compared to cropped condition, which suggests that the actress’s body helped participants to accurately label her facial expression.

More recently, Aviezer et al. (2008a, 2008b) showed that identical disgust expressions were categorised as conveying a variety of contrasting emotions dependent on the configuration of the attached body. For example, a disgusted expression was more likely to be labelled as displaying pride than disgust when superimposed onto a body with arms raised in triumph. This effect replicated even when participants were instructed to avoid using context or informed that the context was irrelevant (Aviezer et al., 2011). Similarly, Aviezer et al. (2012) later found that participants were largely unable to judge whether tennis players had just won or lost a point when given photos of just their faces. However, they were very proficient at accurately judging the outcome of points when provided with a photo of the player’s body alone (with the face blurred out) or the full photo of both the face and body.

Together, this evidence suggests that one's body language can fundamentally alter the meaning of a facial expression.

Other Faces

Another well-studied contextual cue is the presence of other faces within a scene. Traditionally, research on the effect of other faces on facial expression evaluation utilised a sequential "perceptual adaptation" paradigm. For example, Thayer (1980) showed that expressions were rated as more intense when they followed expressions of the opposite valence. Researchers have also presented other faces simultaneously alongside the target expression. Russell and Fehr (1987) observed that a neutral face was typically described as "calm" when presented alone, but when presented next to a smiling face it was described as "sad". These results paralleled earlier work by Cline (1956), who presented line drawings of two faces (a target face and a context face) oriented towards each other. Participants rated target smiles as bolder when paired with a low-arousal "glum" contextual expressions than when paired with high-arousal "frown" expressions. Cline suggested that the pair of expressions are perceived as representing a social interaction, in which one's frown causes the other's sadness.

More recently, Mumenthaler and Sander (2012; 2015) expanded on this research by positing that the effect of the contextual face depends upon its orientation. In their 2012 paper, target expressions were rated as more fearful when a contextual face expressed anger, as opposed to fear or a neutral expression. Importantly however, this effect *only* occurred when the contextual face looked towards (rather than away from) the target. Their subsequent 2015 paper replicated this effect even when the contextual face was visible for only 20 milliseconds. Together, this indicates that expression evaluation may only be influenced by "relevant" contextual information.

Vocal Affect

Outside of the visual modality, other biological features of the expresser have also been shown to influence facial emotion judgements. In the auditory domain, vocalisations are thought to convey affective valence (Bachorowski & Owren, 2008; Pereira, 2000) and affective arousal (Bachorowski, 1999; Pittam et al., 1990), both of which influence how facial expressions are evaluated. For example, de Gelder & Vroomen (2000) showed that emotion recognition from emotionally ambiguous faces was strongly biased by the affective tone of simultaneously presented utterances, even when participants had been instructed to focus on the face alone. Although most research shows that this auditory context effect is strongest when the facial stimulus is neutral (Massaro & Egan, 1996) or noisy (Collignon et al., 2008), congruent face-vocalisation combinations have also been shown to facilitate accurate emotion recognition (Pell, 2005).

Situational Context

Finally, and most importantly for this thesis, our interpretation of facial expressions can also depend on the situation that the expresser is perceived within. The situational context can be manipulated using various methods.

Many researchers have relied on verbal vignettes, which ask the participant to imagine the situation that the expresser is in when they evaluate their expression. For example, Goodenough and Tinker (1931) paired photos of emotional expressions with vignettes describing situations that supposedly elicited the expression. For each combination of expression and vignette, participants chose the experienced emotion from a list of four options. Although Goodenough and Tinker found that the situation took precedence in most combinations (7/12), subsequent researchers failed to replicate these results. Instead, later researchers observed heavy “expression dominance” in emotion recognition (e.g. Knudsen &

Muzekari, 1983; Watson, 1972). Notably, Frijda (1969) revised the original paradigm by asking participants to first rate the expressions and vignettes separately. In a later testing session, ratings of the combined expression-vignette stimuli were far closer to prior expression ratings than prior vignette ratings.

Nonetheless, later theorists have since challenged many of the findings underpinning purported expression dominance. Fernandez-Dols et al. (1991) suggested that vignettes lack influence in the expression-scenario paradigm simply because — unlike with faces — participants lack real-life experience in categorising situations using emotional terms. When participants practiced context categorisation with emotion words, the influence of context on ratings substantially increased. Moreover, Carroll and Russell (1996) outlined several additional reasons for scepticism about the expression dominance observed in previous studies. For example, incongruent combinations of expressions and situations may have led the observer to believe that crucial situational information was missing, leading them to reinterpret the situation by imagining additional detail. When using vignettes that matched the pleasantness and arousal of the expression — but not the discrete emotion — Carroll and Russell found most participants selected an emotion corresponding to the situation rather than the expression.

Moreover, other studies have expanded upon such findings, investigating the conditions under which context effects are enhanced. For example, the extremeness of the accompanying situation interacts with the magnitude of contextual effects. Specifically, Carrera-Levillain and Fernández-Dols (1994) found that emotional ratings of neutral faces were more likely to be influenced by context when the situation was mild (e.g. missing a train) than extreme (e.g. a mountaineering accident). This implies the existence of an intensity threshold, which — when exceeded — is associated with a reduced effect of context on emotion perception.

Despite its widespread use, it has been argued that the expression-scenario paradigm may lack contextual realism. Indeed, when studies manipulate situational context by using more vivid visual stimuli, they tend to find stronger context dominance. An early example, Munn's (1940) "candid picture" paradigm, showed that evaluations of real-life expressions taken from photos in popular magazines were heavily altered by the presence or absence of the surrounding situations. This point was perhaps made most strongly in an elegant series of experiments conducted by Wallbott (1988a, 1988b). In his first experiment, Wallbott used the classic expression-scenario paradigm pioneered by Goodenough and Tinker. As expected, the facial expression influenced expression evaluations far more than the accompanying vignette. However, when faces were presented with photo contexts in his second experiment, the difference between relative effects of face and context was much reduced. Finally, in a third experiment using video contexts, Wallbott instead found the reverse, i.e. a clear context dominance which he attributed to the vivid immediacy of the footage. Likewise, Chen and Whitney (2019) observed context dominance using an "affective tracking" methodology, whereby participants continuously rate the valence and arousal of characters in videos. Notably, when participants rated home videos and documentaries, context explained a higher proportion of unique variance in affect ratings than expressions did. This finding was later replicated using a similar "emotion tracking" methodology (Chen & Whitney, 2020). Consequently, it appears that context effects are magnified when contextual realism is enhanced.

In fact, the power of visual video contexts in affecting facial expression evaluations has been apparent since the work of 1920s Soviet filmmaker Lev Kuleshov, who spliced close-up shots of neutral expressions with footage of different emotional scenes (Tsivian et al., 1996). Depending upon the nature and content of the subsequent context, viewers perceived the neutral face as displaying either happiness, sadness, or hunger. Despite

intermittent debate about the validity of this effect over the intervening century (Goldberg, 1951; Prince & Hensley, 1992; Mobbs et al., 2006), a robust empirical display of the Kuleshov Effect was provided by Barratt et al. (2016), who found that for each of five video contexts, participants rated expressions as displaying the congruent contextual emotion more frequently than alternative options. Further, valence and arousal ratings were also influenced by the emotional context. Together, this research suggests that situational context has substantial effects on how faces are perceived. Not only can a situation change how an emotional expression is evaluated, it can also project emotion onto faces that are “expressionless”. These effects can be found irrespective of the methodology used to manipulate situational context.

Combinations of Cues

Although each of the contextual cues described above can have independent effects on facial expression evaluation, in real-life interactions, people integrate an array of social and contextual cues that may indicate the feelings and intentions of others. This includes speech content, facial expressions, body language, situation, etc. Effects of these cues are likely to be both additive (combining to strengthen an impression) and interactive.

To this end, some studies have altered both situational and body contexts simultaneously. For example, Reschke et al. (2018) assessed the categorisation of disgust expressions displayed with either (1) body postures alone, or (2) body postures *and* visual scenes. They found that angry postures strongly interfered with accurate categorisation of the disgust expressions, whereas fear, sadness, and joy postures did not. Nonetheless, this effect of posture was modified when visual scenes were added to the stimuli. Specifically, both sad and fearful posture-scene combinations led to less accurate categorisations of disgusted expressions. This suggests that a larger amount of contextual information (i.e. *both* posture *and* scene) may be required to produce context effects in some cases.

More recently, Reschke and Walle (2021) examined the independent and interactive effects of body posture and visual scenes on emotion evaluation, using six different facial expressions. When expression, posture, and scene were incongruent, participants categorised expressions according to facial expression 61% of the time, posture 18%, and scene 11% of the time. Nonetheless, body posture had a larger influence on emotion categorisation than the expression for some combinations. In contrast, scenes only enhanced or attenuated the posture effect, and never overrode the expression, suggesting that person-based contextual cues are more influential than external cues in emotion interpretation.

Such complexity in cue integration has been largely ignored by social psychologists but has been highlighted by the emerging computational field of Social Signal Processing (SSP – e.g. Brunet et al., 2009; 2011). SSP researchers argue that by focusing on the isolated contribution of single variables, researchers lack the information required to build more powerful and comprehensive models of social behaviour. Instead, they recommend that multiple cues are measured and recorded at the same time. In the present thesis, I aim to adhere to this idea. Specifically, I investigate interactions between different types of expressions and different types of situational context. Furthermore, I assess the potential moderating effects of adjacent social processes (e.g. eye gaze and mimicry) on these interactions.

Theories of Contextual Influence

Several theories have been proposed to explain the cognitive processes and mechanisms by which contexts affect evaluations and responses to facial expressions.

Source Clarity

Ekman et al. (1972) proposed a simple yet intuitive theory to predict the extent to which contextual factors would influence judgements of facial expressions. Specifically,

these authors argued that the extent to which each source of information would play a role in a “judgement of combinations” would depend on the “source clarity” of each individual source. The clarity of each source was defined as "amount or type of information available to observers when they are exposed to a single source" (p. 138). Ekman et al. (1972) suggested that the source clarity of individual cues was determined by three separate features of the cue:

1. Emotion ambiguity i.e. the extent of agreement as to the presence or absence of a specific emotion
2. Message complexity i.e. whether a single emotion or blend of emotions are present
3. Message strength i.e. the intensity of the emotion observed

To exemplify this, Ekman et al. (1972) put forward a methodological critique of the original Goodenough and Tinker paradigm, which highlighted the importance of source clarity in determining the relative potency of different sources of information. When source clarity was equated across expressions and contexts in a later paper, strong expression dominance was observed (Nakamura et al., 1990).

Ekman et al.’s model was later subtly developed by Trope (1986), who suggested a two-stage model of face processing. In the first stage, facial emotion is identified, whilst in the second stage, dispositional inferences are made about the expresser. Within the first stage, Trope postulated that facial cues are combined with both situational information and prior knowledge of the expresser. To identify emotion from a face, we must consider the ambiguity of both the emotion and the context. Hence, context effects should be enhanced when the face is more ambiguous, but attenuated when the face is less ambiguous. As hypothesised, this is exactly what Trope (1986) found when he conducted an experiment that paired either ambiguous or unambiguous faces with short situational vignettes.

Limited Situational Dominance

A later influential model was developed by Carroll and Russell (1996), who based their theory on the circumplex model of emotion (Russell, 1980). Russell's circumplex model describes emotions along two continuous bipolar dimensions: valence (pleasantness) and arousal (intensity). Valence ranges from positive (pleasant) to negative (unpleasant), while arousal ranges from high (excited) to low (calm). Emotions are positioned based on their combination of these two factors, allowing for a spectrum of emotional states rather than discrete categories. For example, happiness is high in both valence and arousal, while sadness is low in valence and arousal.

Building on this idea, Carroll and Russell proposed that whilst facial expressions provide unambiguous information about a person's affective valence and arousal, they are not informative about the specific emotion experienced. Instead, it is context that helps observers to categorise valence and arousal as a discrete emotion. Consequently, emotion evaluations should be highly influenced by context, whereas valence and arousal ratings should remain relatively unaffected. The researchers referred to this theory as supportive of "limited situational dominance" (p. 206). Although a valuable model in the sense that it postulated a greater role for context effects, various findings have since questioned central tenets of Carroll and Russell's theory.

Emotion Seeds

In particular, Carroll and Russell's hypothesis was strongly challenged by Aviezer et al. (2008a), who found that (1) arousal ratings of sad expressions and (2) valence ratings of disgust expressions were strongly influenced by their body contexts. According to Aviezer and colleagues, these findings contradicted the view that facial expressions provide faithful

readouts of underlying valence and arousal and hence should be largely immune to contextual influence.

To replace this earlier model, Aviezer et al. (2008a) instead proposed the “Emotion Seeds” theory, which suggests that the effect of body language on expression categorisation is moderated by the visual similarity between (1) the target expression and (2) the facial expression typically associated with the body context. According to this theory, “emotion seeds may be thought of as expressing the perceptual information shared by different facial expressions. Although these seeds lie dormant in isolated faces, they can be activated by appropriate context” (p. 731). Therefore, the more similar the respective expressions (i.e. the more “emotion seeds” they share), the greater the expected context effect.

To support this view, Aviezer et al. (2008a) found that when categorising prototypical disgust faces, the extent to which bodily emotions influenced expression categorisation varied greatly. Specifically, emotion recognition accuracy was lowest when the disgust expression was presented with an angry body, in comparison to sad and fearful body contexts. Aviezer et al. argued that the perceptual similarity between prototypical anger and disgust faces was high, and therefore participants were more likely to endorse the idea that the face displayed anger, given the angry body language of the target person. In contrast, there was little perceptual similarity between a prototypical disgust expression and prototypical sad or fear expressions. As a result, sad or fearful body language was less likely to influence face categorisation. Similar results were later found by Reschke et al. (2018) and Reschke & Walle (2021), as described in the previous section.

Together, these findings highlight certain limitations to the models developed by Ekman et al. (1972) and Trope (1986). First, these earlier theories predicted that the magnitude of context effects would be determined entirely by source ambiguity, with no

differentiation between different facial expressions. Likewise, both models assumed that the least ambiguous facial expressions (and hence the facial expressions least likely to be influenced by context) would be the prototypical “Basic Emotion” expressions. Aviezer et al.’s results challenged both of these ideas by showing that (1) context effects varied across facial emotions, even when matched for source clarity, and (2) evaluations of Basic Emotion expressions — supposedly highly unambiguous — could be strongly moderated by situational and body context.

Meaning of Emotional Expression in Context (MEEC)

More recently, the Meaning of Emotional Expression in Context model (MEEC — Hess & Hareli, 2016; 2017) has challenged Aviezer’s Emotion Seeds theory. Hess and Hareli base this model on earlier work into emotional appraisals i.e. evaluations people make about a situation or event that leads to emotional responses. According to appraisal theorists, emotions arise based upon how individuals assess their environment, rather than occurring as automatic reactions to stimuli (e.g. Arnold, 1960; Lazarus, 1991; Smith & Lazarus, 1993). These evaluations include the significance of the event to personal goals, its controllability, and its implications for wellbeing.

Building upon this work, the MEEC Model proposes that it is actually the similarity between *core appraisals* of the expressed emotion and context emotion — not the perceptual similarity between the associated facial expressions — which limits the impact of context on emotional expression evaluations. Accordingly, participants most easily confuse emotions that share core appraisals, not perceptual expression similarity. Thus, the MEEC reinterprets Aviezer et al.’s (2008a) results because the body contexts with the least effect on accuracy (fear and sadness) are also far less compatible with the appraisal pattern for disgust than anger is. Therefore, ambiguity in emotional appraisals may also facilitate context effects.

Bidirectional Context

Each of the models described above has advanced this field of research both theoretically and empirically. Furthermore, each of them seems to have some degree of explanatory power for predicting the extent to which context affects evaluations of different expressions. For example, each seems to plausibly explain certain empirical results (e.g. Aviezer et al., 2012; Nakamura et al., 1990; Reschke et al., 2018). Nonetheless, all are limited in their scope.

First, none of the established theoretical models consider that the relationship between situational context and facial expressions is likely bidirectional. According to classic appraisal theories, emotions are produced by cognitive appraisals about the nature of the present situation or event (e.g. Frijda, 1986; Scherer, 2001). Given that facial expressions therefore reflect a person's evaluation of the current situation/event, it follows that their expressions also provide information about both (1) the goals of the expresser (Hareli & Hess, 2010), and (2) the situation itself. For example, Hareli et al. (2013) found that when witnesses to an event showed anger, observers conclude that a norm had been violated. Hence, social appraisal of other's facial expressions biased participants' personal appraisal of the situation.

A small number of studies have investigated the extent to which facial expressions affect evaluations of contextual information. Hess et al. (2018) found that angry and disgusted expressions produced by supposed witnesses to a behaviour significantly increased participants' ratings of the behaviour's immorality and impoliteness in comparison to when the witnesses displayed neutral facial expressions. The same lab also found that judgments of performance quality in an ambiguous game were strongly influenced by the facial expressions of spectators (Hess et al., 2020). Similarly, two studies have found that facial expressions significantly bias the emotional categorisation of the same target's body language

(Kret et al., 2013; Lecker et al., 2020). However, in both studies, categorisation of facial expressions was influenced more by body language than vice versa. Lecker et al. (2020) hypothesised that this asymmetry reflects the fact that we regularly practice integrating context into the interpretation of facial expressions. In contrast, we have comparatively little experience of integrating facial expressions into context evaluations, which reduces their relative effect.

Given the lack of extant research looking at effects of facial expressions upon evaluations of situational context, my thesis tests this relationship in addition to testing the effects of situational context on facial expression evaluations.

Context and Smile Types

A further problem with the scope of existing theoretical models is that each only describes how context influences the perception of *emotions* from faces. None of the models make predictions about how situational context affects either (1) non-emotional interpretations of facial expressions or (2) interpretations of non-emotional expressions.

This oversight reflects the paucity of research in this area. For example, until 2020, very few papers had investigated how context affects evaluations of different smile types. In that year, Namba et al. (2020) presented participants with photos of non-Duchenne smiles and found that “happy” visual background contexts (e.g. a beach) led to increased ratings of smile genuineness relative to when these expressions were presented in isolation, whereas “polite” background contexts (e.g. a pharmacy) were associated with reduced genuineness. This pattern of results was observed in both Japanese and British samples and was then replicated in an additional experiment which used verbal vignettes to manipulate contextual meaning instead. In the same year, Mui et al. (2020) obtained similar findings with dynamic smile stimuli. Videos of Duchenne smiles presented alongside a verbal vignette of a negative

situation were rated as less genuine than the same smiles rated in isolation. Once more, this finding was replicated in both Western (American) and Eastern (Chinese) participant groups, although context effects were greater for the latter — as expected given earlier findings (e.g. Masuda et al., 2008; 2012).

Whilst undoubtedly providing a promising baseline for future research, it must be noted that the two studies described above relied upon the Duchenne/non-Duchenne smile typology in which different smile types are conceptualised to represent varying levels of genuineness. In addition, both studies looked at just one type of smile, and therefore neither investigated how context effects vary according to the type of smile displayed. In fact, to date, only one study has contrasted the effects of context across different smile types. Specifically, Gagnon et al. (2022) found that smiles were rated as more sincere when displayed by smilers with a prior tendency to return favours in comparison to smilers who didn't tend to return favours. Counter to their hypothesis, this effect was stronger for genuine (Duchenne) smiles than fake (non-Duchenne) ones. Nonetheless, these researchers manipulated dispositional rather than situational information, and therefore we must be careful about generalising such results to situational context.

To my knowledge, no previous studies have investigated how the effects of situational context vary across different smile types — potentially a key moderating factor. In addition, previous studies have examined the emotional categorisation or perceived genuineness of smiles rather than their social function. Given this gap in the literature, my thesis investigates how context affects socio-functional evaluations of smile types defined according to the newer SIMS model typology (Niedenthal et al., 2010; Martin et al., 2017).

Automaticity of Context Effects

Finally, existing models of contextual integration offer little detail about the speed and automaticity of this process. This is an important area of research because it has major implications for the mechanisms by which context is integrated into face processing. Specifically, we don't know whether context implicitly changes how observers perceive facial expressions, or whether it simply alters the way in which observers infer a person's experienced emotion via a more controlled deliberative process.

Aviezer et al. (2008, Study 3) showed that body context quickly altered visual scanning patterns — often by the time of the first fixation to the face — which indicates that body context may be quickly integrated into expression processing. This idea is further supported by the rapid modulation of the early P1 Event Related Potential (ERP) observed by Meeren et al. (2005) for incongruent expression-body pairings. Such a finding is potentially highly significant because the P1 is typically observed just 100 ms after stimulus onset. However, it remains debatable whether the P1 component reflects processing of higher-level features like faces, as opposed to more low-level visual features (Rossion & Caharel, 2011, Rossion & Jacques, 2008).

Nonetheless, ERP research has provided various insights into the time course of the face-context integration process. For example, researchers have recently postulated the existence of an automatic “double-check mechanism” during context integration, which suggests that observers perform a check of (1) valence congruency, followed by a check of (2) discrete emotion congruency (Dieguez-Risco et al., 2015). Valence congruency refers to whether the face and context share the same valence (i.e. whether they are both positive or both negative). Discrete emotion congruency refers to whether the face and context share the same associated emotion (e.g. happiness, anger, sadness, etc). Importantly, Aguado et al. (2019) found that this double check appears to be completed very quickly, as the N170

component — typically observed 170 ms after stimulus onset — was amplified when fearful expressions appeared in angry versus fearful verbal contexts. This ERP component amplification indicates that early face processing may be sensitive to emotional congruency between the target expression and its situational context, rather than mere valence congruency as past studies have found (e.g. Dieguez-Risco et al., 2015). In turn, this suggests that the semantic integration of face and context happens automatically, without time for conscious cognition.

Nevertheless, the validity of context effects on early the N170 component has not been conclusively established. First, other studies have failed to find that the N170 is modulated by emotion incongruence (e.g. Dozolme et al., 2015; Krombholz et al., 2007; Paulmann & Pell, 2010). Moreover, an effect on the N170 has only been definitively observed in tasks where participants either (1) were instructed to make explicit congruency judgements (e.g. Aguado et al., 2019; Dieguez-Risco et al., 2015), or (2) took part in an affective priming paradigm (e.g. Hietanen & Astikainen, 2013). In contrast, N170 modulation is not found in tasks where participants make emotion recognition judgements or when context is presented simultaneously with the facial expression (e.g. Aguado et al., 2019; Dieguez-Risco et al., 2013). This aligns with extensive evidence indicating that the N170 can be influenced by various top-down, controlled processes, such as reappraisal, selective attention, and task demands (Blechert et al., 2012; Cauquil et al., 2000; Goffaux et al., 2003; Rellecke et al., 2012; Wronka & Walentowska, 2011). As a result, alteration of this ERP component in certain studies may not reflect automatic integration of face and context, but instead may reflect the influence of top-down cognitive strategies.

Finally, whilst some previous research has found increased N170 amplitude for *congruent* trials (e.g. Hietanen & Astikainen, 2013; Righart & de Gelder, 2006; 2008a; 2008b), other studies have found increased N170 amplitudes for *incongruent* trials (e.g.

Aguado et al., 2019; Dieguez-Risco et al., 2015; Herring et al., 2011, Werheid et al., 2005). Whilst methodological explanations for this inconsistency have been proposed (e.g. Dieguez-Risco et al., 2015), the evidence of a context effect on early ERP components like the N170 is clearly somewhat mixed. Consequently, further empirical work is required to make stronger conclusions about the automaticity of context integration in face processing. The present thesis contributes to this literature by exploring the speed of face context integration, and the likely psychological mechanisms underpinning this process.

The Second-Person Approach

The vast majority of research investigating how facial expressions are evaluated uses “isolation paradigms” (Becchio et al., 2010), during which participants merely observe and make judgements about other people (typically via a computer screen), rather than actually interact with them. This type of research is grounded within classic “third-person” or “spectator theories” of social knowing, which have traditionally been central to Western study of mental processes (Dewey, 1922). More specifically, spectator theories view participants as detached from the social scene rather than actively engaged within it. Participants must therefore make inferential leaps in order to understand others’ psychological states, based upon constrained information that they passively acquire.

On one hand, these isolation paradigms undoubtedly have great utility because they allow extraneous variables to be controlled relatively simply. Furthermore, they can be easily complemented by additional methodological techniques (e.g. eye tracking, neural recording, electromyography, etc). Nevertheless, despite their long history of use, isolation paradigms are inherently limited because they don’t tap into certain aspects of actual face-to-face behaviour which drive social outcomes. Instead, as argued by Heerey (2015), almost all conclusions have been derived from either (1) “pseudo-social interactions”, in which

participants compete or co-operate with simulated/computerised partners (e.g. during economic games), or (2) experiments in which social stimuli have low ecological validity (e.g. examining how facial expressions in static photos predict trait evaluations). Such experiments typically lack any interactive element.

Therefore, whilst isolation paradigms undoubtedly correlate with real-world outcomes to a certain extent, there are disconnections between this research and observed social behaviour in face-to-face settings. Heerey (2015) cites many examples of such disconnections. For example, a large proportion of autistic people perform adequately on tests of socio-emotional functioning but still experience considerable cognitive difficulty during real-life interactions with social partners (Stone & Gerrans, 2006). Furthermore, a double dissociation between social cognition and real-world social performance can be observed by comparing these autistic samples to schizophrenia patients, who often have severe socio-cognitive impairments despite conserved social interaction ability (McCabe et al., 2004). Finally, there is also obvious variation in interactive ability between different members of the neurotypical population, despite preserved performance on measures of social cognition across this group (Skuse & Gallagher, 2011). Therefore, despite considerable overlap, the requirements of computer-based isolation paradigms seem to diverge somewhat from the requirements of actual face-to-face interaction.

The Foundations of the Second-Person Approach

As a result of the inherent limitations associated with isolation paradigms, a modern methodological perspective — referred to as the “Second-Person Approach” — has been proposed in an attempt to provide a more interactive alternative way of studying social and affective processes (Schilbach et al., 2013). At a broader theoretical level, second-person research is part of a wider movement — summarised by the term “4E Cognition” (Newen et

al., 2020) — which emphasises that cognitive processes are embedded, embodied, enacted, and extended. Hence, cognition must be studied with these characteristics in mind.

For the purposes of the second-person approach to social functioning, perhaps the most important pillar of the 4Es is the concept of *embedded* cognition, which views perception and cognition as active rather than passive processes. Interactants are embedded within and coupled with the external environment (Thompson, 2010). Importantly, by conceiving social cognition as embedded, researchers can capture additional sources of variation in social functioning ability which may be neglected or overlooked by third-person research. In particular, social agents are able to use extra information in the form of “affordances” (Gibson, 1986) — loosely conceptualised as the opportunities encountered as people traverse and manipulate the world around them. With this in mind, Schilbach et al. (2013) argue that social interaction necessarily requires an interactant to perceive the environment as containing collective or “shared” resources (i.e. mutual affordances) rather than merely the resources held by each interactant alone. As a result, knowledge of the other person can be at least partially derived from the inter-agent interaction dynamics, rather than an inferential leap.

In addition, for the purposes of second-person research, another crucial pillar of the 4Es is *embodied* cognition, which suggests that social cognition also depends on “non-mental” physiological bodily processes as well as mental activity. This idea fits neatly with Hess and Fischer’s (2013; 2014) Mimicry in Social Context model, which built upon decades of historical research to argue that mimicry is an affiliative and social process that is “both influenced by and conducive to affiliation”. Such an idea is supported by research showing that participants are much less likely to mimic partners producing “deviant” facial expressions i.e. expressions that are incongruent with the social context (Kirkham et al., 2015; Kastendieck et al., 2021).

Empirical Second-Person Research

At a practical empirical level, a direct consequence of the principles outlined above is that second-person research examines social processes within the context of real-time reciprocal social interaction (either real or perceived), using experimental paradigms that place participants within ecologically valid situations. Furthermore, data may be collected from multiple individuals as they participate in an interaction in order to assess how the experiences of one partner affect the experiences of others.

Recent examples of experimenters using this second-person approach can be found across psychology and neuroscience (see Redcay & Schilbach, 2019 for a review). However, whilst these studies offer important foundations for subsequent research, Redcay and Schilbach (2019) acknowledge that very little/no research has yet assessed dynamic and unconstrained social interactions, or the role facial expressions and other social cues play within such contexts. As a result, the present thesis seeks to utilise the second-person framework in order to study the interaction between contextual and situational factors in facial expression processing. Specifically, in Chapter 5, I conducted a virtual reality (VR) study where participants begin a face-to-face interaction with a realistic virtual avatar who displays a facial expression. Moreover, given the importance of embodied cognition to social interaction, I used electromyography (EMG) as a dependent variable in this VR experiment. Considered a proxy for interaction quality (Hess & Fischer, 2013), measuring mimicry allows the relative social consequences of different smile types and different contexts to be indexed.

Although I have extolled the virtues of the second-person approach in this section, I do not view this type of research as “better” than traditional third-person studies. Instead, second-person experiments are intended to complement third-person research by serving as a testbed for experimental findings that should later be assessed in a more controlled way (or vice versa). Accordingly, in this thesis I present well-controlled isolation paradigms, before

using a second-person set-up in the final chapter, intended to evaluate whether a second-person approach provides convergent evidence with third-person studies.

Overview of the Current Thesis

In sum, this thesis aims to address gaps in the literature on the social functions of smiles, and how context influences our responses to these smiles, whilst utilising various methodological techniques to investigate these phenomena. Consequently, this thesis tackles the broad research question: **How do morphological and contextual cues combine to influence the processing of social smiles?**

To answer this question, I specifically investigated the following sub-questions:

1. How do morphological and contextual cues affect explicit social evaluations of smiles and contexts?
2. What psychological mechanisms influence how smiles and contexts are combined?
3. Do morphological and contextual cues implicitly affect subsequent behavioural responses to smiles?
4. Do morphological and contextual cues influence social responses in scenarios more equivalent to real-life social interactions?

Ultimately, this thesis attempts to further our understanding of how context influences processing of different smile types, and vice versa. This research starts by investigating effects on explicit ratings before moving on to testing implicit behavioural responses (e.g. approach-avoidance responses and mimicry). The first three empirical chapters therefore employ simple “third-person” isolation studies, whilst the final empirical chapter uses an embedded and embodied “second-person” VR plus EMG approach.

In Chapter 2, I investigated how morphological and contextual cues affect explicit social evaluations of smiles and contexts. I aimed to obtain initial evidence of (1) the extent to which evaluations of different functionally-defined smile types are susceptible to the influence of situational context and (2) the extent to which evaluations of different situations are influenced by types of smiles seen within them. To do this, I conducted three separate studies. In Study 1, participants rated reward, affiliation, and dominance smiles along a range of social dimensions. I tested whether ratings of these smiles would be altered when the smiles were seen within either positive (enjoyment), neutral (polite), or negative contexts. In Study 2, participants saw exactly the same stimuli. However, this time, participants were asked to rate the situations, along dimensions that were equivalent to the smile rating scales in Study 1. Finally, in Study 3, I tested whether any effects of context or smile type would be more apparent when participants played a Trust Game with hypothetical interaction partners.

In Chapter 3, I examined the psychological mechanisms that influence how smiles and contexts are combined. I aimed to determine whether the moderating effects of context observed in Chapter 2 were attributable to either attentional or cognitive processes. To do this, participants completed the same tasks as in Study 1 and Study 2 in Chapter 2. However, participants' eye movements were recorded to assess whether there were any differences in attention allocation across smile types and/or situational contexts. In addition, the design was modified so that decision time — an index of cognitive deliberation — could be evaluated to determine the effects of smile type and context category. This enabled me to test the comparative impact of attention and cognition on context/smile integration.

In Chapter 4, I explored whether morphological and contextual cues implicitly affect subsequent behavioural responses to smiles. Specifically, I tested whether approach-avoidance responses towards faces-in-context were affected by the type of smile or type of context, even when task-irrelevant. To do this, I conducted four studies using a mobile app-

based approach-avoidance task (AAT). In each study, participants were required to push (“avoid”) or pull (“approach”) their phone according to an aspect of the face-in-context stimulus. In Study 5, I tested whether response times towards situations were affected by the smiles displayed within them. In Study 6, I tested whether response times to smiles were affected by the situational contexts they were expressed in. In Study 7, I tested whether the findings of Study 6 could be replicated when presenting facial stimuli that are more morphologically dissimilar i.e. happy and angry faces. Lastly, in Study 8, I tested whether responses were affected when both the smile type and situational context were irrelevant to the task.

In the final empirical chapter (Chapter 5), I asked whether morphological and contextual cues influence social responses in scenarios more equivalent to real-life social interactions. Using a VR / EMG set-up, I aimed to determine whether mimicry of an interaction partner’s facial movements — often used as an index of interaction quality — was affected by either the type of smile expressed or the situational context that the smile was seen within. This allowed me to determine whether effects established in previous chapters generalised to a more ecological setting, akin to everyday interactions.

CHAPTER 2: THE EFFECTS OF SMILES AND SITUATIONAL CONTEXTS ON EXPLICIT PARTICIPANT EVALUATIONS

Abstract

Smiles provide information about a social partner's affect and intentions during social interaction. Although smiles are always encountered within a specific situation, the influence of contextual information on smile evaluations has not been widely investigated. Moreover, little is known about the reciprocal effect of smiles on evaluations of their accompanying situations. In this chapter, I assessed how different smile types and situational contexts affected participants' explicit social evaluations and subsequent investment decisions. In Study 1, 85 participants rated reward, affiliation, and dominance smiles embedded within either enjoyable, polite, or negative situations. Context had a strong effect on smile ratings, such that smiles in enjoyable contexts were rated as more genuine and joyful, as well as indicating less superiority than those in negative contexts. In Study 2, 200 participants evaluated the contexts that these smiles were perceived within (rather than the smiles themselves). Although situations paired with reward (vs. affiliation) smiles tended to be rated more positively, this effect was absent for negative situations. In Study 3, 141 participants completed a one-shot Trust Game (in the role of the "investor") with a series of smiling partners ("trustees") in enjoyable, polite, or negative contexts. Paralleling the results of Study 2, investors invested more with trustees displaying reward smiles than affiliation smiles, but this effect was absent in negative contexts. Ultimately, these results indicate a reciprocal relationship between smiles and contexts, suggesting that context significantly modifies how people evaluate and respond to smiles during social interactions. Further, facial expressions influence evaluations of situational contexts.

Introduction

A wealth of social and affective research shows that contextual information impacts responses to prototypical displays of facial emotion (see Wieser & Brosch, 2012, for a review). Emotional evaluations and categorisations of facial expressions are influenced by a range of social cues, including the situation (Goodenough & Tinker, 1931), vocal affect (de Gelder et al., 2005; Tsankova et al., 2015), and body language (Aviezer et al., 2008a). Moreover, these contextual cues can often overlap with one another. For example, Reschke et al. (2018) found that sad and fearful posture-scene combinations hindered accurate categorisation of disgusted expressions.

Although the research cited above has been important for developing our understanding of how context affects facial expression interpretation, the studies are inherently limited by their use of prototypical basic emotional displays. Facial expressions encountered in everyday life rarely match the distinct and mutually exclusive configurations associated with Ekman's (1992) classic basic emotions (e.g. Matsumoto et al., 2009) and may therefore be more amenable to socio-functional evaluations instead. In fact, facial expressions typically convey social as well as emotional meaning (Fridlund, 1991a; Kraut & Johnston, 1979). This confers the adaptive advantage of a more direct influence on the social environment and the behaviours of others, which in turn enables the expresser to achieve their social goals more efficiently. Hence, facial expressions are conceptualised as flexible tools for social influence.

In accordance with the socio-functional view, the Simulation of Smiles Model (SIMS; Niedenthal et al., 2010; Martin et al., 2017) proposes that smiles can be classified in terms of how they affect people's behaviour in the service of fundamental tasks of social living. According to the SIMS model, reward smiles tend to involve activation of the sharp lip puller (AU13), dimpler (AU14), and eyebrow raisers (AU1+2), and reinforce desired

behaviours by inducing positive affect in the perceiver (e.g. Shore & Heerey, 2011).

Affiliation smiles aid the formation and maintenance of social bonds by communicating reassurance or an openness to positive relations. They normally involve activation of the lip pressor (AU24) and dimpler (AU14). Finally, dominance smiles are used to communicate and assert superiority over the perceiver in order to maintain high social status. These smiles are typically associated with asymmetrical activation of *zygomaticus major* muscle (AU12) which upturns just one corner of the mouth, as well as the upper lid raiser (AU5), nose wrinkler (AU9), cheek raiser (AU6), and upper lip raiser (AU10) (Rychlowska et al., 2017).

The varied morphological and socio-functional characteristics of these smiles make them more difficult to discern than prototypical emotional expressions with discrete meaning. Consequently, people may rely on additional cues to disambiguate and infer their meaning. Hence, contextual information is likely to influence the interpretation of a smile more than other expressions (Ekman et al., 1982; Wallbott, 1988a; 1988b). Whilst extant research has shown that context does affect smile evaluations, this work has generally focused on ratings of emotion, genuineness, or authenticity (Gagnon et al., 2022; Krumhuber, Hyniewska, et al., 2023; Mui et al., 2020; Namba et al., 2020). For example, as described in the introductory chapter, Namba and colleagues (2020) found that “happy” visual background contexts and vignettes both led to increased ratings of smile genuineness relative to when the same expressions were presented in isolation, whereas “polite” backgrounds and vignettes reduced genuineness ratings. Likewise, verbal descriptions of eliciting situations strongly affected evaluations of both dynamic (Mui et al., 2020) and static smiles, such that smiles viewed in happy contexts were misremembered as having more distinctive crow’s feet (Krumhuber, Hyniewska, et al., 2023) — traditionally implicated as a marker of smile genuineness (Ekman, 1992; Ekman et al., 1990; Frank & Ekman, 1993).

Although past research has investigated context effects on smile evaluations, only one study to date has contrasted the effects of context across different smile types (Gagnon et al., 2022). Specifically, participants rated smiles as more sincere when they were displayed by smilers with a prior tendency to return favours relative to smilers who didn't usually return favours. Intriguingly, this effect was stronger for Duchenne smiles than non-Duchenne ones. In contrast to the present research however, these authors manipulated dispositional rather than situational information and adhered to Duchenne's (1862) classic smile typology.

To build on this previous work, here I investigated whether context impacts *socio-functional* evaluations of smiles (e.g., politeness/civility, enjoyment/reward, and superiority/condescension). The dependent variables were chosen because they aligned with the purported function of each of the three SIMS smile types. I also retained a measure of genuineness for consistency with previous literature. Furthermore, I tested whether these context effects varied across different smile types, which had not been done previously when using visual contexts.

Although most previous work has assessed how context affects the evaluations of facial expressions, the relationship between context and facial expressions is likely bidirectional (Hess et al., 2020). Research has shown that facial expressions bias emotion categorisation of body language towards the emotion conveyed by the face (Kret et al., 2013; Lecker et al., 2020). Furthermore, the facial expressions of spectators influenced perceptions of a player's success/failure in an ambiguous ball game (Hess et al., 2020) and altered the perceived morality and politeness of unusual behaviours described in verbal vignettes (Hess et al., 2018). As facial expressions often reflect a person's evaluation of their current situation (e.g. Frijda, 1986; Scherer, 2001), they can provide information about the situation itself. For example, participants conclude that a social norm has been violated when they believe that another person is angry about an event (Hareli et al., 2013). However, no previous study had

investigated whether smiles affect evaluations of situational context, and it remains unclear how these evaluations differ across smile types. Consequently, in the present chapter I also assessed how smiles influenced ratings of situational contexts.

A further aim of this chapter was to increase the ecological validity of face and context stimuli by developing a new stimulus set. Most previous researchers have presented participants with static photographs of facial expressions, often displayed by artificially generated (e.g. Maringer et al., 2011) or disembodied faces (e.g. Righart & de Gelder, 2006; 2008). However, facial expressions viewed during social interactions typically unfold dynamically. As a result, static photographs lack certain cues that are present when observing an expression, such as the direction, quality, and speed of facial motion (see Krumhuber et al., 2013, Krumhuber, Skora, et al., 2023, for reviews). Consistent with this notion, dynamic facial expressions are perceived as more intense and realistic than static expressions (Biele & Grabowska, 2006; Cunningham & Wallraven, 2009; Weyers et al., 2006).

In a similar vein, the contextual stimuli used by researchers often lack much resemblance to situational contexts experienced in real life. The most common technique is to present participants with verbal vignettes (e.g. Krumhuber, Hyniewska, et al., 2023; Maringer et al., 2011; Mui et al., 2020), but this means that faces are seen in visual isolation. Furthermore, the vignette method requires an imaginative leap from participants and increases the transparency of the study's aims, potentially encouraging demand characteristics. Whilst a handful of studies have assessed how visual background contexts affect facial expression ratings (e.g. Namba et al., 2020; Righart & de Gelder, 2006; 2008a), these normally take the form of static photographs which don't fit naturally with the faces. In fact, Reschke et al. (2018) explicitly declined to use such face-in-context stimuli in their own study because the combinations appeared unnatural.

This lack of ecological validity is particularly concerning given that the effects of context manipulations appear to vary depending upon their vividness and realism. Notably, as described in the introductory chapter, Wallbott (1986; 1988a; 1988b) conducted a series of experiments which found a steady increase in contextual influence as the realism of the context improved. Wallbott (1988b) suggested that the visual and dynamic presentation of context rendered this form of information more vivid, immediate, and readily accessible to raters, which facilitated the larger impact on emotion attributions. Consequently, Fernandez-Dols et al. (1991) proposed the use of more ecologically valid stimuli, including video clips of facial expressions and situations. Unfortunately, few studies to date have taken this approach, and no study investigating smiles has utilised both dynamic face *and* dynamic context stimuli.

In addition to limited ecological validity, it could also be argued that past research has largely failed to test the cognitive processes deployed during everyday social interactions. When we encounter social cues in real life, our information processing is geared towards guiding a subsequent adaptive response, rather than merely registering or describing the qualities of the stimulus. Such perception-action coupling has been described as a “fundamental process that involves the processing of other people's actions and the integration of those actions into one's own motor planning” (Cracco et al., 2022, p. 1), and has been proposed as the basis for a variety of important social abilities including biological motion perception (Blake & Shiffrar, 2007) and joint action (Sebanz et al., 2006). Unfortunately however, despite a pressing need to go beyond relatively simplistic rating studies, little research has assessed the joint effect of facial expressions and context on subsequent *behaviour*. Moreover, of the research that has been conducted, much has focused on implicit or speeded behavioural responses to such stimuli. For example, perhaps the best-studied behavioural response by researchers in this field is unconscious facial mimicry

(Kastendieck et al., 2021; Kirkham et al., 2015). Consequently, there remains a clear absence of work investigating how facial expressions and context jointly influence *more deliberative* behavioural responses.

This gap in the literature is especially troubling given the wealth of psychological theory suggesting that the key function of facial expressions is to regulate and influence the conscious behaviour of others (Fridlund, 1991a; 1994; Niedenthal et al., 2010). Likewise, evolutionary biologists have long argued that “receivers” who possess the ability to effectively predict the actions of conspecifics from their facial expressions — and hence act appropriately within an interaction — are favoured by natural selection. Conversely, “senders” also gain an evolutionary advantage by being able to influence the behavioural reactions of receivers — a phenomenon often referred to as "manipulation" (Krebs & Dawkins, 1984; Maynard-Smith & Harper, 2003). It is therefore important to understand how context affects subsequent elaborate behavioural responses to smiles, in addition to explicit ratings.

In the empirical literature, elaborate cognitively mediated behavioural responses to faces have been assessed using many methodologies. At the most basic level, researchers have analysed pre-existing sources of real-world visual information to assess correlations between facial expressions and subsequent behaviour. Mullen et al. (1986) studied video footage of newsreaders talking about 1984 US presidential election candidates and observed that one newsreader smiled more often when talking about one candidate (Reagan) than another (Mondale). Importantly, voters who more frequently watched this newsreader were more likely to vote for the candidate that the newsreader had smiled about.

Although correlational research has value, others have attempted to approach this problem by actively manipulating variables of interest instead. For example, Vrugt and Vet

(2009) found that Amsterdam commuters smiled more frequently when they were engaged in conversation by a smiling confederate than a non-smiling confederate. Moreover, smile frequency in turn predicted the pedestrian's willingness to offer the confederate help by completing a voluntary questionnaire. A range of other field experiments have also found similar prosocial effects of smiling (e.g. Gueguen & de Gail., 2003; Hinsz & Tomhave., 1991; Tidd & Lockard, 1978).

Alternatively, some researchers have instead put participants into near-realistic lab-based scenarios to retain greater control of extraneous variables which may confound correlational or field-based results. For example, LaFrance and Hecht (1995) found that smiling targets received more lenient punishments than non-smiling targets when participants judged fictional cases of academic cheating, even though the smiling targets were not perceived as any less guilty. Similarly, a body of research has found that the facial expressions displayed by prospective hosts significantly influence booking intention on websites like Airbnb (Banerjee et al, 2022, Banerjee & Chua, 2020; Fagerstrom et al, 2017).

Nonetheless, perhaps the most commonly used method to assess how smiles affect subsequent behaviour is via lab-based economic games, during which participants are given the option of either (a) contributing some amount of their resources to a collective pot or (b) keeping the resources for themselves. Various economic game paradigms exist, but typically, the participant can benefit from sharing their resources provided that their fellow game players also play in good faith. For example, in the Trust Game (Berg et al., 1995), the invested points are multiplied and can then be distributed back to the participant by the trustee. Although these games are more artificial than the near-realistic scenarios used by other researchers (e.g. sentencing decisions / holiday bookings), this method allows responses to be easily quantified, whilst experimenters retain a large degree of control over potential extraneous variables.

A multitude of previous studies have shown that emotional facial expressions significantly affect behaviour during economic games (Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013; van Kleef et al., 2004). For example, Tortosa et al. (2013) found that partners displaying prototypically happy expressions generated higher levels of trust than partners displaying angry expressions, even though these emotional displays were not predictive of the partner's co-operation rate. Similarly, Reed et al. (2012) showed that participants were more likely to split their own resources during a one-shot Prisoner's Dilemma game when their partner expressed happiness, whereas they were more likely to steal their partner's resources when the partner expressed contempt.

As well as prototypical emotional expressions, behaviour in economic games is also influenced by the type of smile displayed by one's partner (Brown & Moore, 2002; Johnston et al., 2010; Krumhuber et al., 2007; Mehu et al., 2007; Schug et al., 2010; Shore & Heerey, 2011). Notably, participants are likely to invest more resources in partners displaying Duchenne rather than non-Duchenne smiles (Johnston et al., 2010), whilst co-operative participants are more likely to display Duchenne than non-Duchenne smiles themselves (Mehu et al., 2007; Schug et al., 2010). Moreover, morphological features relevant to Niedenthal et al.'s (2010) socio-functional smile classification system also affect investment decisions. Martin et al. (2021, Study 2) showed that participants invested significantly more points in partners displaying reward smiles than those displaying affiliation smiles, who in turn received more than those displaying dominance smiles. Previously, Brown and Moore (2002) had found that participants allocated fewer resources to partners when their smiles were asymmetrical — a key feature of the dominance smile. Similarly, Krumhuber et al. (2007) showed that investment decisions are affected by ballistic aspects of smile timing including the duration of the onset, offset, and apex of the expression.

Although facial expressions clearly affect trust decisions in economic games, very little research has investigated whether / how the influence of these expressions may be moderated by the different contexts they are perceived within. This is surprising, given that Hammond (2007) argued that we are inclined to perceive individuals as untrustworthy when the context suggests that they might act malevolently. For example, faces are judged as more trustworthy when presented in “wealthy” backgrounds (Keres & Chartier, 2016) and less trustworthy in “threatening” contexts (Mattavelli et al., 2021). This effect is observed even at the implicit level, as Brambilla et al. (2018) showed that mouse trajectories towards a “trustworthy” categorisation response button were facilitated when face and context cues were compatible (e.g., a trustworthy face within a safe scene), but trajectories were partially attracted towards the “untrustworthy” response button when cues were incompatible (e.g., a trustworthy face within a threatening scene).

Present Research

Given the above literature, the present research addressed three main research questions. In Study 1, I asked how socio-functional interpretations of different smile types are affected by dynamic visual contexts. In Study 2, I asked whether social interpretations of dynamic visual contexts are affected by the smile type expressed by the person situated within these contexts. In Study 3, I asked how context moderates the effects of different smile types on investment decisions. To this end, I presented participants with vivid, dynamic, and realistic smile-in-context compound stimuli that represent a major advance in ecological validity compared to previous studies.

In Study 1, participants rated the genuineness, reward/enjoyment, politeness/civility, and superiority/condescension of each smile. In Study 2, participants rated how positive, enjoyable/rewarding, polite/civil, and competitive/confrontational each situational context was. In Study 3, participants played a Trust Game in the role of the “investor”. They were

asked to invest some proportion of their endowment with a smiling partner (“the trustee”), who was presented in either an enjoyment, polite, or negative context. Although dominance smiles were presented, they were not included in the primary analyses because my pre-registered hypotheses only related to comparisons between affiliation and reward smiles. I did not have clear hypotheses about dominance smiles, which were included for exploratory purposes.

Hypotheses

In line with previous research (Gagnon et al., 2022; Mui et al., 2020; Namba et al., 2020), I expected that smile evaluations would be influenced by context in Study 1, such that smiles in enjoyment contexts would be evaluated as more genuine and more joyful than those presented in polite or negative contexts (*Hypothesis 1*), whereas smiles in polite contexts would be evaluated as more polite than those in enjoyment or negative contexts (*Hypothesis 2*). Furthermore, I hypothesised that smiles presented in negative contexts would be evaluated as less joyful, less polite, less genuine, and indicating higher levels of superiority than those presented in enjoyment or polite contexts (*Hypothesis 3*). Finally, in line with the hypotheses of Gagnon et al. (2022), I predicted that context effects would be stronger for affiliation smiles than reward smiles (*Hypothesis 4*) because they are more ambiguous and challenging to classify than enjoyment smiles (Johnston et al., 2010; Orłowska et al., 2018; Rychłowska et al., 2017). In Study 2, I predicted that contexts presented with reward smiles would be evaluated as more joyful and positive than those presented with affiliative smiles (*Hypothesis 5*), and contexts presented with affiliation smiles would be evaluated as more polite than those presented with reward smiles (*Hypothesis 6*).

In Study 3, I hypothesised that participants would invest more points with partners displaying reward smiles than partners displaying affiliation smiles and would expect to receive more points in return (*Hypothesis 7*). In addition, in accordance with research

showing contextual effects on trustworthiness (e.g. Brambilla et al., 2018; Keres & Chartier, 2016), I hypothesised that participants would invest more points with partners in enjoyment contexts than partners in polite or negative contexts and would expect to receive more points in return (*Hypothesis 8*). Finally, I also expected to find an interaction between context and smile type, such that the effect of smile type would be stronger when trustees were presented in enjoyment and polite contexts than negative contexts (*Hypothesis 9*). This hypothesis accorded with the prior results of Study 2, which had been analysed before Study 3 had been designed.

Study 1

In Study 1, I aimed to assess whether socio-functional interpretations of different smile types would be affected by the dynamic visual contexts they were embedded within. Furthermore, I explored whether any of the three SIMS smile types were more or less susceptible to contextual influence.

Methods

Participants

To determine sample size, means and standard deviations from Namba et al. (2020) and Mui et al. (2020) were entered into an a priori power analysis using the ANOVA_power shiny app (Lakens & Caldwell, 2019). To detect an interaction between smile type and context category ($\eta_p^2 = .45$) with 90% power, I recruited 85 participants (58 women, 25 men, 2 non-binary) from the United Kingdom. The majority were Caucasian (70.5%; 16 Asian, 6 Multiple ethnic groups, 1 Black, 1 other, 1 prefer not to say), aged 18-70 years ($M_{age} = 29.09$, $SD_{age} = 13.28$). Participants were recruited via Prolific (www.prolific.co) and were paid £7.50 per hour. Power analyses for ANOVA were deemed most suitable given the lack of clear

guidance for calculating power for LMMs. The study was approved by the university's research ethics committee (reference: R79288/RE002).

Materials

First, 36 smile videos were taken from the set developed by Rychlowska et al. (2017). I selected one video of each smile type (reward, affiliation, dominance) produced by 12 White actors (six male, six female) in frontal view. Actors posed each smile type after being coached about its form and accompanying social motivations (see Martin et al., 2017; Rychlowska et al., 2017). In morphological terms (FACS, Ekman et al., 2002), reward smiles were characterized by symmetrical activation of the Lip Corner Puller (AU12), the Cheek Raiser (AU6), Lips Part (AU25) and/or Jaw Drop (AU26). Affiliation smiles were characterised by the Lip Corner Puller (AU12), the Chin Raiser (AU17), with or without Brow Raiser (AU1-2). Dominance smiles were characterised by asymmetrical activation of the Lip Corner Puller (AU12L or AU12R), with additional actions, such as Head Up (AU53), Upper Lip Raiser (AU10), and/or and Lips Part (AU25). Each video showed the face changing from non-expressive to peak emotional display. Videos ranged in duration from 1.8 seconds to 3.0 seconds ($M = 2.40$ seconds) and were 1280 x 720 pixels. All videos were in colour. I used Unscreen (www.Unscreen.com) to remove original video backgrounds.

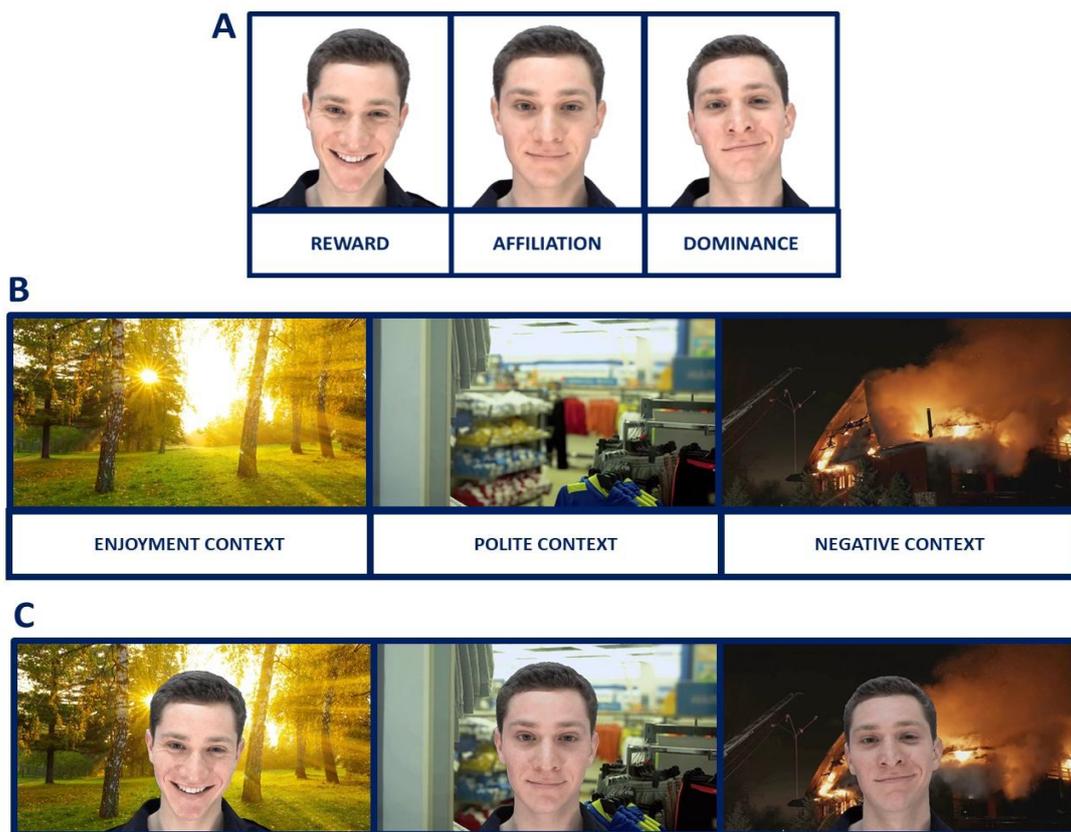
Second, to create new backgrounds, 36 context videos were downloaded from Envato Elements (www.elements.envato.com); 12 of each situation type: enjoyment, polite, and negative. Videos were selected based on stimuli used in previous studies (e.g. Namba et al., 2020; Righart & de Gelder, 2008a; 2008b), and data describing situations in which certain smile types are likely to be produced (e.g. Martin et al., 2021, Study 3). Enjoyment contexts depicted situations where people would typically express joy (e.g. beaches and parks). Polite contexts depicted situations where people would express politeness (e.g. offices and public

transport). Negative contexts depicted situations where people would not normally smile (e.g. cemeteries and rubbish dumps).

Finally, smile videos were superimposed over context videos with the editor tool from Kapwing (www.Kapwing.com). For each actor, nine smile-in-context videos were created such that each smile type was superimposed over the three context types (see Figure 2.1 for examples). Each of the face-in-context videos was 1980 x 1080 pixels.

Figure 2.1

Example Screenshots From (A) Videos of Reward, Affiliation, and Dominance Smiles (B) Videos of Positive, Polite, and Negative Contexts, and (C) Videos of Each Smile Type in Each Context



Procedure

The experiment was programmed using Gorilla (www.Gorilla.sc). After providing informed consent, participants first completed a block of baseline smile-alone ratings. All 36

smile videos (without background context) were presented in a random order. For each smile, participants made a series of ratings along 0-100 scales, starting with the genuineness of each smile (*fake - real*) and their confidence in this judgement (*not confident - very confident*). Participants then rated the extent to which the person was expressing enjoyment/reward (*not at all - very much*), politeness/civility (*not at all - very much*), and superiority/condescension (*not at all - very much*). Participants had unlimited time to respond. Questions were always presented in the same order.

Following this baseline smile-alone block, participants completed a filler task which involved counting the number of squares in a complex figure. This was included as a distractor to ensure that ratings in the second block were not consciously influenced by ratings in the baseline smile-alone block. They then completed a further rating block of smiles embedded within a situational context. Participants were randomly allocated to one of three test blocks, consisting of the 36 smile stimuli presented once each, within either enjoyment, polite, or negative backgrounds (12 of each). Within each smile-in-context block, actor gender and smile type were fully balanced across context type. Furthermore, smile and context were balanced across the three test blocks for each actor, such that every smile video was presented in each context type (enjoyment, polite, and negative) across participants. The rating scales were the same as in the baseline smile-alone block. Next, participants completed the Toronto Alexithymia Scale (TAS-20 — Bagby et al., 1994), the Holistic Cognition Scale (HCS — Lux et al., 2021), and the Depression, Anxiety, and Stress Scale (DASS — Lovibond & Lovibond, 1995). Finally, participants completed a trait rating task, which involved making dispositional judgements about each of the 12 actors. The questionnaire and trait rating data are not included in this thesis. On completion of the experiment, all participants were fully debriefed.

Data Analysis

Data analysis was conducted with R Studio version 2022.02.3 (RStudio Team, 2020) in R version 4.2.1 (R Core Team, 2022). Participant ratings were analysed using linear mixed models, fitting maximal random models before simplifying the random structure using Principal Component Analysis (Bates et al., 2015). Model comparison ensured simplification was justified. Random structure was identified prior to adding fixed effects to the model (Meteyard & Davies, 2020). Simplification of random effects continued until convergence. Satterthwaite's F test determined inferential statistics.

For each rating (genuineness, enjoyment, politeness, superiority), smile type (two levels: reward vs affiliative) and context category (three levels: enjoyment vs polite vs negative) were entered as fixed effect predictors. Dominance smiles were not included in primary analyses as they were included in the study for exploratory purposes. Significant effects were clarified by tests of estimated marginal means (with the Holm-Bonferroni correction applied).

Data Availability

This study's design and analysis were pre-registered. All data, analysis code, and research materials for Study 1 and Study 2 are available at

https://osf.io/d6y7p/?view_only=dfd19c81f0f945e7af70e0ea3bfc99bf.

Results

Manipulation Checks

I conducted four one-way within-subjects ANOVAs on aggregated data from the baseline smile-alone block to assess the influence of smile type (three levels: reward vs affiliation vs dominance) on each of the four main dependent variables. Where Mauchly's Test indicated that assumption of sphericity was violated, the Greenhouse-Geisser correction

was applied. These analyses were performed to ensure that my smile stimuli conveyed the expected meaning as ascribed by Rychlowska et al. (2017).

Genuineness. A significant main effect of smile type was observed, $F(1.86, 155.85) = 258.92, p < .001, \eta^2_G = .63$. As expected, pairwise comparisons indicated that reward smiles ($M = 71.59, SE = 1.84$) were rated as more genuine than affiliation smiles ($M = 39.26, SE = 1.67$), $p < .001$, and dominance smiles ($M = 33.63, SE = 1.65$), $p < .001$.

Enjoyment. A significant main effect of smile type was observed, $F(1.62, 135.93) = 253.94, p < .001, \eta^2_G = .62$. As expected, pairwise comparisons indicated that reward smiles ($M = 72.12, SE = 1.48$) were rated as more joyful than affiliation smiles ($M = 37.03, SE = 1.73$), $p < .001$, and dominance smiles ($M = 35.46, SE = 2.04$), $p < .001$.

Politeness. A significant main effect of smile type was observed, $F(2, 168) = 61.19, p < .001, \eta^2_G = .30$. As expected, pairwise comparisons indicated that affiliation smiles ($M = 67.26, SE = 1.59$) were rated as more polite than reward smiles ($M = 57.59, SE = 2.37$), $p < .001$, and dominance smiles ($M = 43.64, SE = 1.83$), $p < .001$.

Superiority. A significant main effect of smile type was observed, $F(1.77, 148.60) = 277.40, p < .001, \eta^2_G = .59$. As expected, pairwise comparisons indicated that dominance smiles ($M = 60.14, SE = 2.03$) were rated as more superior than affiliation smiles ($M = 35.57, SE = 1.94$), $p < .001$, and reward smiles ($M = 18.21, SE = 1.75$), $p < .001$.

Main Analyses

LMMs were constructed to assess the effect of both smile type (two levels: reward vs affiliative) and context category (three levels: enjoyment vs polite vs negative) on each of the four main dependent variables during the smile-in-context block.

Genuineness. Results revealed a significant main effect of smile type, $F(1, 14.51) = 53.52, p < .001$, such that reward smiles ($M = 70.85, 95\% \text{ CI } [64.12, 77.59]$) were rated as more genuine than polite smiles ($M = 39.26, 95\% \text{ CI } [32.36, 46.16]$), $t(14.51) = -7.32, p < .001$. The main effect of context category was also significant, $F(2, 1844.03) = 7.66, p < .001$. Smiles in enjoyment contexts ($M = 57.00, 95\% \text{ CI } [51.83, 62.16]$) were rated significantly more genuine than smiles in negative contexts ($M = 52.47, 95\% \text{ CI } [47.31, 57.64]$), $t(1844.03) = 3.80, p < .001$. Similarly, smiles in polite contexts ($M = 55.70, 95\% \text{ CI } [50.53, 60.86]$) were rated as significantly more genuine than smiles in negative contexts, $t(1844.03) = 2.71, p = .013$, although there were no genuineness differences between smiles presented in enjoyment compared to polite contexts ($p = .27$). Finally, I did not find an interaction between smile type and context category ($p = .75$). See Figure 2.2a for relevant means and CI's.

Enjoyment. Results revealed a main effect of smile type, $F(1, 16.54) = 84.65, p < .001$, such that reward smiles ($M = 72.09, 95\% \text{ CI } [66.40, 77.77]$) were rated as showing more enjoyment than polite smiles ($M = 36.85, 95\% \text{ CI } [29.82, 43.88]$), $t(16.54) = -9.20, p < .001$. The main effect of context category was also significant, $F(2, 1844.03) = 13.64, p < .001$. Smiles in enjoyment contexts ($M = 57.54, 95\% \text{ CI } [52.47, 62.61]$) were rated as more joyful than smiles in both negative contexts ($M = 51.89, 95\% \text{ CI } [46.83, 56.96]$), $t(1844.03) = 5.17, p < .001$, and polite contexts ($M = 53.98, 95\% \text{ CI } [48.91, 59.04]$), $t(1844.03) = 3.26, p = .002$. There were no enjoyment differences between smiles presented in negative and polite contexts ($p = .057$). Finally, I did not find an interaction between smile type and context category ($p = .84$). See Figure 2.2b for relevant means and CI's.

Politeness. Results revealed a main effect of smile type, $F(1, 60.35) = 22.30, p < .001$, such that affiliation smiles ($M = 65.22, 95\% \text{ CI } [61.56, 68.88]$) were rated as more

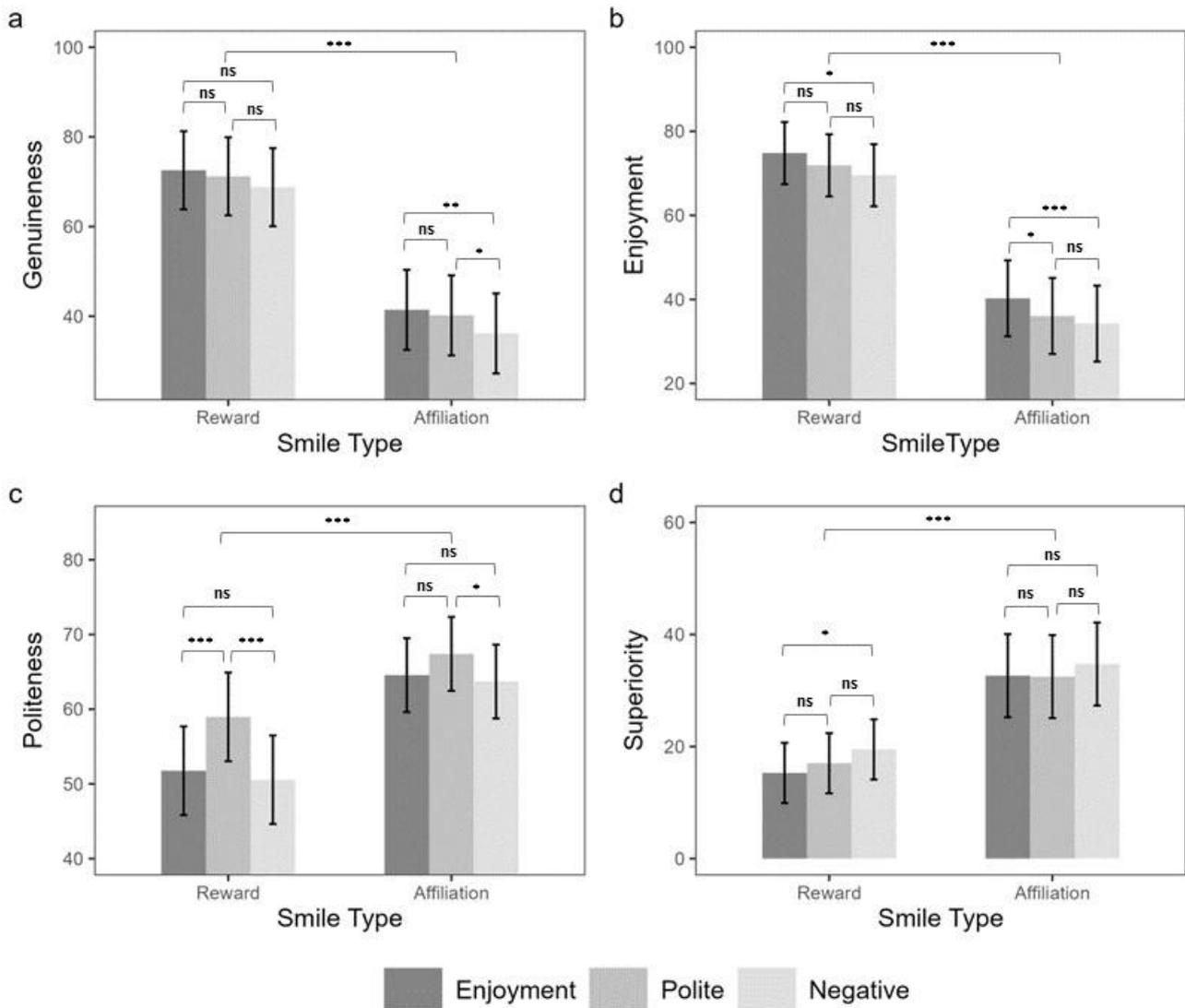
polite than reward smiles ($M = 53.76$, 95% CI [49.23, 58.30]), $t(60.36) = 4.72$, $p < .001$. The main effect of context category was also significant, $F(2, 1844.20) = 18.72$, $p < .001$. Smiles in polite contexts ($M = 63.18$, 95% CI [59.67, 66.71]) were rated as more polite than smiles in both enjoyment contexts ($M = 57.14$, 95% CI [54.64, 61.68]), $t(1844.19) = -4.75$, $p < .001$, and negative contexts ($M = 58.16$, 95% CI [53.61, 60.65]), $t(1844.19) = -5.72$, $p < .001$. There were no politeness differences between smiles presented in enjoyment and negative contexts ($p = .33$). The interaction between smile type and context category was also significant, $F(2, 1844.14) = 3.05$, $p = .047$. For reward smiles, there were significant differences in politeness ratings between polite contexts and enjoyment contexts ($p < .001$), and between polite contexts and negative contexts ($p < .001$). However, for affiliation smiles, there were no significant differences between polite contexts and enjoyment contexts. Furthermore, although still significant ($p = .039$), the difference in politeness ratings between polite contexts and negative contexts was substantially smaller for affiliation smiles than for reward smiles. See Figure 2.2c for relevant means and CI's.

Superiority. Results revealed a main effect of smile type, $F(1, 14.8) = 26.22$, $p < .001$, such that affiliation smiles ($M = 33.29$, 95% CI [27.55, 39.02]) were rated as displaying more superiority than reward smiles ($M = 17.26$, 95% CI [13.24, 21.29]), $t(14.8) = 5.12$, $p < .001$. The main effect of context category was also significant, $F(2, 1844.06) = 4.59$, $p = .010$. Smiles in negative contexts ($M = 27.10$, 95% CI [23.22, 30.99]) were rated as indicating greater superiority than smiles in enjoyment contexts ($M = 23.97$, 95% CI [20.08, 27.85]), $t(1844.06) = -2.91$, $p = .011$. However, there were no superiority differences between smiles presented in negative and polite contexts ($M = 24.76$, 95% CI [20.87, 28.64]) ($p = .059$). In addition, there were no superiority differences between smiles in enjoyment and polite contexts ($p = .46$). Finally, I did not find an interaction between smile type and context category ($p = .55$). See Figure 2.2d for relevant means and CI's.

Figure 2.2

Interactions Between Context Category and Smile Type for Ratings of Smile Genuineness

(a), Enjoyment (b), Politeness (c), and Superiority (d) in Study 1. Error Bars: 95% CI



Note. *** $p < .001$, ** $p < .01$, * $p < .05$, ns not significant

Exploratory Analyses

Exploratory analyses were then performed on the whole dataset (with dominance smiles included). New random effects structures were established using the same procedures described above.

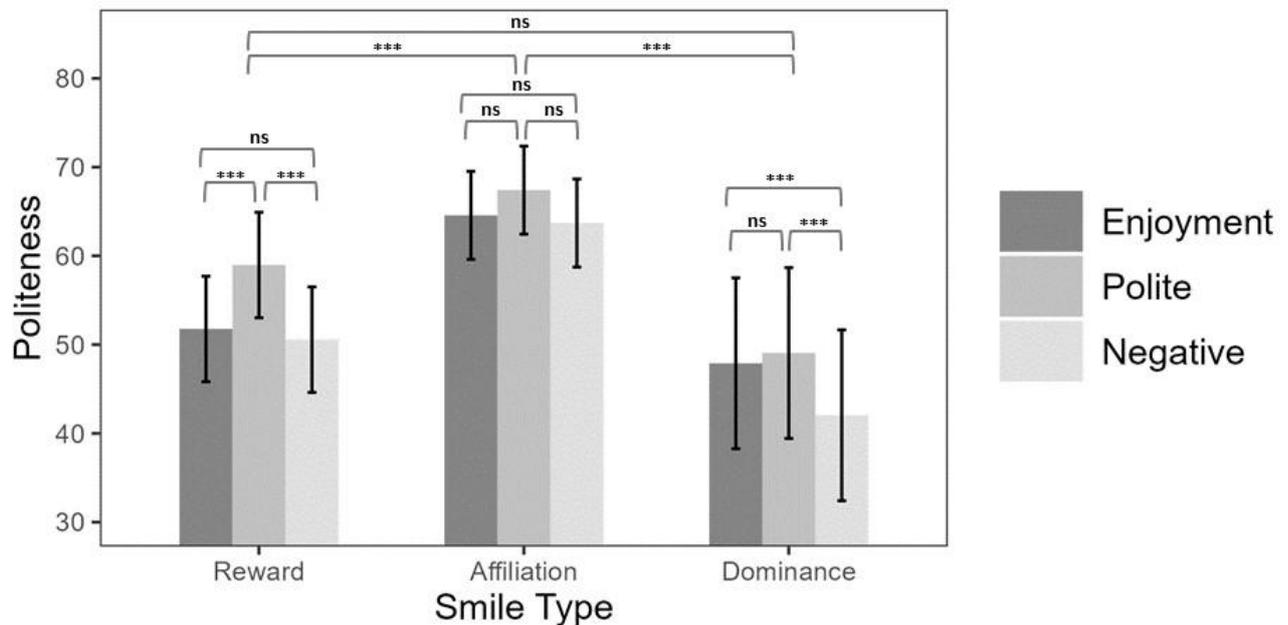
All main effects and interactions reported above were retained. Compared to reward smiles, dominance smiles were rated as less genuine ($p < .001$), less joyful ($p < .001$), and indicating greater superiority ($p < .001$), while politeness ratings did not differ significantly ($p = .054$). Compared to affiliation smiles they were rated as less polite ($p < .001$) and displaying more superiority ($p < .001$), while genuineness ($p = .20$) and enjoyment ($p = .95$) ratings did not differ.

The strengthened interaction between context category and smile type, $F(4, 2766.19) = 3.19, p = .013$, revealed that dominance smiles were rated as less polite than reward smiles in negative and polite contexts, but there were no politeness differences between the two smile types in enjoyment contexts. See Figure 2.3 for relevant means and CI's.

Figure 2.3

Interaction Between Context Category and Smile Type for Ratings of Smile Politeness

When Dominance Smiles are Included in Study 1. Error Bars: 95% CI



Discussion

Study 1 showed that situational context strongly affected evaluations of different smile types. This effect was largely consistent across smile types and rating scales. I did not find the hypothesised heightening of context effects for affiliation smiles. In fact, along the politeness dependent variable, reward smiles seemed more susceptible to contextual influence than affiliation smiles.

Study 2

While Study 1 examined the effects of situational context on smile evaluations, Study 2 aimed to assess the inverse, specifically whether evaluations of situational contexts are influenced by the smile expressed by a person in the situation. I predicted that contexts presented with reward smiles would be evaluated as more joyful and positive than those presented with affiliation smiles, and contexts presented with affiliation smiles would be evaluated as more polite than those presented with reward smiles. I made no predictions about the whether the effects would differ across context categories.

Methods

Participants

I recruited 200 UK-based participants from Prolific (102 women, 96 men, 2 prefer not to say; 172 White/Caucasian, 20 Asian/Asian-British, 3 Mixed/Multiple ethnic groups, 3 Black/Black-British, 1 other, 1 prefer not to say), aged 19-79 years ($M_{\text{age}} = 38.82$, $SD_{\text{age}} = 12.76$). Participants were paid £7.50 per hour. My sample size was deemed sufficient to find a face-on-context interaction effect that was half the size of the reverse context-on-face effect, in line with Kret et al. (2013). Hypothesised means and standard deviations were inputted into a power analysis using the ANOVA_power shiny app (Lakens & Caldwell, 2019), with

the goal to obtain 90% power to detect a medium-sized interaction ($\eta_p^2 = .23$) between smile type and context category.

Materials

The materials used were the same as for Study 1.

Procedures

The procedures were almost the same as Study 1. However, participants rated situations rather than smiles. In the baseline context-alone block, situation videos were presented rather than smiles.

On each trial, participants first evaluated the valence of the situation (*negative - positive*) and their confidence in this evaluation (*not confident - very confident*). Participants then rated the extent to which the situation was enjoyable/rewarding (*not at all - very much*), polite/civil (*not at all - very much*), and competitive/confrontational (*not at all - very much*).

Results

Manipulation Checks

I conducted four one-way within-subjects ANOVAs on aggregated data from the baseline context-alone block, to assess the influence of context category (three levels: enjoyment vs polite vs negative) on each of the dependent variables. These analyses were performed to ensure that my context stimuli were interpreted as intended. Where Mauchly's Test indicated that assumption of sphericity was violated, the Greenhouse-Geisser correction was used.

Valence. A significant main effect of context category was found, $F(1.90, 377.28) = 3447.54$, $p < .001$, $\eta^2_G = .90$. As expected, pairwise comparisons indicated that enjoyment

contexts ($M = 87.53$, $SE = 0.79$) were rated as more positive than polite contexts ($M = 57.22$, $SE = 0.97$), $p < .001$, and negative contexts ($M = 15.01$, $SE = 0.75$), $p < .001$.

Enjoyableness. A significant main effect of context category was found, $F(2, 398) = 2788.72$, $p < .001$, $\eta^2_G = .88$. As expected, pairwise comparisons indicated that enjoyment contexts ($M = 85.53$, $SE = 0.85$) were rated as more enjoyable than polite contexts ($M = 48.36$, $SE = 1.21$), $p < .001$, and negative contexts ($M = 12.64$, $SE = 0.80$), $p < .001$.

Politeness. A significant main effect of context category was found, $F(1.62, 321.43) = 724.98$, $p < .001$, $\eta^2_G = .58$. Surprisingly, pairwise comparisons indicated that enjoyment contexts ($M = 73.01$, $SE = 1.29$) were rated as more polite than polite contexts ($M = 65.22$, $SE = 1.24$), $p < .001$. However, as anticipated, polite contexts were rated as more polite than negative contexts ($M = 34.38$, $SE = 1.19$), $p < .001$.

Competitiveness. A significant main effect of context category was found, $F(1.62, 321.43) = 724.98$, $p < .001$, $\eta^2_G = .58$. As expected, pairwise comparisons indicated that negative contexts ($M = 31.13$, $SE = 1.76$) were rated as more competitive than polite contexts ($M = 25.78$, $SE = 1.44$), $p = .002$, and enjoyment contexts ($M = 14.84$, $SE = 1.12$), $p < .001$.

Main Analyses

Once again, LMMs were constructed to assess the effect of both smile type (two levels: reward vs affiliative) and context category (three levels: enjoyment vs polite vs negative) on each of the four dependent variables. Significant effects were clarified by tests of estimated marginal means (Holm-Bonferroni correction applied).

Valence. Results revealed a main effect of context category, $F(2, 19.9) = 159.90$, $p < .001$, such that enjoyment contexts ($M = 75.51$, 95% CI [71.79, 79.22]) were rated more positively than polite contexts ($M = 61.66$, 95% CI [57.80, 65.52]), $t(24.61) = 11.72$, $p < .001$, which in turn were rated more positively than negative contexts ($M = 24.88$, 95% CI [18.62,

31.15]), $t(13.58)$, $p < .001$. The main effect of smile type was also significant, $F(1, 12.8) = 20.89$, $p < .001$, such that contexts paired with reward smiles ($M = 56.20$, 95% CI [53.00, 59.40]) were rated as more positive than contexts paired with affiliation smiles ($M = 51.84$, 95% CI [49.02, 54.65]), $t(12.76) = -4.57$, $p < .001$. The interaction between smile type and context category was also significant, $F(2, 3959.9) = 13.50$, $p < .001$. For both enjoyment and polite contexts, valence ratings were lower when paired with a polite smile compared to a reward smile ($t(28.56) = -4.00$, $p < .001$; $t(28.56) = -6.19$, $p < .001$, respectively). However, smile type did not significantly affect valence ratings for negative contexts ($p = .31$). See Figure 2.4a for relevant means and CI's.

Enjoyableness. Results revealed a main effect of context category, $F(2, 20.1) = 178.09$, $p < .001$, such that enjoyment contexts ($M = 71.45$, 95% CI [67.75, 75.14]) were rated as more enjoyable than polite contexts ($M = 53.73$, 95% CI [49.47, 58.00]), $t(21.75) = 11.78$, $p < .001$, which in turn were rated as more enjoyable than negative contexts ($M = 21.19$, 95% CI [16.21, 26.17]), $t(13.91) = -9.93$, $p < .001$. The main effect of smile type was also significant, $F(1, 12.9) = 17.85$, $p = .001$, such that contexts paired with reward smiles ($M = 51.00$, 95% CI [47.76, 54.25]) were rated as more enjoyable than contexts paired with affiliation smiles ($M = 46.58$, 95% CI [43.88, 49.28]), $t(12.9) = -4.23$, $p = .001$. The interaction between smile type and context category was also significant, $F(2, 3960.2) = 6.67$, $p = .001$. For both enjoyment and polite contexts, enjoyableness ratings were lower when paired with a polite smile compared to a reward smile ($t(25.83) = -3.57$, $p = .001$; $t(25.83) = -5.26$, $p < .001$, respectively). Once again, smile type did not significantly affect valence ratings for negative contexts ($p = .079$). See Figure 2.4b for relevant means and CI's.

Politeness. Results revealed a main effect of context category, $F(2, 12.8) = 32.18$, $p < .001$, such that enjoyment contexts ($M = 71.11$, 95% CI [66.99, 75.23]) were rated as more polite than polite contexts ($M = 66.03$, 95% CI [62.44, 69.61]), $t(11.92) = 4.04$, $p < .001$,

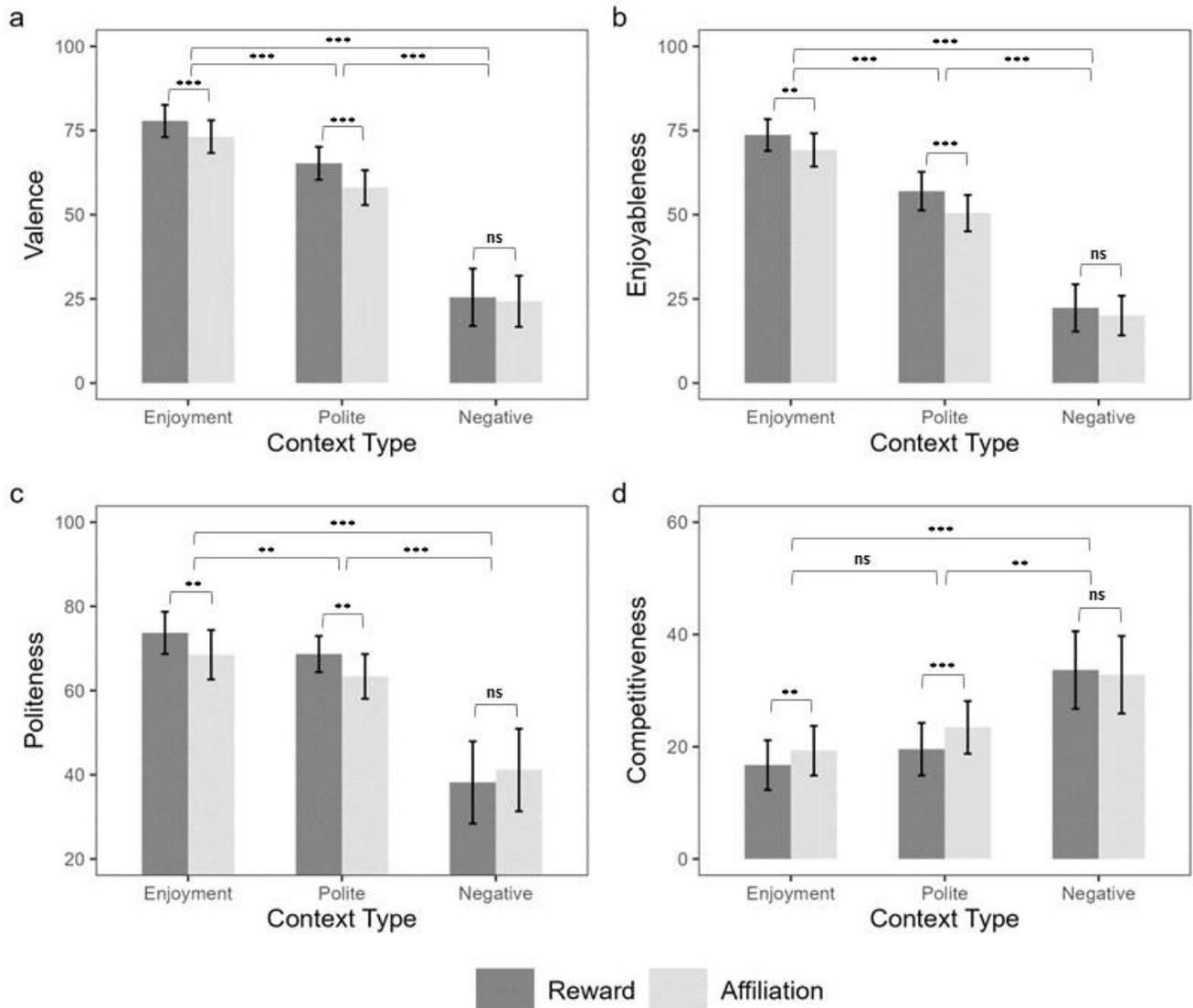
which in turn were rated as more polite than negative contexts ($M = 39.66$, 95% CI [32.07, 47.26]), $t(13.47) = -6.36$, $p < .001$. Intriguingly, the main effect of smile type was non-significant for politeness ratings, $F(1, 13.1) = 4.03$, $p = .066$. Nevertheless, the interaction between smile type and context category was significant, $F(2, 3956.9) = 29.77$, $p < .001$. For both enjoyment and polite contexts, politeness ratings were lower when paired with a polite smile compared to a reward smile ($t(22.83) = -3.61$, $p = .002$; $t(22.83) = -3.68$, $p = .001$, respectively). Once more, smile type did not significantly affect valence ratings for negative contexts ($p = .053$). See Figure 2.4c for relevant means and CI's.

Competitiveness. Results revealed a main effect of context category, $F(2, 13.2) = 27.46$, $p < .001$, such that negative contexts ($M = 33.25$, 95% CI [27.77, 38.72]) were rated as more competitive than polite contexts ($M = 21.50$, 95% CI [17.81, 25.18]), $t(16.60) = 3.65$, $p = .003$, which in turn were rated as more competitive than enjoyment contexts ($M = 18.00$, 95% CI [14.53, 21.48]), $t(10.98) = -4.24$, $p = .003$. The main effect of smile type was also significant, $F(1, 4164.8) = 13.11$, $p < .001$, such that contexts paired with affiliation smiles ($M = 25.18$, 95% CI [22.16, 28.20]) were rated as more competitive than contexts paired with reward smiles ($M = 23.32$, 95% CI [20.30, 26.34]), $t(4164.81) = 3.62$, $p < .001$. The interaction between smile type and context category was also significant $F(2, 4164.8) = 7.53$, $p < .001$. For both enjoyment and polite contexts, competitiveness ratings were higher when paired with a polite smile compared to a reward smile ($t(4164.82) = 2.88$, $p = .004$;

$t(4164.81) = 4.35, p < .001$, respectively). However, smile type did not affect valence ratings for negative contexts ($p = .34$). See Figure 2.4d for relevant means and CI's.

Figure 2.4

Interactions Between Context Category and Smile Type for Ratings of Context Valence (a), Enjoyment (b), Politeness (c), and Competitiveness (d) in Study 2. Error Bars: 95% CI



Exploratory Analyses

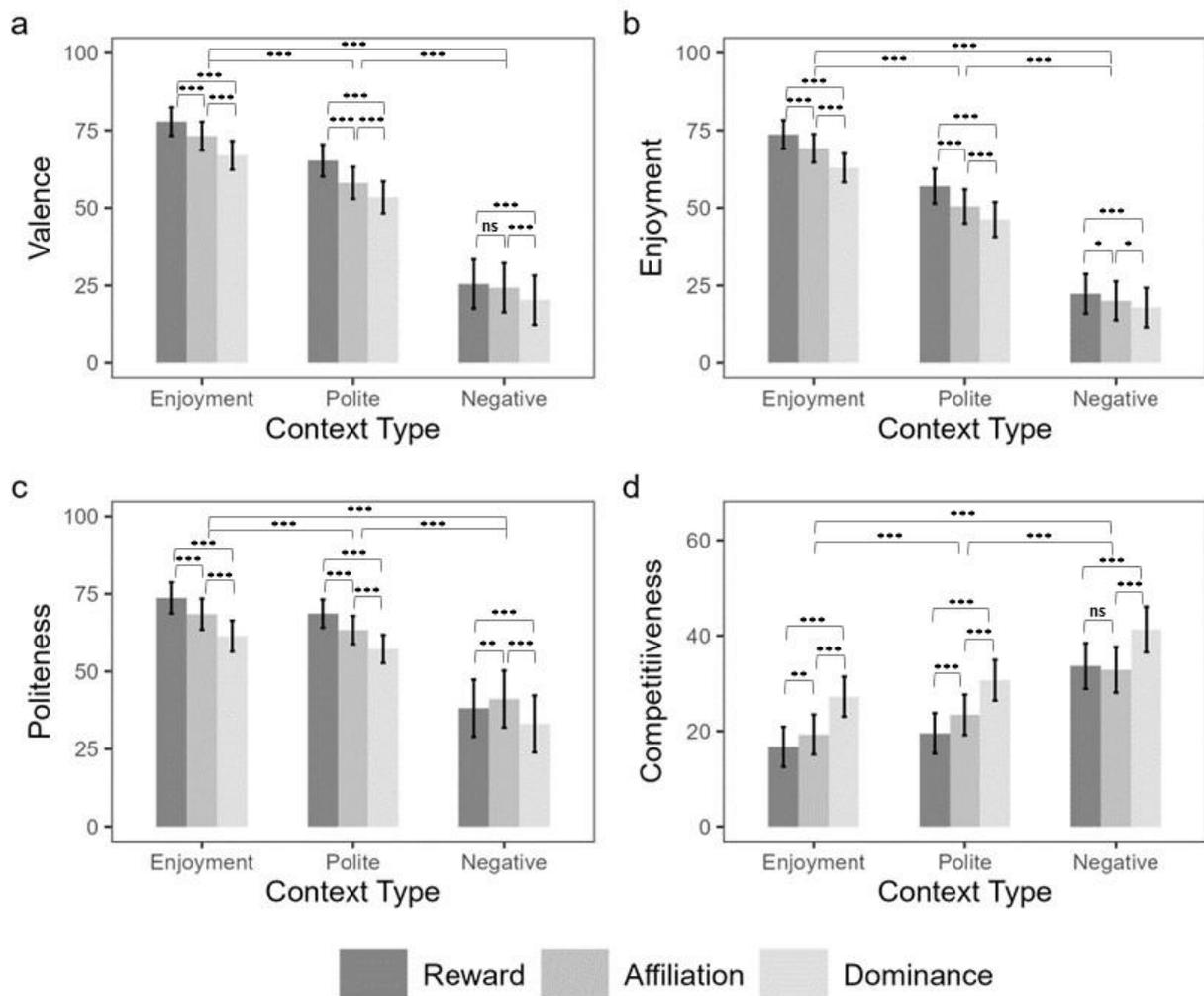
Exploratory analyses were conducted in the same way as Study 1. All main effects and interactions from the primary analysis retained their significance when dominance smiles were included. As expected, tests of estimated marginal means showed that contexts paired

with dominance smiles were rated as significantly less positive ($p < .001$), less enjoyable ($p < .001$), and more confrontational ($p < .001$) than contexts paired with reward smiles. Likewise, they were rated as less positive ($p < .001$), less enjoyable ($p < .001$), and more confrontational ($p < .001$) than contexts paired with affiliation smiles.

For the politeness dependent variable, the main effect of smile type was now significant, $F(2, 6561) = 182.30, p < .001$, such that contexts paired with reward smiles ($M = 60.19, 95\% \text{ CI } [56.88, 63.51]$) were rated as more polite than contexts paired with affiliation smiles ($M = 57.67, SE = 1.63, 95\% \text{ CI } [54.36, 60.98]$), $t(6561.04) = -4.84, p < .001$, which in turn were rated as more polite than contexts paired with dominance smiles ($M = 50.58, 95\% \text{ CI } [47.27, 53.90]$), $t(6561.04) = 13.58, p < .001$. Finally, the strength of the interactions between smile type and context category seemed to be relatively unaffected by the addition of dominance smiles to the analysis. See Figure 2.5 for a representation of these interactions.

Figure 2.5

Interactions Between Context Category and Smile Type for Ratings of Context Valence (a), Enjoyment (b), Politeness (c), and Competitiveness (d), with Dominance Smiles Included in Study 2. Error bars: 95% CI



Comparison of Smile and Context Effects

Although LMMs do not provide standardised effect size estimates, I used estimated marginal mean contrasts to compare the magnitude of context effects in Study 1 with the magnitude of smile effects in Study 2. For Study 1, the size of each context effect was calculated by taking the largest mean difference between two context categories for each dependent variable, using the full dataset. I then divided this difference by the standard error

of the difference. For example, the effect size for the genuineness dependent variable was the difference between mean genuineness ratings of smiles in enjoyment contexts and mean genuineness ratings of smiles in negative contexts, divided by the standard error of this difference. Likewise, for Study 2, smile effect sizes were calculated by taking the largest mean difference between two smile types for each dependent variable and then dividing by the standard error of this difference, using the full dataset with dominance smiles included.

Across all comparable dependent variables, the mean context effect in Study 1 was smaller than the comparable mean smile effect in Study 2. Descriptive statistics of these comparisons are displayed in Table 2.1.

Table 2.1

Effect Size Comparison for Context (Study 1) and Smile Type (Study 2) Effects across Dependent Variables

Study 1 Variable	Context Effect Size	Study 2 Variable	Smile Effect Size
Genuine	4.20	Positive	19.00
Enjoyment/Reward	4.94	Enjoyable/Rewarding	11.21
Politeness/Civility	7.09	Polite/Civil	18.48
Superiority/Condescension	4.40	Competitive/Confrontational	17.41
Mean	5.16	Mean	16.53

Note. Effect size was operationalised as the largest difference between two groups for each dependent variable. For Study 1, I compared mean smile ratings across context categories. For Study 2, I compared mean context ratings across smile types.

Discussion

The findings from Study 2 show that the relationship between smiles and situational contexts is bidirectional such that evaluations of situational contexts are also influenced by

smiles. This indicates that when making explicit evaluations of both expressions and situations, other social information is integrated into the evaluation. Moreover, the effect of smiles on evaluations of situational contexts may be moderated by the type of context itself. Specifically, smiles seem to have less impact on evaluations of negative situational contexts.

Nonetheless, as with most computerised tasks, the experimental set-ups used in Study 1 and Study 2 are only rough approximations of the real social world. To show that the psychological processes I observed actually drive real-life social behaviour, these results should be replicated in tasks that better approximate social interactions. To this end, I conducted an additional study in which participants made behavioural decisions based on these social stimuli.

Study 3

Whilst Study 1 and Study 2 provided an important insight into how faces and situations affect participant's conscious evaluations, these studies relied entirely upon using explicit ratings as the dependent variable. However, humans rarely, if ever, process social cues using a deliberative rating/evaluation. Hence, my dependent variables may not provide an accurate representation of how these sources of information influence behaviour in everyday scenarios. As a result, Study 3 builds on Study 1 and Study 2 by investigating whether the effects of smiles and contexts on explicit ratings were retained when participants made social decisions. Specifically, participants were given the opportunity to invest a proportion of points with a smiling partner ("trustee") presented in either an enjoyment, polite, or negative context, as part of a Trust Game (Berg et al., 1995).

Methods

Participants

To determine sample size, means and standard deviations from Martin et al. (2021) and an unpublished study conducted by another member of my lab using a similar methodology were entered into an a priori power analysis using the ANOVA_power shiny app (Lakens & Caldwell, 2021). To detect a two-way interaction between smile type and context category ($\eta^2 = .05$) with 90% power, I recruited 141 participants (49 women, 91 men, 1 prefer not to say) from the United Kingdom. The majority were Caucasian (86.5%; 11 Asian, 8 Black, 1 Multiple ethnic groups, 1 other), aged 18-77 years ($M_{\text{age}} = 40.00$, $SD_{\text{age}} = 12.47$). One additional participant was excluded from the study because they failed the pre-game instruction comprehension test. Participants were recruited via Prolific (www.prolific.co) and were compensated for their time. Power analyses for ANOVA were deemed most suitable given the lack of clear guidance for calculating power for LMMs. The study was approved by the university's research ethics committee.

Materials

The video stimuli used were the same as those used in Study 1 and Study 2.

Procedure

The experiment was programmed using Gorilla (www.Gorilla.sc). I specified that participants could only complete the study using a computer. Smartphones and tablets could not be used.

After providing consent and demographic information, participants were given a clear step-by-step summary of how the Trust Game works, alongside visual diagrams. Participants were told that they would take the role of Investor in the game, and they would be investing money

Box 2.1 – Information Given to Participants About the Trust Game

We are interested in how people make decisions about investing with other people. In this section of the study, you will see videos of participants who took part in a previous study conducted in our lab. In the previous study, pairs of participants played an investment game with each other. You will see videos of some of these participants. You will then be asked how much you would invest with these past participants if you were playing the same game. The next screens will tell you how the Investment Game works. **You will be quizzed on your understanding of the Investment Game before you begin the task**, so please read through the screens slowly and pay close attention!

In an Investment Game each participant is given a role to play. One player is the Investor and the other player is the Trustee. The aim of the game is to earn as many points as possible. **You will be playing as the Investor.**

At the beginning of each round the Investor is given 100 points.

The Trustee has 0 points. The Investor then chooses how many of the 100 points to send to the Trustee. **The invested points are multiplied by 3 before being sent to the Trustee.** For example, if the Investor sends 70 points to the Trustee, the Trustee will receive 210 points (70x3).

The Trustee then chooses how many of the received points to return to the Investor. The points they do not return they keep! For example, if the Trustee returns 100 points, the Investor will end the game with 130 points and the Trustee will end with 110 points.

Once the Trustee has returned points to the Investor the round is over and the points are added to each player's total. The next round then starts and the Investor is given another 100 points. The aim of the game is to earn as many points as you can, so invest wisely e.g. invest more with Trustees you expect to return more.

with participants who had played the Trust Game in a previous study. Box 2.1 above shows the information participants were given. Note that the Trust Game was referred to as the “Investment Game” to participants.

Next, participants were asked five simple comprehension questions about the Trust Game in order to screen out those who had misread or misunderstood the information. Participants were excluded if they answered any of the five questions incorrectly. Only one participant was excluded.

Following the comprehension test, participants began the Trust Game. Participants were randomly allocated to one of three test blocks, consisting of the 36 smile stimuli presented once each in a random order, within either enjoyment, polite, and negative backgrounds (12 of each). Within each block, face gender and smile type were fully balanced across context type. Furthermore, smile and context were balanced across the three test blocks for each actor, such that every smile video was presented in each context type (enjoyment, polite, and negative) across participants.

For each video, participants made two ratings along 0-100 scales. First, they were asked “*How many points would you invest with this person?*”. Then, on a new screen, they were asked “*What percentage of the tripled points would you expect to receive back from this person?*”. Participants had unlimited time to respond. Questions were always presented in the same order. Each video could be watched only once and could not be replayed.

Finally, participants completed the Toronto Alexithymia Scale (TAS-20 — Bagby et al., 1994) and the Holistic Cognition Scale (HCS — Lux et al., 2021), the results of which are not included in this thesis. On completion of the experiment, all participants were fully debriefed.

Data Analysis

Data analysis was conducted with R Studio version 2023.06.2 (RStudio Team, 2020) in R version 4.2.2 (R Core Team, 2022). Participant ratings were analysed using linear mixed models.

Like Study 1 and Study 2, I again followed the advice of Bates et al. (2015) when conducting my analysis. For both dependent variables (invested points, expected points returned), smile type (two levels: reward vs affiliative) and context category (three levels: enjoyment vs polite vs negative) were entered as fixed effect predictors. Dominance smiles were not included in primary analyses as they were included in the study for exploratory purposes. Significant effects were clarified by tests of estimated marginal means (with the Holm-Bonferroni correction applied).

Data Availability

This study's design and analysis were pre-registered. The pre-registration (Study 2 of the pre-reg), data, analysis code, and research materials are available in the Trust Game section at this link: https://osf.io/4wa5d/?view_only=479faab92dcc466caacd8b8d57b12fae.

Results

Main Analyses

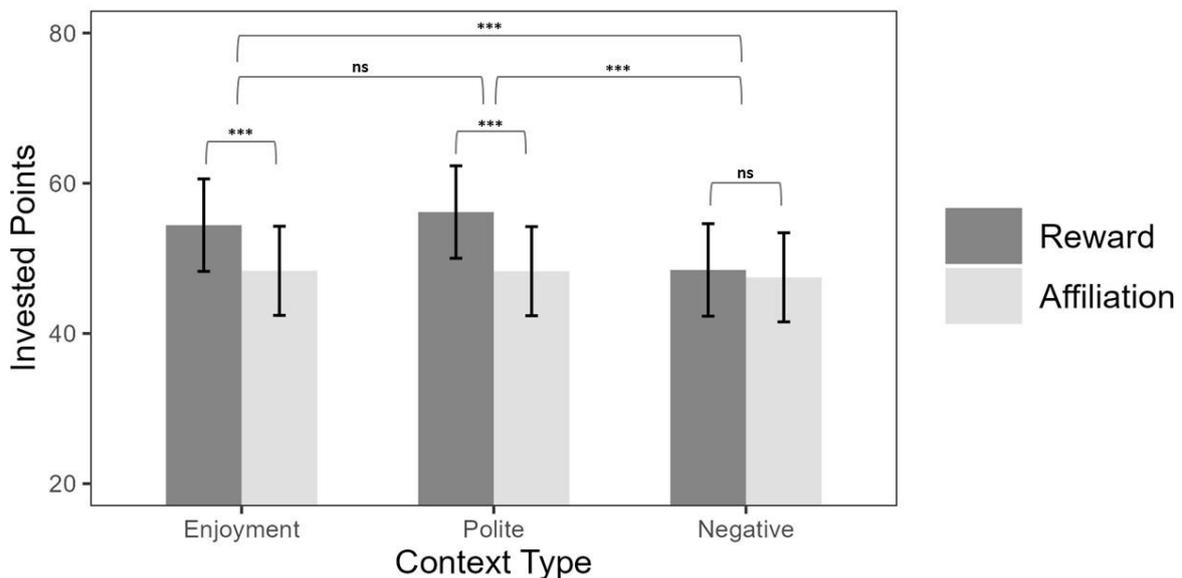
LMMs were constructed to assess the effect of both smile type (two levels: reward vs affiliative) and context category (three levels: enjoyment vs polite vs negative) on both dependent variables.

Invested Points. Results revealed a significant main effect of smile type, $F(1, 11.0) = 16.20, p = .002$, such that participants were willing to invest more points with trustees displaying reward smiles ($M = 53.01, 95\% \text{ CI } [48.18, 57.85]$) than affiliation smiles ($M = 48.04, 95\% \text{ CI } [43.38, 52.69]$). The main effect of context category was also significant, $F(2, 3217.3) = 17.27, p < .001$, such that participants invested significantly more points with

trustees in enjoyment contexts ($M = 51.38$, 95% CI [46.75, 56.02]) than trustees in negative contexts ($M = 47.97$, 95% CI [43.33, 52.60]), $t(3217.35) = 4.45$, $p < .001$. Similarly, participants invested more with trustees in polite contexts ($M = 52.23$, 95% CI [47.59, 56.87]) than trustees in negative contexts, $t(3217.35) = -5.55$, $p < .001$, although there were no investment differences between trustees in enjoyment compared to polite contexts ($p = .27$). Finally, there was a significant interaction between smile type and context category, $F(2, 3216.6) = 10.82$, $p < .001$. Participants were willing to invest more with trustees displaying reward smiles than affiliation smiles for both enjoyment ($t(25.17) = -4.00$, $p < .001$) and polite contexts ($t(25.17) = -5.17$, $p < .001$). However, smile type did not affect points invested with trustees when seen in negative contexts ($p = .52$). See Figure 2.6 for relevant means and CI's.

Figure 2.6

Interaction Between Context Category and Smile Type for Invested Points. Error Bars: 95% CI

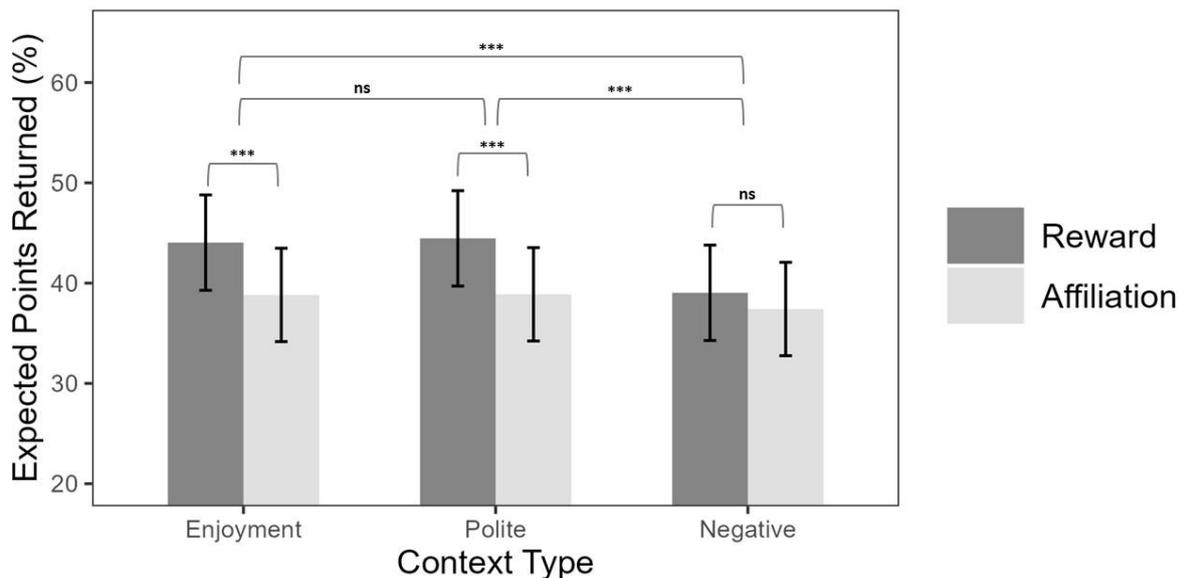


Expected Points Returned. Again, results revealed a significant main effect of smile type, $F(1, 11.0) = 15.99$, $p = .002$, such that participants expected trustees displaying reward smiles ($M = 42.51$, 95% CI [38.80, 46.22]) to return a higher percentage of points than trustees displaying affiliation smiles ($M = 38.38$, 95% CI [34.75, 42.01]). The main effect of

context category was also significant, $F(2, 3217.4) = 17.66, p < .001$, such that participants expected trustees in enjoyment contexts ($M = 41.43, 95\% \text{ CI } [37.86, 45.00]$) to return a higher percentage of points than trustees in negative contexts ($M = 38.22, 95\% \text{ CI } [34.66, 41.80]$), $t(3217.37) = 4.95, p < .001$. Similarly, participants expected trustees in polite contexts ($M = 41.67, 95\% \text{ CI } [38.10, 45.24]$) to return a higher percentage of points than trustees in negative contexts, $t(3217.37) = -5.32, p < .001$, although there were no differences in expected returns between trustees in enjoyment compared to polite contexts ($p = .71$). Finally, the interaction between smile type and context category was also significant, $F(2, 3216.7) = 5.72, p = .003$. Participants expected trustees displaying reward smiles to return a higher percentage of points than trustees displaying affiliation smiles in both enjoyment ($t(25.46) = -4.09, p < .001$) and polite contexts ($t(25.46) = -4.37, p < .001$). However, smile type did not affect the expected points returned for trustees in negative contexts ($p = .22$). See Figure 2.7 for relevant means and CI's.

Figure 2.7

Interaction Between Context Category and Smile Type for Expected Points Returned. Error Bars: 95% CI



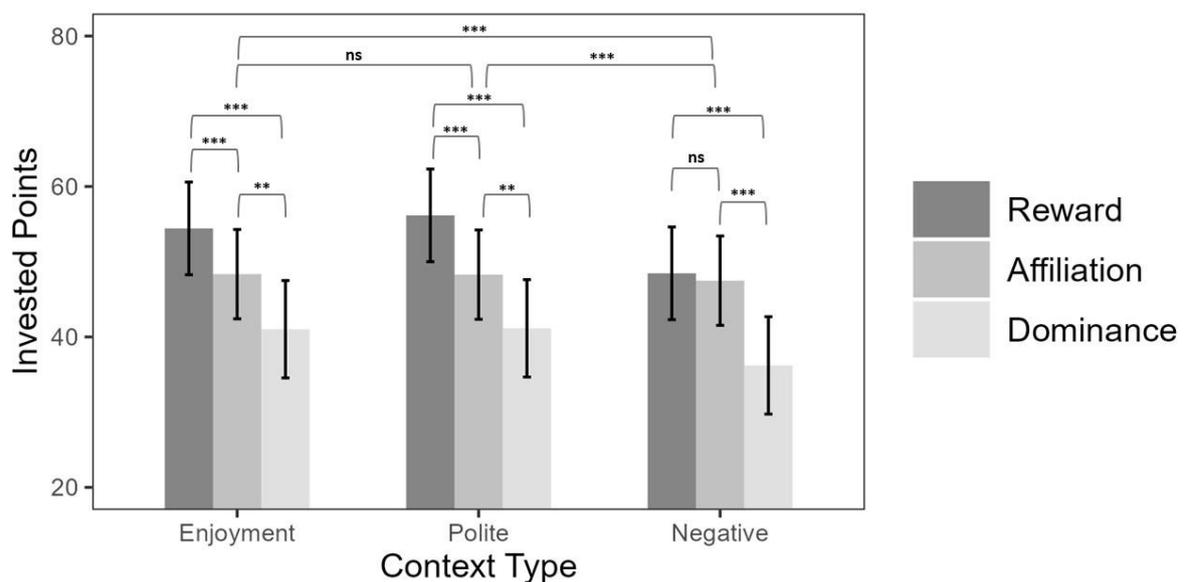
Exploratory Analyses

Exploratory analyses were then performed on the whole dataset (with dominance smiles included). New random effects structures were established using the same procedures described previously.

All main effects reported in the primary analyses were retained. Compared to trustees displaying reward smiles and dominance smiles, participants were willing to invest fewer points with trustees displaying dominance smiles ($M = 39.46$, 95% CI [34.37, 44.55]) and expected to receive a smaller percentage of points in return ($M = 30.99$, 95% CI [26.67, 35.31]), all $p < .001$.

Figure 2.8

Interaction Between Context Category and Smile Type for Invested Points, when including Dominance Smiles. Error Bars: 95% CI



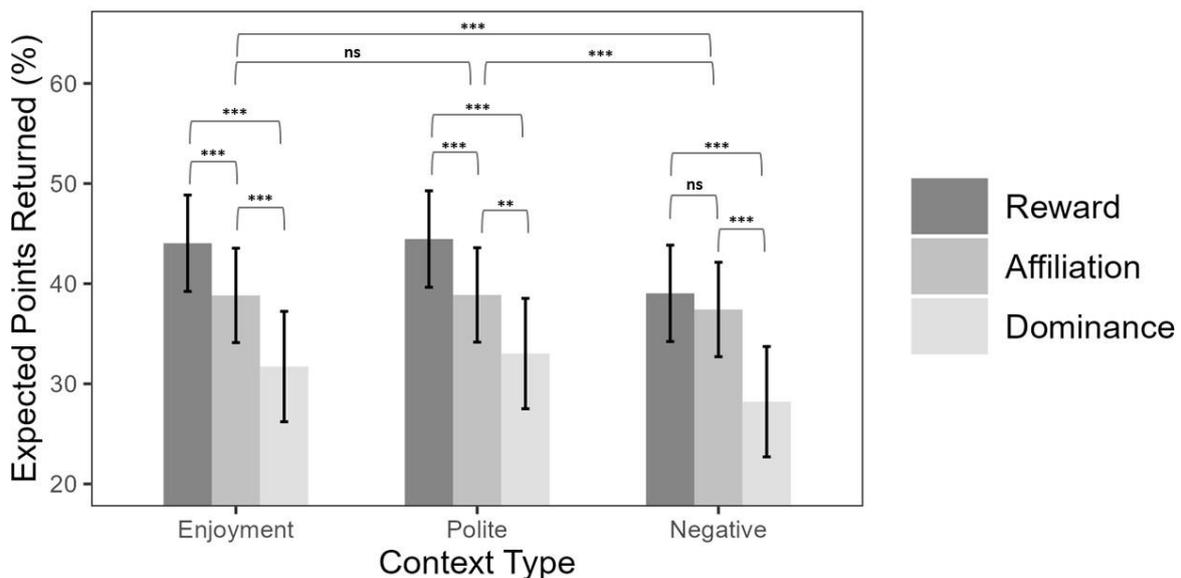
For points invested, the interaction between context category and smile type remained significant, $F(4, 4896.2) = 5.74$, $p < .001$. Dominance smiles did not seem to contribute towards this interaction because participants were willing to invest significantly fewer points

with dominance smiles (than reward or affiliation smiles) across all context categories (all $p < .002$). See Figure 2.8 for relevant means and CIs.

Likewise, for expected points returned, the context-by-smile type interaction remained significant, $F(4, 4896.1) = 3.25, p = .011$. Again, dominance smiles did not seem to contribute to this interaction, as participants expected trustees displaying dominance smiles to return fewer points (than trustees displaying both other smile types) across all context categories (all $p < .003$). See Figure 2.9 for relevant means and CI's.

Figure 2.9

Interaction Between Context Category and Smile Type for Expected Points Returned, when including Dominance Smiles. Error Bars: 95% CI



General Discussion

In Study 1, I found that context affected evaluations of smiles. In line with Hypothesis 1, smiles in enjoyment contexts were rated as more genuine and more joyful than smiles in negative contexts. In accordance with Hypothesis 2, smiles in polite contexts were rated as more polite than smiles in both enjoyment and negative contexts. As expected by Hypothesis

3, smiles in negative contexts were evaluated as less genuine, less enjoyable, and indicating greater superiority than smiles in enjoyment contexts, and less polite and less genuine than smiles in polite contexts. However, contrary to Hypothesis 4, the magnitude of context effects was largely consistent across smile types. In fact, politeness evaluations of reward smiles were affected by polite contexts more than affiliation smiles were.

In Study 2, I found that smiles affected context evaluations. In line with Hypothesis 5, situations paired with reward smiles were rated as more positive, more enjoyable, and less competitive than situations paired with affiliation smiles. Contrary to Hypothesis 6, situations paired with affiliation smiles were not rated as more polite than situations with reward smiles. Exploratory analyses showed that contexts were perceived as less positive, less enjoyable, less polite, and more confrontational when accompanied by a dominance smile. The smile type effect was moderated by context, such that differences between reward and affiliation smiles were reduced or eliminated in negative situations. Intriguingly, the effect of smiles on ratings of situational contexts appeared to be much larger than the converse effect of situational contexts on smile ratings.

In Study 3, I found that investment decisions made by investors during trust games were influenced by both the type of smile displayed by the trustee, and the situational context the trustee was seen within. In line with Hypothesis 7, participants invested more points with trustees displaying reward smiles than trustees displaying affiliation smiles, and they expected to receive a higher percentage return. As per Hypothesis 8, participants invested more points with trustees presented within enjoyment and polite contexts than trustees presented within negative contexts, and they expected to receive a higher percentage return. Finally, as per Hypothesis 9, the influence of smile type was stronger when participants were presented in enjoyment and polite contexts than negative contexts. Participants invested significantly more points when trustees displayed reward smiles compared to affiliation

smiles within polite and enjoyment contexts (and expected to receive a higher percentage return). However, there were no significant differences in investments between trustees displaying these respective smile types in negative contexts.

The effect of context on social inferences from smiles (Study 1) is consistent with a body of recent research showing that contextual information alters smile interpretations (Gagnon et al., 2022; Krumhuber, Hyniewska, et al., 2023; Maringer et al., 2011; Mui et al., 2020; Namba et al., 2020; Orłowska et al., 2021). However, my findings extend this research by showing that *socio-functional* evaluations of smiles are influenced by the surrounding situation, and that this effect occurs for both reward and affiliation smiles. Although contrary to my hypotheses, the failure to find enhanced context effects for affiliation smiles is consistent with Gagnon et al. (2022), who unexpectedly showed that evaluations of Duchenne smiles were more influenced by dispositional contextual information than evaluations of non-Duchenne smiles. These authors attributed this unexpected finding to methodological shortcomings which produced floor effects in their participants' sincerity ratings. Nonetheless, Gagnon et al. (2022) stressed that non-Duchenne smiles were not highly ambiguous stimuli (like neutral or blended expressions) and hence they were reluctant to present their study as a test of the idea that context exerts a stronger influence on ambiguous expressions. Similarly, it is possible that the affiliation smiles in my research were not the most suitable stimuli to test this hypothesis because they have a well-defined social function. In fact, it is possible that my affiliation smiles are actually *less* ambiguous social signals than reward smiles along the politeness dimension. This theory could explain the unexpected interaction between smile type and context category for ratings of politeness, whereby politeness evaluations of reward smiles were affected by polite contexts more than evaluations of affiliation smiles were.

The converse effect of smile type on context evaluations (Study 2) is in line with prior research showing that expressions may affect how body postures, behaviours, and situations are evaluated (Hess et al., 2018; 2020; Kret et al., 2013; Lecker et al., 2020). Building on this work, I showed that facial expressions also affect evaluations of *visual situational* contexts. This effect is especially notable because the effect of smile type on context evaluations appeared to be larger than the opposite effect of context category on smile evaluations.

Although I am wary of drawing strong conclusions without standardised effect sizes, my findings are in sharp contrast with the results of Lecker et al. (2020), who observed an effect of body posture on facial emotion ratings that was twice as large as the converse effect of facial expression on body emotion ratings. To explain this potential discrepancy, I suggest that the effect of facial expression on situation evaluations may be distinct in nature from the reciprocal effect of situational context on facial expression. In turn, this inflates the magnitude of the effect of smile type on context ratings. Whilst substantial, the influence of situational context on facial expressions is inherently limited because the situation is not an active part of the facial expression. Consequently, the situation only contributes *indirectly* to face evaluations by indicating an increased likelihood that a person may be feeling or communicating a certain emotion or social motive. The face may be entirely unaffected by the context. In contrast, the face is a major part of the situation itself. A situation with a person smiling widely is of a completely different nature to a situation with someone smirking mockingly, even if both situations occur in the same location. Therefore, smiles contribute *directly* to evaluations of the situational context. The situation cannot be separated from the facial expression. Such an asymmetry is not present in the relationship between body language and facial expression. Hence, the more direct effect that smiles have on situational evaluations helps to overcome the natural advantage afforded by our regular practice in integrating context into the interpretation of facial expression (Lecker et al., 2020).

In Study 3, I expanded upon Study 1 and 2 by testing the effects of smile type and context on social decisions. The finding that participants invested significantly more points with trustees displaying reward smiles than affiliation smiles replicated the results of Martin et al. (2021, Study 2) who presented the SIMS smile types alone. Moreover, like Martin et al. (2021), I found that trustees displaying dominance smiles received significantly fewer points than those displaying affiliation smiles. This finding builds on previous work going back to Brown and Moore (2002), who showed that that participants allocated fewer resources to partners when their smiles were asymmetrical. Asymmetry in activation of the *zygomaticus major* is a core feature of the dominance smile (Rychlowska et al., 2017). These results, alongside those of Study 1 and Study 2, lend further support to Niedenthal et al.'s (2010) SIMS classification. Clearly, there are important and substantial distinctions between the meanings ascribed to different smile types, as well as their subsequent behavioural effects. Relatedly, the findings of Study 3 add to a large body of research showing that one's facial expressions strongly influence the subsequent behaviour of interaction partners (Fridlund, 1991; 1994; Krebs & Dawkins, 1984; Maynard Smith & Harper, 1995; Niedenthal et al., 2010), as demonstrated across many economic games (e.g. Johnston et al., 2010; Reed et al., 2012; Scharlemann et al., 2001; Tortosa et al., 2013).

More significantly, the results of Study 3 represent the first empirical example whereby situational context affects behavioural responses towards a partner in an economic game. Previously, it has been found that context implicitly affected mouse trajectories during a facial trustworthiness categorisation task (Brambilla et al., 2018). Likewise, situational context also affects unconscious mimicry of facial expressions (Kastendieck et al., 2021; Kirkham et al., 2015). Nonetheless, it had yet to be shown that context affects *more elaborate* cognitively mediated behavioural responses to smiles. Such a finding is important because it expands upon the results of studies that assessed context effects using explicit ratings /

categorisations as the only dependent variable, including Study 1 and 2 (see also: Gagnon et al., 2022; Mui et al., 2020; Namba et al., 2020). Rather than asking participants to make simple explicit ratings of facial meaning, instead I asked them to make decisions based on inferences drawn from the social signals perceived. Accordingly, Study 3 enhances the generalisability of previous findings and moves towards more ecologically valid results.

Importantly, I found a significant interaction between smile type and context category in Study 2 and Study 3. Specifically, there was a reduction or absence of a smile type effect in negative contexts in both studies. The replication is noteworthy given the “replication crisis” currently afflicting the discipline of psychology (Ioannidis, 2005; Open Science Collaboration, 2015). It therefore indicates that Study 2’s findings are likely to generalise to behavioural scenarios. Moreover, the result itself is important because it provides evidence that context can limit the social power of smiles. There are two plausible explanations for this interaction. On one hand, the moderating effect of negative situational context may have an attentional origin, such that the ratio of attention allocation towards the face relative to the context is reduced when encountering an aversive situation. Consequently, processing of the subtle morphological differences necessary to distinguish between smile meanings may be reduced in negative scenes but not positive or neutral. Intuitively, one would expect that aversive stimuli attract greater levels of attention because of their greater threat, and this hypothesis has been supported by previous eye tracking studies (e.g. Chajut & Algom, 2003; Hancock & Warm, 2003).

On the other hand, the moderating effect of negative context may have a cognitive origin, such that smiles are cognitively “discounted” or reinterpreted when they are seen in situations in which smiles would typically be unexpected i.e. because they are processed as incongruent or deviant. Hence, participants may ultimately rely on the smile type displayed to either a lesser extent or in a different way to usual when making their investment decisions.

This is somewhat in line with the findings of Carrera-Levillain and Fernandez-Dols (1994), who found that emotional evaluations of neutral faces were less affected by vignettes of uncommon and extreme situations than by common everyday scenarios. In both studies there appears to be a “congruency boundary” beyond which the presence of additional information was less likely to affect ratings of the focal stimulus as it typically would. This account is circumstantially supported further by the finding that dominance smiles retain their significant negative effect on investment decisions (relative to the other “more prosocial” smile types) when seen within negative situations. First, this suggests that participants can in fact direct sufficient attention towards the trustee’s facial expression even when presented within a negative context (although it could be argued that dominance smiles are themselves more negative stimuli and therefore negate the enhanced attentional demand of the negative scene). Second, as implied by Niedenthal et al. (2010) and Rychlowska et al. (2017), dominance smiles are much more congruent with negative or aversive scenarios than reward or affiliation smiles. Hence, they are less likely to be cognitively discounted or reinterpreted in these scenarios — as suggested by the present results. Nonetheless, this empirical question is not fully settled. As a result, in Chapter 3 of this thesis, I conducted further research to distinguish between these potential explanations.

Beyond my empirical results, this research contributes further to the study of social interaction by comparing the effects of different contexts across smile types, and vice versa. Apart from Gagnon et al. (2022), previous research has presented participants with just one type of smile, failing to consider the potential for interactions between social cues. However, overlooking these interactions fundamentally limits how we comprehend social processes. During everyday exchanges, people integrate a vast array of cues relevant to understanding the feelings and intentions of an interaction partner, including linguistic content, facial expression, tone of voice, body language, eye gaze, situation/setting, interaction history,

physiological indicators, dispositional information, gender, age, ethnicity, social group membership, etc. Whilst these variables may have additive effects, combining to strengthen an impression, interactions between variables are inevitable. For example, if a person is smiling, it may indicate the experience of happiness. Nevertheless, if the smile is combined with blushing, stuttering, and gazing at their feet, the person is most likely not happy at all but is trying to mask embarrassment (Brunet et al., 2009). Likewise, relationships between these cues may be bidirectional, as social signals emitted are being constantly modified according to how they have been interpreted (Barrett, 2017). The present research shows evidence for these relationships, however it only captures a small subset of the various factors that may influence facial expression processing during social interaction. Future research should study how a wider array of social cues influence subsequent responding.

In addition, there are further limitations to this research. First, it is possible that the results do not generalise beyond the specific set of UK-based participants. Previous research has demonstrated that culture affects both smile evaluations (e.g. Thibault et al., 2012) and the magnitude of context effects in smile ratings (e.g. Namba et al., 2020). It is important to note though that responses did not differ by ethnicity in my studies. However, the findings may not generalise to neuroatypical groups such as autistic people, who typically struggle to integrate information during social interactions (e.g. Minshew & Goldstein, 1998). Furthermore, although I attempted to increase the generalisability of previous findings in this area by testing whether context affects participants' subsequent behaviour rather than their mere ratings of faces, the Trust Game in Study 3 still suffers from constraints to ecological validity. Economic games are artificial and unlike any scenario that one would come across in everyday life. Moreover, as argued by Scharlemann et al. (2001), one-shot interactions are likely to have been a rarity during human evolutionary history. Therefore, the extent to which I can extrapolate the present findings to real-life social behaviour is still somewhat limited.

Finally, although I ensured that my context stimuli were as realistic as possible (e.g. by using colour videos rather than static greyscale photos), it is possible that the situations trustees were seen within lacked believability (especially the more extreme negative scenarios). Although it is apparent that these contexts affected participants' ratings and investment decisions, the lack of believability may have reduced participants' task engagement. To rectify this issue, in Chapter 5 I embedded participants into more embodied and realistic virtual reality (VR) environments.

Conclusion

To conclude, this research shows that the relationship between smiles and contexts is complex, with interactions between morphological features of the facial expression and the nature of the situation. Notably, different smile types lacked separable social effects in negative scenarios. It remains unclear whether this effect has a cognitive or attentional origin. At a practical level, Study 3 advanced on previous research by assessing more elaborate and cognitively mediated behavioural responses to smiles in context, rather than simple ratings. At a theoretical level, this study represents an early step towards understanding the combined effects of cues in social interaction. The rest of this thesis explored the underlying mechanisms of cue integration to further understand the observed context and smile effects.

CHAPTER 3: THE PSYCHOLOGICAL MECHANISMS UNDERLYING CONSCIOUS FACE-CONTEXT INTEGRATION

Abstract

The previous chapter showed that context affected social ratings of smiles. Similarly, smiles influenced how situations are evaluated. However, the psychological mechanisms underlying these effects are not clear. Consequently, to determine whether my observed effects depended on the relative extents to which different aspects of the stimuli were attended to, in this chapter I recorded participants' (n = 66) eye movements as they viewed smile-in-context videos across two different tasks. In one task, participants made social evaluations of different smile types, while in the other they evaluated the different situations. Consistent with Chapter 2, I found that ratings of smiles were affected by the types of situational contexts they were seen within, whilst ratings of situations were affected by their accompanying smile type. However, contrary to my hypothesis, participants did not attend to negative situational contexts to a significantly greater extent than polite or enjoyment contexts. Instead, both rating and response time data indicated that the interaction between smiles and contexts was likely due to cognitive rather than attentional processes. Specifically, it appeared that interactions between smile type and context category were driven by the particular incongruity of reward smiles when seen within negative situations. This incongruity subsequently influenced how the context itself was evaluated, and the extra cognitive deliberation required was indexed by slower response times. Overall, the findings suggest that the processing of faces-in-context is a complex bidirectional process, in which the social meanings of the face and situation mutually and dynamically interact with one another. Situational context influences how faces are consciously evaluated, which in turn influence how the situation is re-evaluated.

Introduction

Smiles are important: they occur at a high frequency within social interactions (Heerey & Kring, 2007; Hess & Bourgeois, 2010), grab the attention of observers (Campos et al, 2015), and affect dispositional inferences made about the smiler (Senft et al, 2016). Moreover, smiles also have strong effects upon the behaviour of perceivers. Shore and Heerey (2011) showed that participants were willing to forego monetary reward in exchange for a “genuine” smile. Likewise, smiles also have considerable influence over real-world outcomes, ranging from relatively low-level decisions such as how much to tip a waitress in a cocktail bar (Tidd & Lockard, 1978), to high-consequence decisions like voting preference (Mullen et al, 1986) and criminal sentencing severity (LaFrance & Hecht, 1995).

The idea that smiles — and facial expressions more broadly — function to influence the subsequent behaviours of others is foundational to the social-functionalist “Behavioural Ecology” approach to facial expressions (Carroll & Russell, 1996; Fridlund, 1991a; 1994). Proponents of this approach conceive of facial expressions as flexible tools for social influence rather than reflections of the expresser’s underlying internal emotions. Consistent with this view, Behavioural Ecologists have recently proposed a new social-functional smile typology — the Simulation of Smiles (SIMS) Model — which divides smiles into three categories, each serving a different basic human need that arises within the social environment (Niedenthal et al., 2010). Specifically, “reward smiles” reinforce desired behaviours by inducing positive affect in the perceiver, “affiliation smiles” aid the formation and maintenance of social bonds by communicating reassurance or an openness to positive relations, whereas “dominance smiles” are used to communicate and assert superiority over the perceiver in order to maintain high social status (Rychlowska et al., 2017).

During face-to-face interactions in everyday life, the faces of others are rarely, if ever, perceived in isolation as single entities, but instead are nearly always encountered alongside

or within some sort of context, including situational, vocal, bodily, and dispositional information. From a broader theoretical perspective, well-established principles of perception stemming back to Helmholtz (1867) suggest that top-down contextual variables such as those listed above are likely to influence how facial expressions are perceived and evaluated. Consistent with these principles, it is empirically well-established that contextual information strongly influences evaluations of facial expressions (Aviezer et al., 2017; Gendron et al., 2013; Wieser & Brosch, 2012).

Given the above, Study 1 of the previous chapter assessed how situational contexts affected participants' social evaluations of reward, affiliation, and dominance smiles. I found that context strongly influenced smile ratings, such that smiles in enjoyable situations were rated as more genuine and joyful, as well as indicating less superiority than those in negative situations. Likewise, smiles in "polite" contexts (e.g. shops, workplaces) were rated as more polite than smiles in positive or negative contexts. Moreover, in Study 2 of the previous chapter I established that the relationship between context and facial expressions is likely reciprocal. Previous research had found that facial expressions biased evaluations of a player's success/failure in an ambiguous ball game (Hess et al., 2020) and moral judgements of unusual behaviours described in verbal vignettes (Hess et al., 2018). Consistent with these studies, I found that situations paired with reward smiles were rated as more positive, more enjoyable, and less competitive than situations paired with affiliation smiles. Furthermore, exploratory analyses showed that contexts were perceived as less positive, less enjoyable, less polite, and more confrontational when accompanied by a dominance smile. Importantly however, these effects were moderated by the type of context, such that smile-associated ratings differences were reduced or absent in negative situations.

The observed interaction between smile type and context category situation evaluations was important because it demonstrated limits to the social power of smiles.

Specifically, it indicated that negative contexts blunted the distinctive effects of different smile types on situation ratings. There are two potential psychological mechanisms that could explain this effect: one attentional and one cognitive. On one hand, the reduction of a smile effect in negative situations may have been caused by the attention demanding nature of the negative situation itself. When encountering an aversive situation such as a fire or rubbish dump, it is possible that one's attention to less arousing features of the situation (e.g. the facial expression) is reduced in favour of enhanced focus on the source of the aversion (Chajut & Algom, 2003; Hancock & Warm, 2003). Hence, processing of the subtle morphological differences necessary to distinguish between smile meanings may be reduced in negative scenes but not positive or neutral. This could explain why both reward and affiliation smiles had similar effects on situation ratings.

This attentional explanation is circumstantially supported by previous eye tracking studies which determined that ratings of different facial expressions were affected by the extent to which participants fixated on the face. In particular, Masuda et al. (2008) presented both American and Japanese participants with cartoons depicting either a happy, sad, angry, or neutral target person, who was surrounded by other people expressing either a congruent or incongruent facial emotion. Intriguingly, Japanese participants' categorisations of the focal expression were influenced by the surrounding faces whereas American categorisations were not. Moreover, this behavioural difference was paralleled by differences in eye fixation patterns. Specifically, the Japanese participants tended to broaden their search for information more quickly than Americans, and therefore fixated to a greater extent on the surrounding people relative to the target. Such findings suggest that the relative attentional demands of faces versus contexts may influence participants' subsequent evaluations. If negative contexts are more attention demanding, then a subsequent reduction of smile impact may logically follow on.

Alternatively, the incongruity or unexpectedness of smiles in negative situations may trigger a process whereby the situation is reinterpreted to fit the smile. This is in line with Hess and Hareli's (2016; 2017) Meaning of Emotional Expressions in Context (MEEC) model, which argues that perceiving a facial expression within a situation often leads to a conscious re-engineered appraisal of the situation itself. For example, if an expresser shows an incongruous fearful response to a kitten, an observer may "reconcile the expression and the emotion elicitor by either postulating a specific significance of the situation for the expresser (i.e., the expresser is ailurophobic [cat phobic]) or by changing the meaning of the situation (i.e., there is in fact something dangerous to be seen [a growling dog behind the kitten])" (Hess & Hareli, 2017, p. 384). Thus, in the previous chapter, the incongruity of reward smiles in negative situations may have triggered a reinterpretation of the situation — evident in subsequent situation ratings. This cognitive reinterpretation explanation is also somewhat in line with the findings of Carrera-Levillain and Fernandez-Dols (1994), who found that emotional evaluations of neutral faces were less affected by vignettes of uncommon and extreme situations than by common everyday scenarios. In both that study and my previous chapter there appeared to be a "congruency boundary" beyond which the presence of additional information failed to affect ratings of the focal stimulus in the way that it usually would. It is perhaps at this abstract boundary where the two sources of information become too incongruent, facilitating a reinterpretation process that limits the typical effect of one of the sources.

Present Research

This chapter aimed to test whether negative contexts were attended to more frequently than positive and polite contexts, and if so, whether this influenced participants' evaluations of the different smile types. To do this, I used an eye tracker to record participant's fixations as they viewed the face-in-context stimuli. I then assessed the relative extent to which they

fixated on the face versus the context. Moreover, I also recorded participants' response times for each rating, intended as an indirect measure of cognitive effort. This in turn enabled me to assess whether certain smile-context combinations triggered more extensive deliberation.

Hypotheses

With regards to eye tracking, I hypothesised that the proportion of time spent fixated on the context (versus the face) would be higher for negative contexts compared to polite and enjoyable contexts (Hypothesis 1).

In line with the results of the previous chapter, for the face ratings task, I hypothesised that smiles presented in enjoyment contexts would be rated as more joyful than those presented in polite or negative contexts (Hypothesis 2). Likewise, I hypothesised that smiles presented in polite contexts would be rated as more polite than those presented in enjoyment or negative contexts (Hypothesis 3), whilst smiles presented in negative contexts would be rated as more superior than those presented in enjoyment or polite contexts (Hypothesis 4).

For the situation ratings task, I hypothesised that situational contexts presented with reward smiles would be rated as more joyful and polite than those presented with affiliation or dominance smiles (Hypothesis 5). Similarly, I hypothesised that contexts presented with dominance smiles will be rated as more competitive/confrontational than those presented with reward or affiliation smiles (Hypothesis 6). Unlike the face ratings task, I also hypothesised an interaction between smile type and context category, such that the effects of smile type would be greater for ratings of enjoyment and polite contexts than negative contexts (Hypothesis 7).

Study 4

Methods

Participants

As there was no previous research to provide a reasonable estimate of expected effect size, I did not conduct a power analysis. Instead, other eye tracking studies addressing similar research questions provided benchmarks for a target sample size (e.g. Chua et al., 2005; Friesen et al., 2019, Study 5; Kawakami et al., 2014; Masuda et al., 2008). The mean sample size of these studies was 54. Therefore, I targeted a minimum of 60 participants. In total, I tested 71 participants to allow for some attrition (e.g. issues with eye tracker calibration).

Overall, I used data from 66 participants (45 women, 21 men) living in the United Kingdom. The majority were White (63.6%; 20 Asian, 2 mixed race, 1 Black, 1 other), aged 18-53 years ($M_{\text{age}} = 24.67$, $SD_{\text{age}} = 7.37$). Participants were recruited via the psychology department's participant recruitment system, posters, social media posts, and word of mouth. Participants were compensated at a rate of £10 per hour or with course credits. An additional five participants were excluded from my data analysis because of technological malfunctions which prevented me from recording either eye or ratings data. The study was approved by the university's research ethics committee.

Materials

I used the same stimuli as in the previous chapter; 36 smile videos were taken from the set developed by Rychlowska et al. (2017), one video of each smile type (reward, affiliation, dominance) produced by 12 White actors (six male, six female) in frontal view. Each video showed the face changing from non-expressive to peak emotional display. Videos ranged in duration from 1.8 seconds to 3.0 seconds ($M = 2.40$ seconds).

These, smile videos were superimposed over context videos with the editor tool from Kapwing (www.Kapwing.com). Thirty-six context videos were downloaded from Envato Elements (www.elements.envato.com); consisting of 12 of each situation type: enjoyment, polite, and negative. For each actor, nine smile-in-context videos were created such that each smile type was superimposed over the three context types. Each of the face-in-context videos was 1980 x 1080 pixels.

Procedure

The experiment was programmed using PsychoPy (Peirce et al., 2019). After providing informed consent, participants completed two tasks, which varied according to whether participants were instructed to rate the smiles or the situations. Task order was counterbalanced across participants.

To ensure there were sufficient trials to detect fixation time effects, participants completed 108 trials per task, which meant that each participant saw every smile in every context. However, participants answered just one question per trial. All stimuli were presented in a random order and could be watched only once. Each video was preceded by a central fixation cross which remained on the screen for 700 ms. After viewing each video, participants made one rating per trial, along a 1-100 scale. In the face ratings task, participants rated the extent to which the person was expressing either (1) enjoyment/reward, (2) politeness/civility, or (3) superiority/condescension (*not at all - very much*). In the situation ratings task, participants were told to “imagine coming across this situation in your everyday life”. They then rated the extent to which the situation was either (1) enjoyable/rewarding, (2) polite/civil, or (3) competitive/confrontational (*not at all - very much*). Within each task participants answered each question 36 times, balanced across context and smile types. Further, because each participant answered only one question for each face-in-context combination within a task, participants were randomly assigned to one

of three question routines. The question associated with each stimulus varied across routines. For each trial, participants were given unlimited time to respond.

Upon completion of the experiment, all participants were fully debriefed.

Eye Tracking Acquisition

The eye tracker (EyeLink 1000, SR Research, sampling rate = 1000) was located on a table ~15 cm in front of the monitor and ~90 cm away from the eyes. Gaze positions along the horizontal and vertical axes were continuously recorded for both eyes. However, on some occasions, recordings from one eye were lost. Specifically, this occurred on 0.67% of trials in the face rating task, and on 1.46% of trials in the situation rating task. In these cases, I used data from the remaining eye only, which is common practice in eye tracking studies (e.g. Tatler, 2007; Vlaskamp et al., 2005). Before starting each task, I calibrated the eye tracker using the standard calibration and validation protocols from the EyeLink software.

Eye tracking data was read into R Studio, and all trials in which the participant blinked for more than 30% of the total video duration were removed. This occurred on 2.24% of trials in the face rating task, and 2.74% of trials in the situation rating task. To define my regions-of-interest (ROIs), each stimulus video was processed using the OpenFaceOffline app (Baltrusaitis et al., 2018). From the facial coordinates outputted by OpenFace, I created a dynamic “convex hull” for each video using the grDevices package. Specifically, the hull corresponded to the x and y coordinates of points 0 to 26, which comprise the outline of the target’s face. I then correlated the time stamps of the OpenFace data with the onset and offset timings of each video from the experiment data to determine where the face was relative to the participants’ fixation at each time point. All fixations within this hull were considered face fixations. Any fixations outside the hull were considered context fixations.

Using data about the length of each fixation and the total trial duration, I calculated the proportion of each trial that participants spent fixated on either the face or the background context.

Data Analysis

Data analysis was conducted with R Studio version 2023.03.0 (RStudio Team, 2020) in R version 4.2.3 (R Core Team, 2022). I used linear mixed models to analyse (1) participant's ratings and (2) the proportion of the trial spent fixated on the context.

I followed the advice of Bates et al. (2015) when conducting my analysis. Bates et al. proposed that one should start with a maximal model and remove the random effect components which account for the smallest variance, one-by-one. In line with Bates et al.'s recommendations, after each simplification, the reduced model was subjected to a Principal Components Analysis (PCA), using the rePCA function from the 'lme4' package. The output of the rePCA function indicated whether there were any random effect terms in the model that did not explain any covariance.

In theory, this process should continue until each remaining random effect term explains a considerable portion of variance. However, after each simplification, I also compared the goodness-of-fit of my reduced model to the more parameterised model with a likelihood ratio test (using the anova function from the 'stats' package). If goodness-of-fit did not significantly differ, the simplification was justified because parsimony was prioritised. However, if the goodness-of-fit differed significantly, I retained the more parameterised model and stopped the PCA-based model simplification process.

Random structure was identified prior to adding fixed effects to the model (Meteyard & Davies, 2020). Simplification of random effects continued until convergence. Satterthwaite's F test determined inferential statistics.

For the eye tracking and response time dependent variables smile type (three levels: reward vs affiliation vs dominance), context category (three levels: enjoyment vs polite vs negative), and task (two levels: face vs situation) were entered as fixed effect predictors. Significant effects were clarified by tests of estimated marginal means (with the Holm-Bonferroni correction applied).

For each rating (enjoyment, politeness, superiority), smile type (three levels: reward vs affiliation vs dominance) and context category (three levels: enjoyment vs polite vs negative) were entered as fixed effect predictors. Significant effects were clarified by tests of estimated marginal means (with the Holm-Bonferroni correction applied).

Data Availability

All data, analysis code, and research materials are available at https://osf.io/rabh6/?view_only=f3ca244248ac4397808d90960265d97f. This study's design and analysis were pre-registered.

Results

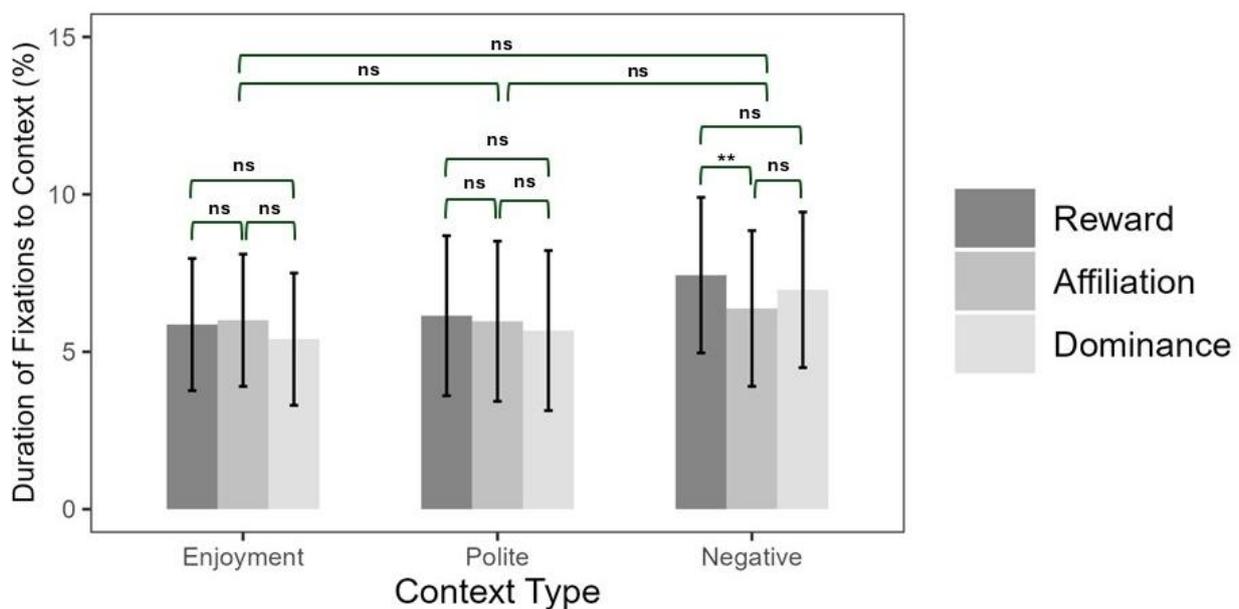
Eye Tracking Analysis

An LMM was constructed to assess the effect of smile type (three levels: reward vs affiliation vs dominance), context category (three levels: enjoyment vs polite vs negative), and task (two levels: face vs situation) on the proportion of each trial spent fixated on the context.

Figure 3.1

Duration of Fixations to the Situational Context as a Proportion of Total Trial Duration

Across Both Tasks. Error Bars: 95% CI



Results revealed a significant main effect of task on fixations, $F(1, 64.5) = 4.18, p = .045$. Contexts were fixated on for a greater proportion of each trial during the situation rating task ($M = 7.11, 95\% \text{ CI } [5.02, 9.19]$) than the face rating task ($M = 5.30, 95\% \text{ CI } [3.39, 7.21]$). The main effect of context category ($p = .064$) and smile type ($p = .057$) did not reach significance. All other main and interaction effects did not reach significance (all $ps > .08$). See Figure 3.1 for relevant means and CIs.

Face Ratings Analyses

LMMs were constructed to assess the effect of both smile type (three levels: reward vs affiliation vs dominance) and context category (three levels: enjoyment vs polite vs negative) on each of the three face rating dependent variables.

Enjoyment/Reward. Results revealed a main effect of smile type on enjoyment ratings, $F(2, 18.75) = 78.14, p < .001$, such that reward smiles ($M = 77.93, 95\% \text{ CI } [74.73, 81.12]$) were rated as more joyful than affiliation smiles ($M = 50.71, 95\% \text{ CI } [43.37, 58.05]$), $t(16.51) = -7.83, p < .001$, and dominance smiles ($M = 48.56, 95\% \text{ CI } [44.35, 52.76]$), $t(27.47) = -11.51, p < .001$. There were no enjoyment differences between affiliation and dominance smiles ($p = .57$). A main effect of context category was also found, $F(2, 2127.36) = 6.38, p = .002$. Smiles in enjoyment contexts ($M = 60.69, 95\% \text{ CI } [57.23, 64.16]$) were rated as more joyful than smiles in negative contexts ($M = 57.78, 95\% \text{ CI } [54.31, 61.24]$), $t(2126.25) = 3.49, p = .002$, and polite contexts ($M = 58.72, 95\% \text{ CI } [55.26, 62.18]$), $t(2127.62) = 2.36, p = .04$. There were no enjoyment differences between smiles presented in negative and polite contexts ($p = .25$). Finally, the interaction between smile type and context category was not significant ($p = .08$). See Figure 3.2a for relevant means and CI's.

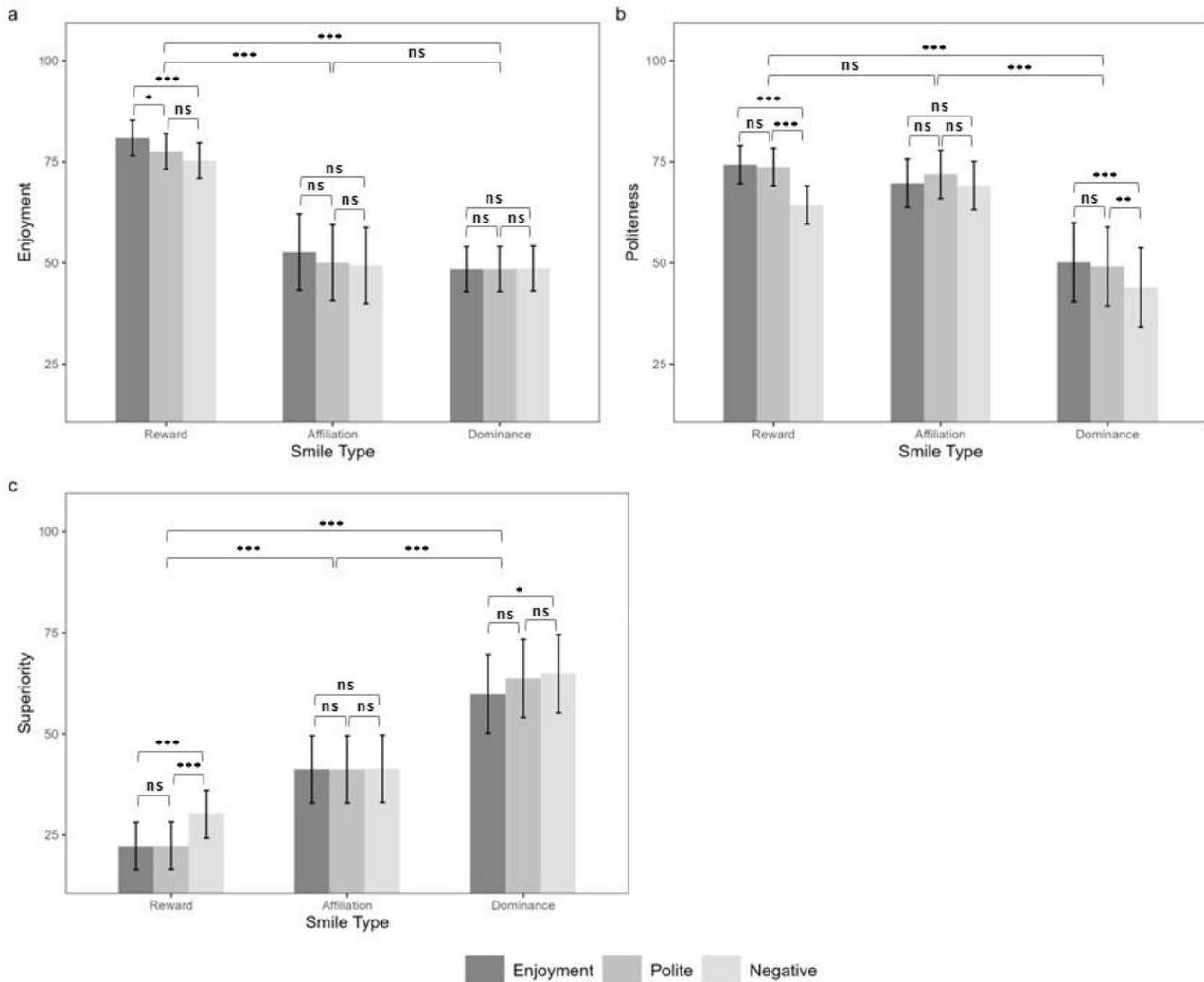
Politeness/Civility. Results revealed a main effect of smile type on politeness ratings, $F(2, 18.68) = 16.89, p < .001$. Affiliation smiles ($M = 70.24, 95\% \text{ CI } [65.69, 74.79]$) were rated as significantly more polite than dominance smiles ($M = 47.75, 95\% \text{ CI } [40.13, 55.36]$), $t(14.30) = 5.67, p < .001$, as were reward smiles ($M = 70.78, 95\% \text{ CI } [67.34, 74.22]$), $t(15.86) = -5.59, p < .001$. There were no politeness differences between affiliation and reward smiles ($p = .79$). A main effect of context category was also found, $F(2, 2122.79) = 28.65, p < .001$. Smiles in polite contexts ($M = 64.91, 95\% \text{ CI } [61.37, 68.45]$) were rated as more polite than smiles in negative contexts ($M = 59.14, 95\% \text{ CI } [55.60, 62.68]$), $t(2121.89) = -6.64, p < .001$, as were smiles in enjoyment contexts ($M = 64.72, 95\% \text{ CI } [61.18, 68.26]$),

$t(2120.36) = 6.41, p < .001$. There were no politeness differences between smiles in enjoyment and polite contexts ($p = .83$). Finally, there was a significant interaction between smile type and context category, $F(4, 2125.94) = 5.45, p < .001$. Specifically, for reward and dominance smiles, politeness ratings were higher when the smile was seen in enjoyment and polite contexts than when seen in negative contexts ($p < .002$ for all comparisons). However, for affiliation smiles, there were no significant politeness differences between smiles seen in different contexts (all $ps > .19$). See Figure 3.2b for relevant means and CI's.

Superiority/Condescension. Results revealed a main effect of smile type on superiority ratings, $F(2, 15.85) = 46.20, p < .001$. Dominance smiles ($M = 62.81, 95\% \text{ CI } [55.33, 70.28]$) were rated as significantly more superior than affiliation smiles ($M = 41.28, 95\% \text{ CI } [34.89, 47.68]$), $t(14.44) = -5.25, p < .001$, which in turn were rated as more superior than reward smiles ($M = 24.92, 95\% \text{ CI } [20.55, 29.28]$), $t(16.33) = 9.17, p < .001$. A main effect of context category was also found, $F(2, 2140.71) = 9.21, p < .001$. Smiles in negative contexts ($M = 45.47, 95\% \text{ CI } [41.11, 49.82]$) were rated as more superior than smiles in polite contexts ($M = 42.43, 95\% \text{ CI } [38.07, 46.78]$), $t(2140.25) = 2.92, p = .007$, and smiles in enjoyment contexts ($M = 41.11, 95\% \text{ CI } [36.76, 45.47]$), $t(2140.70) = -4.18, p < .001$. There were no superiority differences between smiles in enjoyment and polite contexts ($p = .21$). Finally, there was a significant interaction between smile type and context category, $F(4, 2137.18) = 3.87, p = .004$. Specifically, for reward and dominance smiles, superiority ratings were higher when the smile was seen in negative contexts than when seen in enjoyment contexts ($p < .02$ for both comparisons). However, for affiliation smiles, there were no politeness differences between smiles seen in different contexts (all $ps > .99$). See Figure 3.2c for relevant means and CI's.

Figure 3.2

Interactions Between Context Category and Smile Type for Ratings of Smile Enjoyment (a), Politeness (b), and Superiority (c) in the Face Rating Task. Error Bars: 95% CI



Situation Ratings Analyses

LMMs were constructed to assess the effect of both smile type (three levels: reward vs affiliation vs dominance) and context category (three levels: enjoyment vs polite vs negative) on each of the three situational context rating dependent variables.

Enjoyable/Rewarding. Results revealed a main effect of context category on enjoyableness ratings, $F(2, 66.50) = 46.72, p < .001$. Enjoyment contexts ($M = 61.67, 95\% \text{ CI } [57.83, 65.50]$) were rated as more enjoyable than polite contexts ($M = 53.80, 95\% \text{ CI } [50.37,$

57.24]), $t(66.88) = 4.86, p < .001$, which in turn were rated as more enjoyable than negative contexts ($M = 42.12, 95\% \text{ CI } [38.20, 46.05]$), $t(67.15) = -8.49, p < .001$. A main effect of smile type was also found, $F(2, 10.44) = 41.86, p < .001$. Contexts paired with reward smiles ($M = 63.98, 95\% \text{ CI } [60.43, 67.54]$) were rated as more enjoyable than contexts paired with affiliation smiles ($M = 53.63, 95\% \text{ CI } [48.01, 59.25]$), $t(10.72) = -3.88, p = .004$, which in turn were rated as more enjoyable than contexts paired with dominance smiles ($M = 39.98, 95\% \text{ CI } [34.98, 44.98]$), $t(10.82) = 4.04, p = .004$. Finally, there was a significant interaction between context category and smile type, $F(4, 2160.16) = 28.03, p < .001$. Specifically, whilst enjoyment and polite contexts were rated as more enjoyable when paired with reward smiles than affiliation smiles ($p < .001$ for both comparisons), this effect of smile type reversed (although not significantly) for negative contexts ($p = .17$). See Figure 3.3a for relevant means and CI's.

Polite/Civil. Results revealed a main effect of context category on politeness ratings, $F(2, 2157.03) = 94.48, p < .001$. Enjoyment contexts ($M = 67.87, 95\% \text{ CI } [64.43, 71.31]$) were rated as more polite than polite contexts ($M = 63.82, 95\% \text{ CI } [60.38, 67.26]$), $t(2156.79) = 4.68, p < .001$, which in turn were rated as more polite than negative contexts ($M = 56.18, 95\% \text{ CI } [52.74, 59.63]$), $t(2155.68) = -8.82, p < .001$. A main effect of smile type was also found, $F(2, 18.95) = 20.77, p < .001$. Contexts paired with affiliation smiles ($M = 69.85, 95\% \text{ CI } [64.62, 75.08]$) were rated as more polite than contexts paired with dominance smiles ($M = 48.73, 95\% \text{ CI } [42.75, 54.71]$), $t(15.00) = 5.99, p < .001$, as were contexts paired with reward smiles ($M = 69.29, 95\% \text{ CI } [65.72, 72.86]$), $t(19.20) = -6.13, p < .001$. Finally, there was a significant interaction between context category and smile type, $F(4, 2150.69) = 29.93, p < .001$. Specifically, enjoyment contexts were rated as more polite when paired with reward smiles than affiliation smiles ($p = .013$), but this effect of smile type reversed for negative

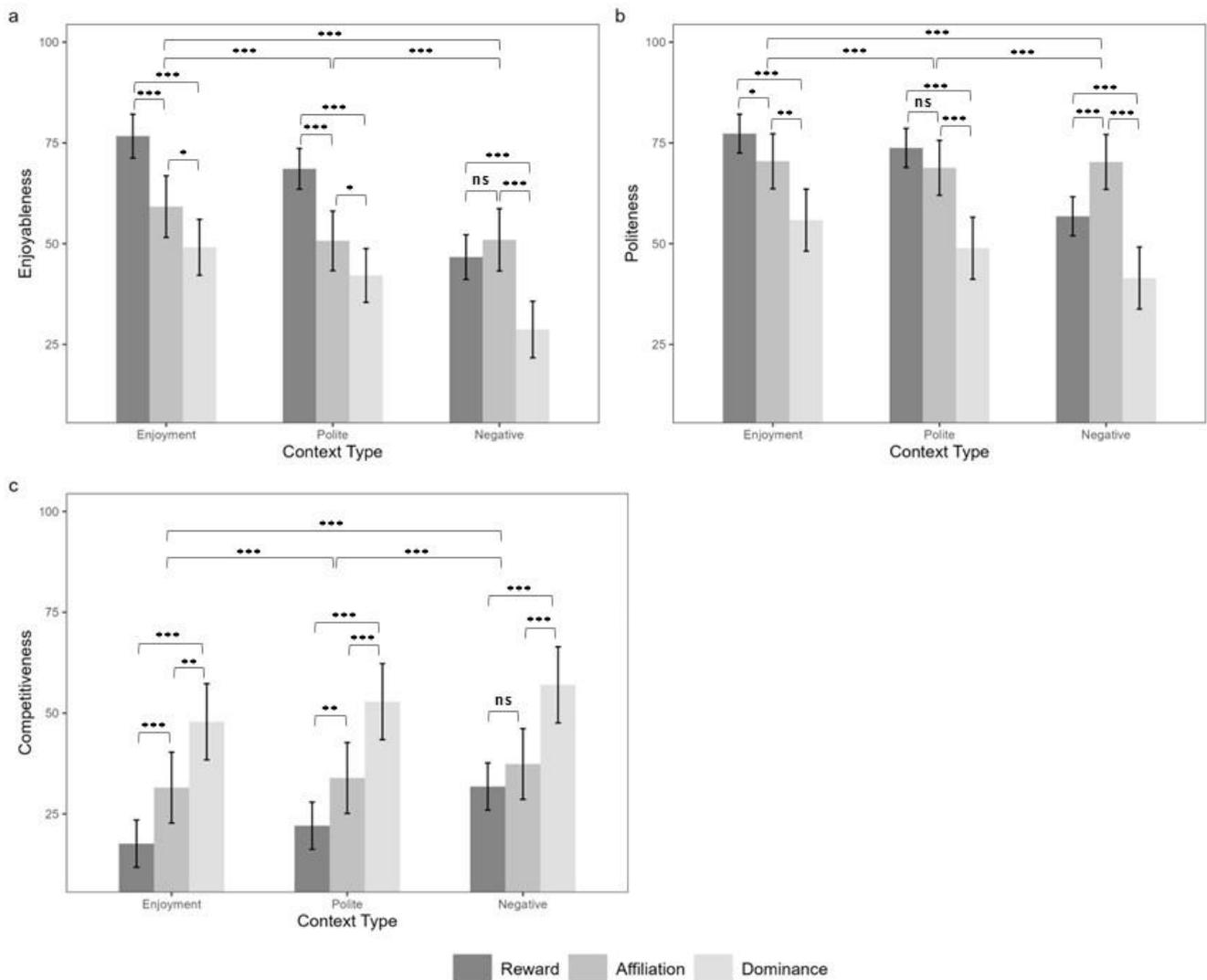
contexts ($p < .001$). This effect was not significant for polite contexts ($p = .07$). See Figure 3.3b for relevant means and CI's.

Competitive/Confrontational. Results revealed a main effect of context category on competitiveness ratings, $F(2, 2160.19) = 44.16, p < .001$. Negative contexts ($M = 42.05, 95\%$ CI [37.66, 46.44]) were rated as more competitive than polite contexts ($M = 36.28, 95\%$ CI [31.89, 40.66]), $t(2162.06) = 5.54, p < .001$, which in turn were rated as more competitive than enjoyment contexts ($M = 32.33, 95\%$ CI [27.94, 36.72]), $t(2162.14) = -3.79, p < .001$. A main effect of smile type was also found, $F(2, 15.39) = 25.28, p < .001$. Contexts paired with dominance smiles ($M = 52.57, 95\%$ CI [45.26, 59.87]) were rated as more competitive than contexts paired with affiliation smiles ($M = 34.27, 95\%$ CI [27.50, 41.03]), $t(13.47) = -4.48, p = .001$, which in turn were rated as more competitive than contexts paired with reward smiles ($M = 23.82, 95\%$ CI [19.52, 28.13]), $t(16.39) = 3.52, p = .003$. Finally, there was a significant interaction between context category and smile type, $F(4, 2157.15) = 3.18, p = .013$. Specifically, whilst enjoyment and polite contexts were rated as more competitive when paired with affiliation smiles than reward smiles ($p < .002$ for both comparisons), this effect

of smile type was absent for negative contexts ($p = .10$). See Figure 3.3c for relevant means and CI's.

Figure 3.3

Interactions Between Context Category and Smile Type for Ratings of Situational Context (a) Enjoyableness (a), Politeness (b), and Competitiveness (c) in the Situation Rating Task



Exploratory Analysis: Response Time

If the incongruity between smiles and negative contexts triggers a cognitive process whereby the smile is reinterpreted to fit the context, then participants may take longer to rate smiles seen in incongruent (negative) contexts compared to congruent (polite and enjoyment)

contexts. The increased response time would correspond to the extra cognitive deliberation needed to make a judgement. Furthermore, we may expect response time to increase most for particularly incongruent combinations (i.e. a reward smile in a negative context).

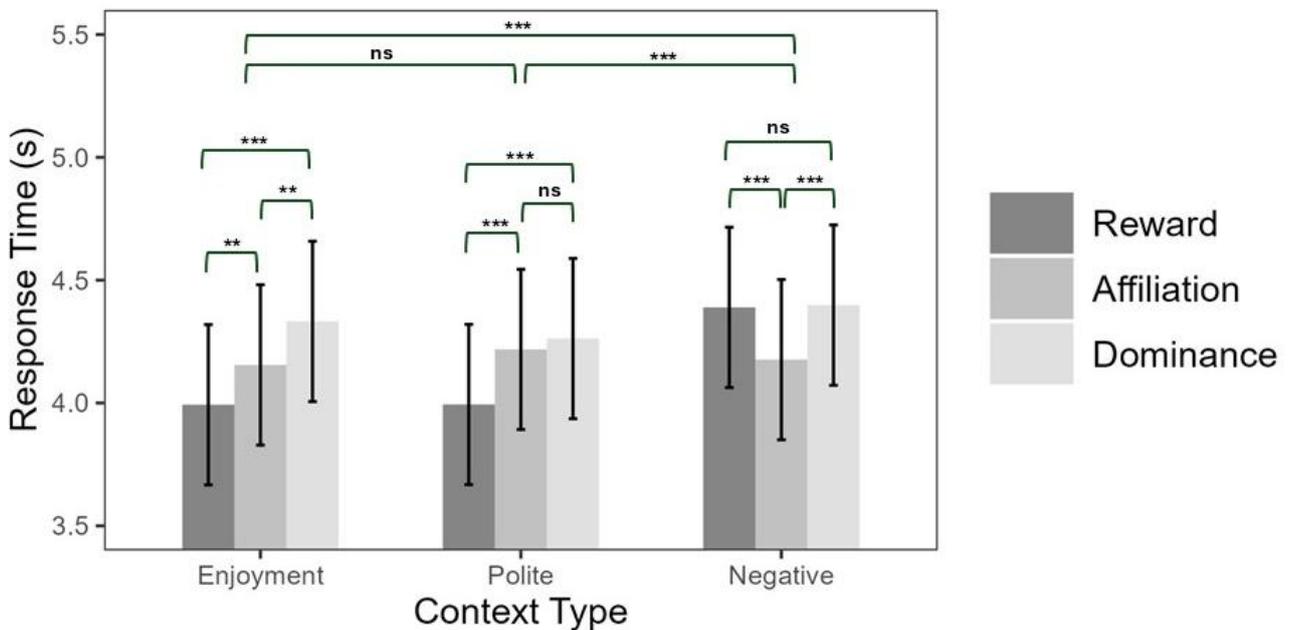
Given this possibility, I conducted additional exploratory analyses with response time as the dependent variable. An LMM was constructed to assess the effect smile type (three levels: reward vs affiliation vs dominance), context category (three levels: enjoyment vs polite vs negative), and task (two levels: face vs situation) on response time. All trials in which response times were greater than two standard deviations from the mean were removed.

Results revealed a main effect of smile type on response time, $F(2, 13573.4) = 23.80$, $p < .001$. Stimuli containing dominance smiles ($M = 4.33$, 95% CI [4.07, 4.59]) were rated more slowly than reward smiles ($M = 4.13$, 95% CI [3.87, 4.38]), $t(13573.31) = 6.69$, $p < .001$, and affiliation smiles ($M = 4.18$, 95% CI [3.92, 4.44]), $t(13573.64) = -4.82$, $p < .001$, although the time difference between affiliation and reward smiles was not significant ($p = .06$). A main effect of context category was also found, $F(2, 13573.9) = 18.61$, $p < .001$. Stimuli displaying negative contexts ($M = 4.32$, 95% CI [4.06, 4.58]) were rated more slowly than enjoyment contexts ($M = 4.16$, 95% CI [3.90, 4.42]), $t(13474.43) = -5.25$, $p < .001$, and polite contexts ($M = 4.16$, 95% CI [3.90, 4.42]), $t(13474.02) = 5.32$, $p < .001$, although there were no significant time differences between polite and enjoyment contexts ($p = .95$). Importantly, there was also a significant interaction between context category and smile type, $F(4, 13573.2) = 11.13$, $p < .001$. Specifically, stimuli containing reward smiles were rated more quickly than affiliation and dominance smiles in enjoyment and polite contexts ($p < .003$ for all comparisons). However, in negative contexts, reward smiles were rated more slowly than affiliation smiles ($p < .001$) and no differently to dominance smiles ($p = .86$). The

main effect of task failed to reach significance ($p = .064$), as did the three-way interaction ($p = .28$). See Figure 3.4 for relevant means and CI's.

Figure 3.4

Interaction Between Context Category and Smile Type on Rating Response Time Across Both Tasks. Error Bars: 95% CI



General Discussion

In this study I measured participants' fixations, response times, and explicit evaluations as they viewed dynamic face-in-context stimuli. Contrary to my central eye tracking hypothesis, although participants spent a greater proportion of each trial fixating on negative contexts than polite or enjoyment contexts, this difference was not significant when aggregated across both the face rating and situation rating tasks. Therefore, I could not confidently conclude that participants fixated to a greater extent on negative contexts than other context types.

In addition to the eye tracking data, participants' explicit evaluations during the face rating task again showed that situational context influences socio-functional inferences from smiles. Supporting Hypothesis 2, I found that smiles presented in enjoyment contexts were rated as more joyful than those presented in polite and negative contexts. In line with Hypothesis 3, participants rated smiles in polite contexts as more polite than those presented in negative contexts. Likewise, in support of Hypothesis 4, smiles presented in negative contexts were rated as more superior than those presented in enjoyment and polite contexts. This ultimately adds to the body of work demonstrating that context influences how smiles and — more broadly — facial expressions are evaluated (Aviezer et al., 2017; Gendron et al., 2013; Mui et al., 2020; Namba et al., 2020; Wieser & Brosch, 2012)

Further, the findings from the situation rating task again show that this relationship is reciprocal such that evaluations of situational contexts are also influenced by the smiles expressed within them. Supporting Hypothesis 5, I found that situational contexts presented with reward smiles were rated as more joyful and polite than those presented with affiliation and dominance smiles. In line with Hypothesis 6, contexts presented with dominance smiles were rated as more competitive/confrontational than those presented with reward and affiliation smiles. Although not as well established as the converse relationship, this adds to research showing how facial expressions affect evaluations of other social cues (Hess et al., 2018; 2020; Kret et al., 2013; Lecker et al., 2020).

Importantly, the finding that negative contexts were not fixated on to a greater extent than neutral or enjoyment contexts is contrary to the attentional explanation for the interaction between smile type and context found Chapter 2. Consequently, it seems unlikely that participants were simply unable to detect the subtle visual morphological differences between the reward and affiliation smiles when faces were presented in negative contexts. In fact, participants spent only a very small proportion of each trial fixated on the background

situation relative to the face (< 10% across all contexts), which suggests that faces were processed sufficiently, irrespective of context type. This finding also fails to align with previous work showing the enhanced attentional salience of aversive stimuli (Chajut & Algom, 2003; Hancock & Warm, 2010).

In contrast however, a closer inspection of the interactions observed within the situation ratings indicates that the cognitive explanation offers a far more convincing account of the interactions observed in Study 2 of the previous chapter. First, the direction of the smile-by-context interaction was not always as anticipated. Most notably, when participants rated the politeness/civility of situations, the differential effects of reward and affiliation smiles were found very clearly for negative contexts and were less apparent or not apparent in ratings of enjoyment and polite contexts. This shows that negative contexts do not always obscure the distinctive effects of reward and affiliation smiles. Instead, it seems likely that the effects of these different smile types upon ratings of the surrounding situation may be better explained by the nature of the cognitive reinterpretation of the smiles. In some cases, this reinterpretation will obscure differences between smiles and blunt their distinctive subsequent effects (i.e. on situation ratings), whereas in other cases it will accentuate differences and enhance their specific effects.

To support this view, the interaction between smile type and situational context for ratings of situations appeared to be driven to a large degree by changes in the perceived meaning of the reward smile in negative contexts. Negative situations paired with reward smiles were rated 20 points less polite than enjoyment situations paired with reward smiles. In contrast, there was almost no difference between the perceived politeness of different types of situations paired with affiliation smiles. This pattern replicated — albeit to a slightly lesser degree — for the perceived enjoyableness and competitiveness of the situations.

This idea is further supported by two additional lines of evidence. First, in the face rating task, the significant smile-by-context interactions were again driven mostly by changes to evaluations of the reward smile in negative contexts. For example, there were no significant differences between the perceived politeness and superiority of reward smiles in enjoyment and polite contexts, but they were rated as significantly more superior and less polite when seen in negative contexts.

Second, the exploratory response time analyses showed increased response times towards reward smiles in negative contexts, which implies the occurrence of a conscious re-evaluation process. Across both tasks, stimuli containing reward smiles were rated far more quickly than both other smile types, *apart from* when they were seen within negative contexts. Instead, the presence of a negative context significantly slowed response times, as would be expected if an effortful cognitive deliberation was required to resolve the clear discrepancy between the expression and the situation.

Consequently, it seems that — relative to other smile types — reward smiles are far more incongruous with negative contexts, and this incongruity triggers a cognitive reinterpretation process which subsequently changes how the surrounding situation is evaluated. Such an explanation aligns with Hess and Hareli's (2016) MEEC Model, which proposes that all facial expressions are perceived within a situational context, and then interpreted within an “interpretive” context, based upon the observer's perceptions of the real world. It is by this process that a reward smile within a strongly negative context is either (1) discounted as deviant, or (2) triggers the re-evaluation of the situation itself (which is what I propose happened in this experiment). The re-evaluative process corresponds largely to Hareli and Hess' earlier concept of “re-engineered appraisals” (Hareli & Hess, 2010), whereby appraisals of a situation are adjusted based on the emotional reaction of a person

within the situation. This re-evaluation occurs only when a perceived incongruity between the situation and the facial expression requires resolving.

Nonetheless, it does not necessarily follow that attention does not at all affect how context influences evaluations of smiles. In fact, the observed (albeit non-significant) trend that participants paid more attention to negative contexts compared to other context types suggests that the influence of negative situations on face evaluations may possibly be amplified by an attentional effect.

This chapter is not without limitations. First, there are potential issues with the eye tracking dependent variable, which indexed the proportion of each video that participants spent fixated on the background situation versus the face. Unlike Masuda et al. (2008; 2012), I used proportions rather than raw time because my video stimuli varied in length from 1.8 seconds to 3 seconds. Consequently, differences in video length across trials would have confounded any fixation measures based on raw time. Nonetheless, solving this problem by measuring proportions also confers certain problems. In particular, any differences in my participants' eye scanning strategies across contexts or smile types may have been obscured by these variations in video length, given that previous work has shown that fixation patterns diverge most as time progresses (Masuda et al., 2008). Future research may attempt to measure eye tracking patterns using face stimuli of equal durations, although this is not possible with the current SIMS smile set.

Moreover, although this study expanded considerably on our understanding of the cognitive and attentional mechanisms underpinning face-context integration, it could have gone further. Whilst I strongly suggest that participants reinterpreted negative situations paired with reward smiles, the nature of this reinterpretation was unstudied. Future research

may utilise more qualitative techniques to ask participants exactly how they consciously reinterpreted incongruent or unexpected face-context combinations.

Given that this chapter is a near-replication of the previous chapter, some shortcomings are shared. For example, my participants were all UK-based again, and therefore the results may not generalise beyond the specific set of participants given well-established cultural differences in face processing (e.g. Thibault et al., 2012; Namba et al., 2020). Furthermore, face ratings tasks are only proxies for real-world interaction, and the face-context compound stimuli I used may not be fully realistic.

Conclusion

To conclude, this study shows that when evaluating face-in-context stimuli, people do not attend significantly more frequently to negatively-valenced situational contexts than neutral or positive contexts. Therefore, ratings differences associated with different smile types likely do not have an attentional explanation. Instead, it seems that the social meanings of smiles are reinterpreted as more antisocial when seen within negative contexts. This occurs via a deliberative cognitive process in line with Hess and Harel's (2016) MEEC Model. Moreover, it points towards the importance of bidirectional links between faces and contexts. Situational context influenced how faces were evaluated, which in turn affected how the situation was re-evaluated.

CHAPTER 4: MORPHOLOGICAL AND CONTEXTUAL CUES AFFECT IMPLICIT APPROACH-AVOIDANCE RESPONSES TO SMILES

Abstract

Extant research shows that evaluations of smiles are influenced by context and vice versa. However, the influence of smiles and situational context on subsequent behaviour is less clear. Consequently, the present chapter assessed implicit behavioural responses to faces-in-context using a mobile approach-avoidance task. Participants were instructed to push (“avoid”) or pull (“approach”) their phone according to situational valence (Study 5), smile type (Study 6), facial emotion (Study 7), and smiler gender (Study 8). In Study 5, positive situations were approached more quickly than negative situations, and this pattern reversed for avoidance responses. Smile type did not significantly affect either approach or avoidance response times. In Study 6, reward smiles were approached more quickly than dominance smiles, and this pattern reversed for avoidance responses. Importantly, there was also a significant context-response interaction, such that smiles in positive contexts were approached more quickly than smiles in negative contexts, whereas there were no differences for avoidance movements. In Study 7, happy expressions were approached more quickly than angry expressions, and vice versa for avoidance responses. However, there was no context-response interaction. Finally, in Study 8, participants reacted to smiles in positive contexts more quickly than smiles in negative contexts, but smile type did not significantly affect response time. Together, these findings suggest that both situations and facial expressions can implicitly influence one’s approach-avoidance response tendencies, but their relative influence depends upon the focus of the perceiver’s response and the difficulty of the social task.

Introduction

As shown in Chapter 2 and 3, contextual information strongly influences how facial expressions are *explicitly* evaluated (see also, Aviezer et al., 2017; Wieser & Brosch, 2012). However, the effect of contextual information on *implicit* responses to facial expressions is less well understood. This is an important oversight, because social cognition is geared towards guiding adaptive behavioural responses rather than merely evaluating stimulus qualities (Blake & Shiffrar, 2007; Cracco et al., 2022; Sebanz et al., 2006). As a result, in the present study I examined whether speeded categorisations of facial expressions are implicitly affected by both (1) the type of facial expression displayed and (2) the surrounding situational context. This research takes a social-functional approach to emotion expressions, adopting the idea that their meaning is socially determined (Fridlund, 1994; Kraut & Johnston, 1979).

Smiles are the most ubiquitous facial expression, occurring with high frequency in social interactions (Hess & Bourgeois, 2010). Research shows they influence perceiver behaviour (Shore & Heerey, 2011), and regulate interpersonal interactions (Martin et al., 2017). Traditionally, smiles were defined dichotomously as either genuine or non-genuine (Duchenne, 1862; Ekman et al., 1982). However, more recent research suggests they have a variety of social functions (Rychlowska et al., 2017), with three main types proposed: reward, affiliation, and dominance smiles (Niedenthal et al., 2010; Martin et al., 2017). Reward smiles reinforce desired behaviours by inducing positive affect in the perceiver; affiliation smiles aid the formation and maintenance of social bonds by communicating reassurance or openness to positive relations; and dominance smiles communicate and assert superiority over the perceiver. In Chapter 2, I found that situational context influenced evaluations of social-functional information from these different smile types. Furthermore, this effect was bidirectional, such that situation evaluations were influenced by the type of smile displayed within the situational context. Both factors also influenced investments with hypothetical

partners as part of an economic game. In Chapter 3, I showed that the combined effects of smile type and context on explicit ratings or decisions (i.e. the interactions between the two) are likely explained by a deliberative re-evaluation of stimuli.

Despite considerable work into context effects on explicit outcome variables, limited research has examined how context implicitly impacts responses to faces. In the domain of mimicry, both Kirkham et al. (2015) and Kastendieck et al. (2021) found that participants mimicked smiles less frequently in negative scenes than positive scenes, which suggests that incongruent, “affectively deviant” expressions are less likely to be mimicked. However, mimicry likely has both automatic and deliberative components (see Hess & Fischer, 2013). Outside of mimicry, Brambilla et al. (2018) examined whether trustworthiness categorisations of faces were implicitly affected by context. The researchers tracked participant’s mouse movements and found that trajectories towards the correct response were facilitated when face and context cues were compatible (e.g., an untrustworthy face within a threatening scene), but trajectories were partially attracted towards the context-associated response button when cues were incompatible. Hence, context implicitly affected participants’ actions/movement, even if not apparent from the explicit trustworthiness categorisation. Nonetheless, this study only examined how context affected evaluations of personal trustworthiness (based on static facial features) — not of dynamic facial expressions themselves.

Deciding whether to approach or avoid a stimulus is a fundamental behavioural response tendency, strongly associated with processing of stimulus valence (Lewin, 1935; Osgood, 1953). Specifically, positive objects immediately activate approach motivations whereas negative objects activate avoidance motivations (Lang et al., 1990). Within the social domain, there is clear evolutionary benefit to determining the intentions of others and subsequently deciding whether to approach or avoid a conspecific (Zebrowitz & Collins,

1997). In fact, Elliot et al. (2006) suggested that approach and avoidance behaviours are fundamental building blocks of social interaction, relationship satisfaction, and ultimately overall wellbeing. Consistent with this idea, certain prototypical emotional facial expressions (e.g. fear and anger) induce approach and avoidance responses respectively (Marsh et al., 2005; Stins et al., 2011). Nonetheless, it has not been established whether different socially defined smile types induce contrasting approach-avoidance tendencies, or whether these tendencies are influenced by context. Consequently, I attempt to answer that question in this chapter. Furthermore, given the established reciprocal relationship between facial expressions and context (Hess et al., 2018; 2020), I also assess whether tendencies to approach or avoid different situational contexts are affected by the presence of different smile types.

Approach-avoidance tendencies are usually studied using the standard approach-avoidance task (AAT), where participants are instructed to pull stimuli closer to themselves or push stimuli away (e.g. Solarz, 1960; Chen & Bargh, 1999; Rinck & Becker, 2007). In the original version of the AAT, Solarz (1960) provided participants with cards featuring positive and negative words, and then instructed them to pull certain cards closer and push others away. He discovered that participants responded more quickly when asked to approach positive words and avoid negative words than when the instructions were reversed. Solarz's early paradigm was ultimately replaced by computerised versions of the AAT, which greatly increased the flexibility of the task and allowed researchers to study approach-avoidance tendencies across many research areas (e.g. Chen & Bargh, 1999; Rinck & Becker, 2007). Nonetheless, like the original AAT, computerised AATs are inconvenient for field research because they require specialist equipment that is unlikely to be found outside the lab. Furthermore, at a theoretical level, computerised tasks replace change in actual physical distance (between the participant and the stimulus) with virtual or suggested distance change. This may reduce the extent to which the tasks tap into basic approach-avoidance tendencies.

To overcome this problem, Zech et al. (2020) developed a mobile version of the AAT, which “combines the behavioural properties of the original AAT with the flexibility and field-readiness provided by smartphones” (p. 2085), enabling online data collection. Stimuli are displayed on a smartphone screen and — akin to the original AAT (Solarz, 1960) — participants physically pull the phone towards themselves to approach stimuli and push it away from themselves to avoid stimuli. This reliance upon *physical* distance change rather than virtual or suggested distance aligns with prevalent approach-avoidance theories which suggest that approach tendencies lead individuals to reduce the physical distance from a stimulus, whereas avoidance tendencies prompt an increase in distance (Krieglmeyer et al., 2013; Eder & Rothermund, 2008). In addition, using actual distance change as the dependent variable helps to clarify participant responses. Unlike most computerised AATs that rely on virtual cues such as labelled responses (Chen & Bargh, 1999), changes in stimulus size (Rinck & Becker, 2007), or movements of an avatar toward or away from the stimulus (de Houwer et al., 2001; Rougier et al., 2018), the mobile AAT doesn't require such guiding elements. Consequently, the mobile AAT avoids measurement problems associated with computerised versions of the AAT, such as approach-avoidance effects becoming unreliable or reverting completely (Lavender & Hommel, 2007; Markman & Brendl, 2005; Seibt et al., 2008; Stins et al., 2011).

Importantly for the purpose of addressing whether morphological and contextual cues implicitly affect subsequent behavioural responses to smiles, the AAT allows the investigation of the automaticity of context effects. Approach-avoidance response tendencies are thought to be automatically activated (Chen & Bargh, 1999; Corwin, 1921; Lewin, 1935). In addition, by requiring participants to make speeded responses, the influence of top-down cognitive processes on responses should be limited even further. Moreover, by asking participants to respond to just one feature of the face-in-context stimuli (e.g. the face), I was

able to measure the implicit influence of “task-irrelevant” features (e.g. the context) on approach-avoidance tendencies.

The approach-avoidance app collects response time (RT) data. Given the wealth of previous research showing that differences in speeded reaction times can reflect variations in implicit or automatic processing of stimuli, this is the primary dependant variable. Most famously, the Implicit Association Test (IAT – Greenwald et al., 1998) demonstrated that participants respond faster to congruent than incongruent word category pairings. Relatedly, Ohman, Flykt, et al. (2001) found that participants responded faster to fear-relevant stimuli (e.g. snakes and angry faces) relative to neutral stimuli, even when presented outside of conscious awareness. Therefore, response time differences in the present study should reflect differences in implicit processing. As approach-avoidance tendencies indicate stimulus valence (Lang et al., 1990), faster approach responses should reflect more positive evaluations, whereas faster avoidance responses should signal more negative evaluations.

Present Research

Across four studies I asked: how do facial expressions and situational contexts influence approach-avoidance response tendencies? In all studies, participants completed a mobile AAT, responding to different characteristics of face-in-context stimuli. However, the response dimension varied across studies to test how different features of these stimuli implicitly affected participant’s responses when they were “task-irrelevant”.

In Study 5, to test whether the expected tendency to approach positive situations and avoid negative situations is affected by the presence of different smile types, participants were instructed to respond to the valence of the situational context. In Study 6 and 7, to test whether the expected tendency to approach reward smiles / happy expressions and avoid dominance smiles / angry expressions is affected by context, participants were instructed to

respond according to the facial expression displayed. Finally, in Study 8, to test whether approach-avoidance responses are affected by smile type or situational context when both are task-irrelevant, participants responded to an unrelated response dimension: smiler gender.

Hypotheses

In line with Zech et al. (2020), I hypothesised that participants would respond faster when approaching versus avoiding stimuli across all studies (*Hypothesis 1*). Furthermore, in line with previous chapters, I hypothesised that participants would approach reward smiles more quickly than affiliation smiles, which in turn would be approached more quickly than dominance smiles, but that this pattern would be reversed for avoidance responses (*Hypothesis 2*). In addition, I hypothesised that participants would respond faster when approaching positive situations than negative situations, and the opposite for avoidance responses (*Hypothesis 3*). Finally, in line with Chapter 2 and Chapter 3, I hypothesised a three-way interaction between smile type, situational context valence, and response direction, such that the interaction between smile type and response direction would be stronger when smiles were in positive situations than when smiles were in negative situations (*Hypothesis 4*). However, this three-way interaction was only hypothesised in Study 5, because Chapter 2 and Chapter 3 found limited evidence of an interaction between smile type and context valence on explicit expression evaluations.

Study 5

Methods

Participants

An a priori power analysis using the ANOVA power shiny app (Lakens & Caldwell, 2021) and estimated values derived from Zech et al. (2020) indicated a target sample size of

150 participants. I therefore recruited 150 participants (51 women, 98 men, 1 other) from the United Kingdom. The majority were Caucasian (87.3%; 8 Asian, 6 Black, 4 Multiple ethnic groups, 1 prefer not to say), aged 19-68 years ($M = 40.92$, $SD = 11.94$). Eleven additional participants were excluded from analyses because their performance failed to exceed the pre-determined 80% correct response threshold from Zech et al.'s (2020) procedures. Participants were recruited via Prolific (www.prolific.co) and were compensated for their time. Power analyses for ANOVA were deemed most suitable given the lack of clear guidance for calculating power for linear mixed models (LMMs). The study was approved by the university's research ethics committee.

Materials

I took 48 smile videos from the set developed by Rychlowska et al. (2017). I selected one video of each smile type (reward, affiliation, dominance) produced by 16 actors (eight male, eight female, 12 white, four black) in frontal view. See Chapter 2 for a description of how I developed this smile set. Stills from each video were taken when the expression was at peak intensity. I used Remove.bg (www.remove.bg) to remove original video backgrounds.

For situational contexts, 32 photos were downloaded from Unsplash (www.unsplash.com); 16 of each situation type: positive and negative. I selected photos based on stimuli used in Chapter 2, previous studies (e.g. Namba et al., 2020; Righart & de Gelder, 2008a), and data describing situations in which certain smile types are likely to be produced (e.g. Martin et al., 2021). Positive contexts depicted situations where people would typically express joy, whereas negative contexts depicted situations where people would not normally smile. The type and number of contextual stimuli were evenly distributed. For positive contexts, I had two subcategories with the themes of “luxury” and “park”. For negative contexts I had two subcategories themed “fire” and “rubbish”. These subcategories

were balanced within- and between blocks. Each subcategory consisted of eight unique photos.

Finally, I centrally superimposed smile stimuli over context images in Microsoft PowerPoint. For each actor, I created six smile-in-context photos such that each smile type was superimposed over both of the context types (see Figure 4.1 for examples). Each of the stimuli were 1280 x 720 pixels, although the actual size of the stimulus seen by each participant depended upon the size of their phone screen.

Figure 4.1

Example of a reward smile in a positive situational context (left) and a dominance smile in a negative situational context (right)



Procedure

The experiment was programmed using Gorilla (www.Gorilla.sc) and Android Studio. After providing informed consent and demographic information, participants were instructed to download the AAT app onto their Android smartphones. The app technology was only compatible with Android phones, so iPhone users were not able to take part.

During the AAT, face-in-context stimuli were presented on a smartphone that participants were instructed to either pull toward themselves or push away from themselves.

Participants completed two blocks – which I refer to as “push negative” and “pull negative”. In the pull negative block, they were instructed to pull negative scenes toward themselves and to push positive scenes away from themselves. In the push negative block, the instructions were reversed. The order in which these blocks were completed was counterbalanced across participants. During each block, participants were meant to see each of the three smile types (reward, affiliation, dominance) displayed by each of the 16 actors in both context types (positive, negative), yielding 96 trials per block. However, in this study participants saw only half of the full set of faces-in-context in each block (48 trials per block) due to a programming error. Nonetheless, the 48 stimuli presented from each set of 96 faces-in-context were pseudo-randomly selected such that different smile types and context categories were seen in equal proportions. No stimuli were repeated.

Participants were instructed to hold the phone in a horizontal orientation and, between trials, to move the phone to a starting position from which they could easily pull it towards themselves or push it away from themselves. Two GIF animations displayed examples of approach and avoidance movements respectively. Before each block, participants were instructed which stimuli to pull / push. They were also reminded of these instructions during breaks which occurred every 12 trials. Within each sub-block of 12 trials, stimuli were selected pseudo-randomly, such that participants saw each smile type and context valence equally often.

Participants were instructed to react as quickly and accurately as possible. Each stimulus was preceded by a fixation cross which remained on screen for 1.5 seconds. If no response was registered within two seconds, a clock appeared on the screen to inform participants that the trial had timed out. Before each block, participants completed 12 practice trials, followed by feedback (a tick for a correct response and a cross for an incorrect response). Participants were not given feedback on experimental trials. The source code of

the mobile AAT is openly available at Zech et al.'s (2020) Open Science Framework page:

<https://osf.io/y5b32/>.

Finally, participants completed the Toronto Alexithymia Scale (TAS-20 — Bagby et al., 1994) and the Holistic Cognition Scale (HCS — Lux et al., 2021), then answered additional questions about the personality traits of the smiling targets. This chapter contains no further discussion of these measures because they are not pertinent to the present research questions. Upon completion of the experiment, all participants were fully debriefed.

Data Preprocessing

I conducted data preprocessing following Zech et al. (2020), using Python version 3.8.0. All preprocessing scripts are available on the same Open Science Framework page as the mobile AAT source code (see above).

Data Exclusions

I followed Zech et al.'s (2020) data exclusion criteria. Specifically, practice trials, error trials (incorrect response direction), trials with missing response time data, trials with implausibly short response times (< 200 ms), and trials with low absolute maximum forces (< 1 m/s², indicating non-responses) were excluded from the analysis. Participants with less than 80% valid experimental trials were also excluded. The same exclusion criteria were used for all studies.

Data Analysis

Data analysis was conducted with R Studio version 2023.06.2 (RStudio Team, 2020) in R version 4.2.2 (R Core Team, 2022). Response time (RT) was analysed using linear mixed models. Importantly, I included dominance smiles only in exploratory analyses because few previous studies have studied responses to these smiles.

For analyses, I followed Bates et al.'s (2015) proposal that researchers should start with a maximal model and remove the random effect components which account for the smallest variance, one-by-one. In accordance with these recommendations, after each simplification, I subjected the reduced model to a Principal Components Analysis (PCA), using the rePCA function from the 'lme4' package (Bates et al., 2015). The output indicated whether there were any random effect terms in the model that did not explain any covariance.

This process continued until each remaining random effect term explained a considerable portion of variance. However, after each simplification, I also compared the goodness-of-fit of the reduced model to the more parameterised model with a likelihood ratio test, by using the anova function from the 'lmerTest' package (Kuznetsova et al., 2017). If goodness-of-fit did not significantly differ, the simplification was justified because I prioritised parsimony (Matuschek, 2017). However, if the goodness-of-fit differed significantly, retained the more parameterised model and stopped the model simplification process.

Random structure was identified prior to adding fixed effects to the model (Meteyard & Davies, 2020). Simplification of random effects continued until convergence. Satterthwaite's F test determined inferential statistics.

I normalised RTs by using the inverse transformation (Zech et al., 2020). Inverted RTs can be interpreted as the number of responses a participant can perform in one second. Therefore, higher scores correspond to faster responses. Response direction (two levels: approach vs. avoid), smile type (two levels: reward vs. affiliative), and context valence (two levels: positive vs. negative) were entered as fixed effect predictors. Exploratory analyses had an additional level of smile type: dominance smile. The final models were specified as:

*Inverted RT ~ response_direction * smile_type * context_valence*

Significant effects were clarified by tests of estimated marginal means (with the Holm-Bonferroni correction applied), using the ‘emmeans’ package (Lenth, 2024).

In my pre-registration, I also stated that I would conduct the same analyses on a Response Force (RF) measure. However, I decided against reporting these analyses because the RF measure often failed to show the most basic approach-avoidance effects. For example, in Study 6, people responded more forcefully when approaching dominance smiles than reward smiles, and that this relationship reversed for avoidance movements. Likewise, Zech et al. (2020, Study 2) also failed to find the hypothesised approach-avoidance effect on RF in their field study. These authors argued that relative to response time, RF measurements are more vulnerable to participant idiosyncrasies in the execution of approach-avoidance movements, which likely increased the noisiness of the data. Furthermore, they argued that RF measurements may be more affected by noise associated with the exact model of Android device used by participants, which vary greatly in sensitivity and precision of force detection. Therefore, given such concerns about the reliability of the RF measure, I do not report this dependent variable.

Data Availability

The design, methodology, and analysis techniques used in the present chapter were pre-registered on OSF, although only the response dimension of Study 8 (target gender) was pre-registered (see Study 1 of the pre-registration). The pre-registration, data, analysis code, and research materials for Study 5 to Study 8 are available at:

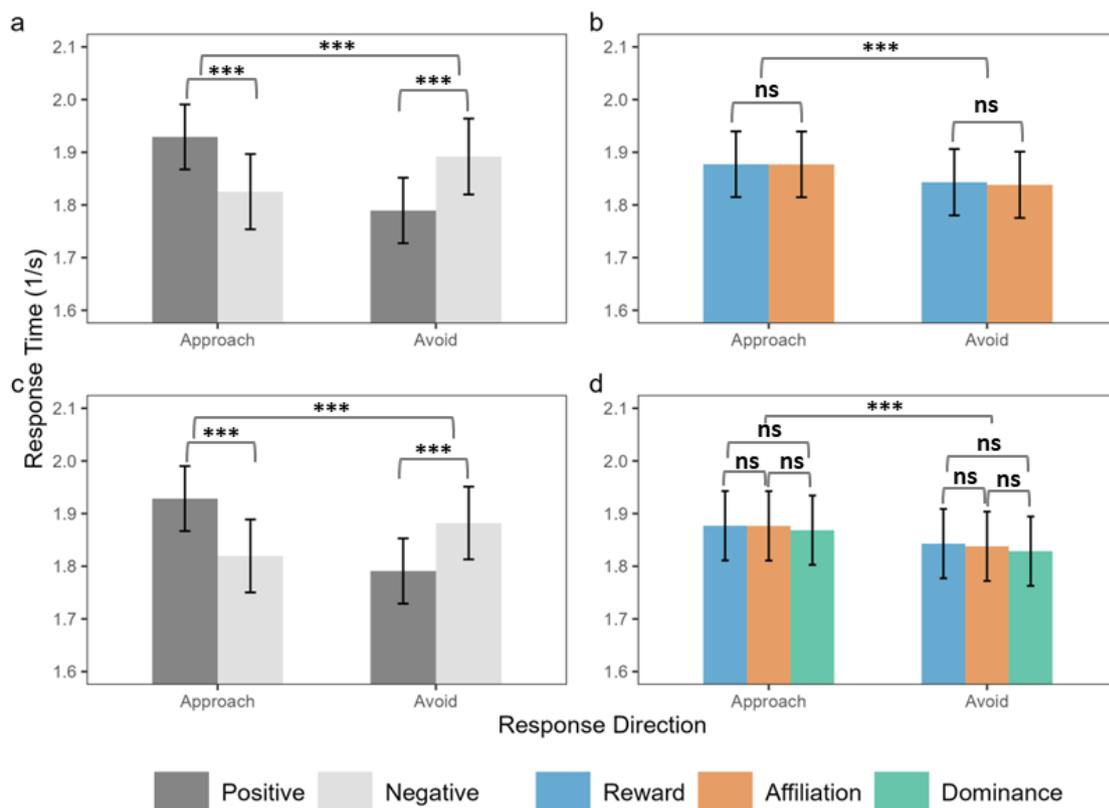
https://osf.io/4wa5d/?view_only=479faab92dcc466caacd8b8d57b12fae.

Results

Following Zech et al.'s (2020) criteria, 5.1% of the experimental trials completed were excluded from analyses.

Figure 4.2

Interactions Between Response Direction and (a) Context Valence and (b) Smile Type for Response Times to Categorise Situational Contexts in Study 5. Plots (c) and (d) Show the Same Interactions when Dominance Smiles were Included in the Analysis. Error Bars: 95% CI



Main Analyses

Response Time. As hypothesised, results revealed a significant main effect of response direction, $F(1, 147.7) = 48.04, p < .001$, such that participants reacted faster when approaching ($M = 1.88, 95\% \text{ CI } [1.82, 1.93]$) than when avoiding stimuli ($M = 1.84, 95\% \text{ CI } [1.79, 1.89]$). As shown in Figure 4.2a, there was also a significant interaction between

response direction and context valence, $F(1, 8594.9) = 154.89, p < .001$, such that positive contexts ($M = 1.93, 95\% \text{ CI } [1.88, 1.98]$) were approached more quickly than negative contexts ($M = 1.83, 95\% \text{ CI } [1.76, 1.89]$), $t(19.64) = -4.49, p < .001$, whereas negative contexts ($M = 1.89, 95\% \text{ CI } [1.83, 1.95]$) were avoided more quickly than positive contexts ($M = 1.79, 95\% \text{ CI } [1.74, 1.84]$), $t(19.67) = 4.44, p < .001$. As shown in Figure 4.2b, the interaction between response direction and smile type was not significant, $F(1, 8596.7) = 0.08, p = .78$. There were no other significant main effects or interactions (all $ps > .17$).

Exploratory Analyses

Exploratory analyses were then performed including dominance smiles. New random effects structures were established using the same procedures described above. As shown in Figure 4.2c and 4.2d, all main effects reported above were retained and no new main or interaction effects were found. Furthermore, neither target gender nor target ethnicity affected approach or avoidance response times.

Discussion

In Study 5, I found that approach-avoidance tendencies towards situations were affected by the valence of the situation but were not affected by the type of smile displayed within the situation. This contrasts with the results of Chapter 2 (Study 2) and Chapter 3, which found that explicit ratings of situations were affected by the smiles displayed within them. This suggests that smiles are integrated into explicit evaluations of situations but fail to influence implicit responses towards them. The lack of a smile effect indicates that integrating facial information into situation processing may require some sort of conscious cognitive deliberation not available during a speeded approach-avoidance task. Therefore, there appear to be clear differences between implicit and explicit tasks regarding the nature of how smiles are integrated into situational evaluations.

Study 6

In Study 6, I tested the reverse relationship i.e. whether situational context affects implicit behavioural responses to smiles. To test this, participants responded to the type of smile displayed rather than the situational valence. In line with Chapter 2 findings, I hypothesised an interaction between response direction and smile type (the response dimension). Further, in line with the work of Kirkham et al. (2015) and Kastendieck et al. (2021) I expected to find an interaction between response direction and situational context category. If found, this would support the idea that context implicitly affects behavioural responses to smiles.

Methods

Participants

An a priori power analysis indicated that I required 50 participants to detect a two-way interaction between response direction and context valence with 90% power. In total, I recruited 53 participants (23 women, 30 men) from the United Kingdom. The majority were Caucasian (81.1%; 5 Asian, 1 Black, 3 Multiple ethnic groups, 1 other), aged 21-68 years ($M_{\text{age}} = 38.79$, $SD_{\text{age}} = 10.70$). Ten additional participants were excluded from analyses because their performance failed to exceed the 80% correct response threshold.

Procedure

Participants were instructed to push or pull their phone according to the type of smile displayed. I chose to remove affiliation smiles from this study because the AAT requires a binary response dimension, and the contrast between reward and dominance smiles was the closest parallel to the contrast between positive and negative situations. Therefore, only reward and dominance smiles were presented.

Overall, participants completed two blocks, which I refer to as “pull reward” and “push reward”. In the pull reward block, they were instructed to pull reward smiles toward themselves and to push dominance smiles away from themselves. In the push reward block, the instructions were reversed. The order in which these blocks were completed was counterbalanced across participants. During each block, participants saw two smile types displayed by each of the 16 actors in both context categories, yielding 64 trials per block. Breaks were offered to participants every 16 trials.

Before beginning the AAT, participants received information about both reward and dominance smiles (see Box 4.1). They also saw video examples of both smile types. The example stimuli did not appear in the main experimental trials. All other procedures were the same as Study 5.

Box 4.1 – Information Given to Participants Before the AAT in Study 6

Reward Smile

A reward smile is a positive reaction to something good. For example, you would reward smile if your roommate told you that they cleaned the entire apartment which makes your life a lot easier.

Dominance Smile

A dominance smile shows superiority and often occurs during a competitive interaction. People produce a dominance smile when they are in control or have the upper hand in a competitive situation. For example, you might produce a dominance smile if you just successfully bluffed and won the pot of money in a game of poker.

Results

Following Zech et al.'s (2020) criteria, 8.5% of the experimental trials completed were excluded from analyses.

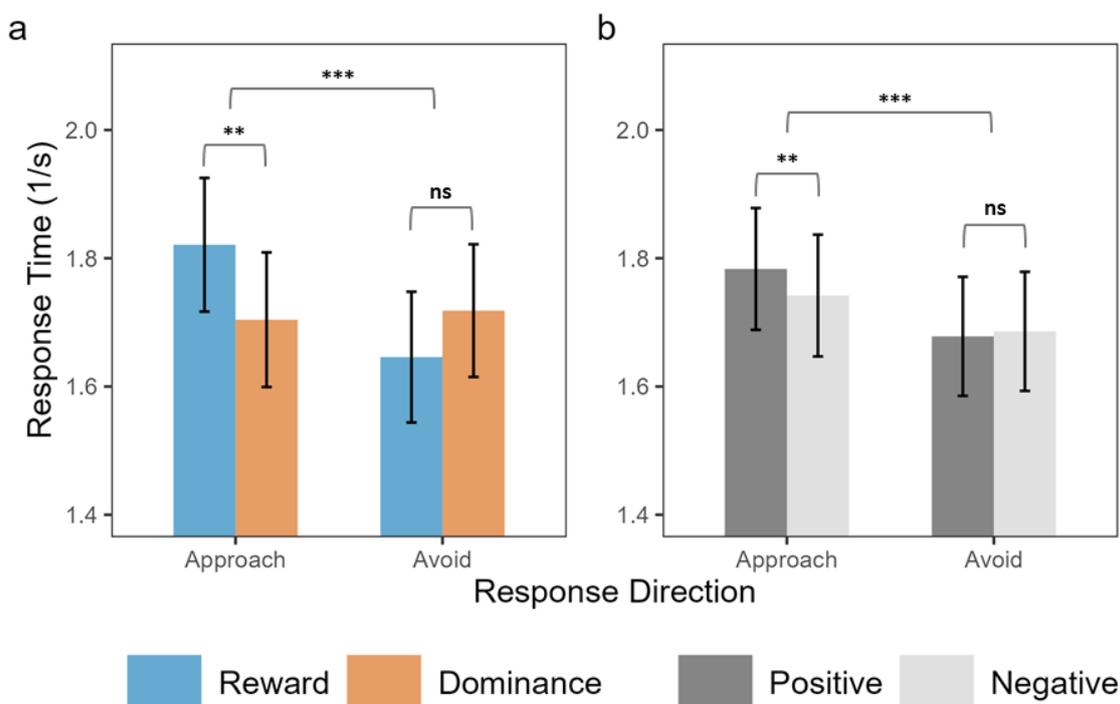
Main Analyses

Response Time. As hypothesised, results revealed a significant main effect of response direction, $F(1, 52) = 35.13, p < .001$, such that participants reacted faster when approaching ($M = 1.76, 95\% \text{ CI } [1.68, 1.84]$) than when avoiding stimuli ($M = 1.68, 95\% \text{ CI } [1.60, 1.76]$). As shown in Figure 4.3a, there was a significant interaction between response direction and smile type, $F(1, 6028.6) = 108.27, p < .001$, such that reward smiles ($M = 1.82, 95\% \text{ CI } [1.73, 1.91]$) were approached more quickly than dominance smiles ($M = 1.70, 95\% \text{ CI } [1.61, 1.80]$), $t(20.26) = -2.91, p = .009$. There were no significant differences for avoidance responses, $t(20.31) = 1.81, p = .09$. Importantly, as shown in Figure 4.3b, there was also a significant interaction between response direction and context valence, $F(1, 6019.3) = 7.35, p = .007$, such that participants approached smilers more quickly in positive contexts ($M = 1.78, 95\% \text{ CI } [1.70, 1.87]$) than in negative contexts ($M = 1.74, 95\% \text{ CI } [1.66, 1.82]$), $t(6021) = -3.23, p = .001$, whereas there was no difference in avoidance response times to smilers in positive ($M = 1.68, 95\% \text{ CI } [1.60, 1.76]$) versus negative contexts ($M = 1.69, 95\% \text{ CI } [1.61, 1.77]$), $t(6021.02) = 0.61, p = .54$. No other main or interaction effects were significant (all p 's $> .05$).

Exploratory analyses showed that neither target gender nor target ethnicity affected approach or avoidance response times.

Figure 4.3

Interactions Between Response Direction and (a) Smile Type and (b) Context Valence for Response Times to Categorise Smiles in Study 6. Error Bars: 95% CI



Discussion

Study 6's results show that, as expected, reward smiles were approached more quickly than dominance smiles, and that this pattern reversed for avoidance responses, although not significantly. More importantly, there was also a significant interaction between context valence and response direction, such that smiles in positive contexts were approached more quickly than smiles in negative contexts, whereas there were no differences for avoidance movements.

The context-response interaction highlights an asymmetry between responding to facial expressions versus situations. When participants responded to situations (Study 5), smile type did not affect responses. However, when responding to smiles, context valence

affected responses, such that smiles in positive situations were approached more quickly than smiles in negative situations.

One potential explanation is that response differences occur due to top-down goal-based influences on response tendencies and behaviour. Specifically, when responding to facial expressions, context may be automatically integrated into the perceiver's approach-avoidance response tendencies. However, when the perceiver must respond to situations, the facial expressions of people within the situation may not be automatically integrated into their response tendencies. Supporting this explanation, top-down context effects on facial expression processing have been found in both behavioural (e.g. Aviezer et al., 2011) and ERP studies (Dieguez-Risco et al., 2015; Hietanen & Astikainen, 2013, Righart & de Gelder, 2008a; 2008b). In contrast, facial expressions do not seem to be automatically integrated into perceivers' response tendencies towards situations. Although Hess et al. (2020, p. 540) theorised that one's "facial expression necessarily provides information about the situation", these authors did not explicitly discuss the automaticity of this process. In fact, their paper implied that the influence of facial expressions on situation evaluations likely entails considerable cognitive effort, given that face effects were moderated by the expresser's perceived expertise. Taken together, this suggests that contextual information is fundamental to understanding expressions (e.g. Hassin et al., 2013) and hence is automatically integrated into face processing, whereas expression information — although undoubtedly useful — is not strictly necessary for understanding situations. To this end, most researchers have based their experimental designs upon the presumption that the meaning of the context remains stable when contrasted with a facial expression (e.g. Aviezer et al., 2008; Righart & de Gelder., 2008a).

An alternative explanation is that this asymmetry is due to differences in stimulus ambiguity. Specifically, it has been argued that — because they often co-occur with negative

emotions or non-emotional states — different types of smiles are ambiguous social signals (Ekman & Friesen, 1982; Niedenthal et al., 2013). Hence, when responding to different smile types, perceivers may rely upon additional contextual information (i.e. the surrounding situation) to help better disambiguate smile meaning (Ekman et al., 1972; Nakamura et al., 1990). Conversely, when discriminating between positive and negative situations, perceivers may not need additional facial information because the stimuli are far less ambiguous and therefore do not require additional information to inform their response. This stimulus ambiguity theory is supported by the slower RTs and reduced accuracy in Study 6 compared to Study 5, which suggests that the situation discrimination task was easier than the smile discrimination task (Gold & Shadlen, 2000; Sternberg, 1969).

Study 7

Study 7 aimed to determine whether the asymmetry between responding to faces versus contexts was due to goal-based responding or stimulus ambiguity. To do this, participants were asked to discriminate between reward smiles and prototypical angry expressions, as these are less ambiguous than reward smiles and dominance smiles (Niedenthal et al., 2010). Therefore, whilst ensuring that participants were still required to respond according to facial expression, this task was more comparable to Study 5 in terms of stimulus ambiguity.

Most importantly, I hypothesised that I would replicate the interaction between response dimension and context valence, such that expressions in positive contexts would be approached more quickly and avoided more slowly than expressions in negative contexts. Finding this interaction would support the top-down goal-based account by showing that context automatically affects responses to facial expressions even when the stimuli are less ambiguous.

Methods

Participants

A priori power analysis indicated that I required 50 participants to detect a two-way interaction between response direction and context valence with 90% power. Ultimately, I recruited 59 participants (25 women, 33 men, 1 prefer not to say) from the United Kingdom. The majority were Caucasian (79.7%; 7 Asian, 4 Black, 1 Multiple ethnic groups), aged 19-69 years ($M_{\text{age}} = 37.95$, $SD_{\text{age}} = 10.65$). Five additional participants were excluded from analyses because their performance failed to exceed the 80% correct response threshold.

Procedure

Participants were instructed to push or pull their phone according to facially expressed emotion rather than smile type. Angry expressions were taken from the same face set developed by Rychlowska et al. (2017) and superimposed over the same situational context images as the dominance smiles in Study 6.

Participants completed two blocks – which I will refer to as “pull happy” and “push happy”. In the pull happy block, they were instructed to pull happy expressions (i.e. reward smiles) toward themselves and to push angry expressions away from themselves. In the push happy block, the instructions were reversed. The order of these blocks was counterbalanced across participants. During each block, participants saw both expressions displayed by each of the 16 actors in both context categories, yielding 64 trials per block. Breaks were offered to participants every 16 trials. All other procedures were the same as previous studies.

Results

Following Zech et al.’s (2020) criteria, 6.0% of the experimental trials completed were excluded from analyses.

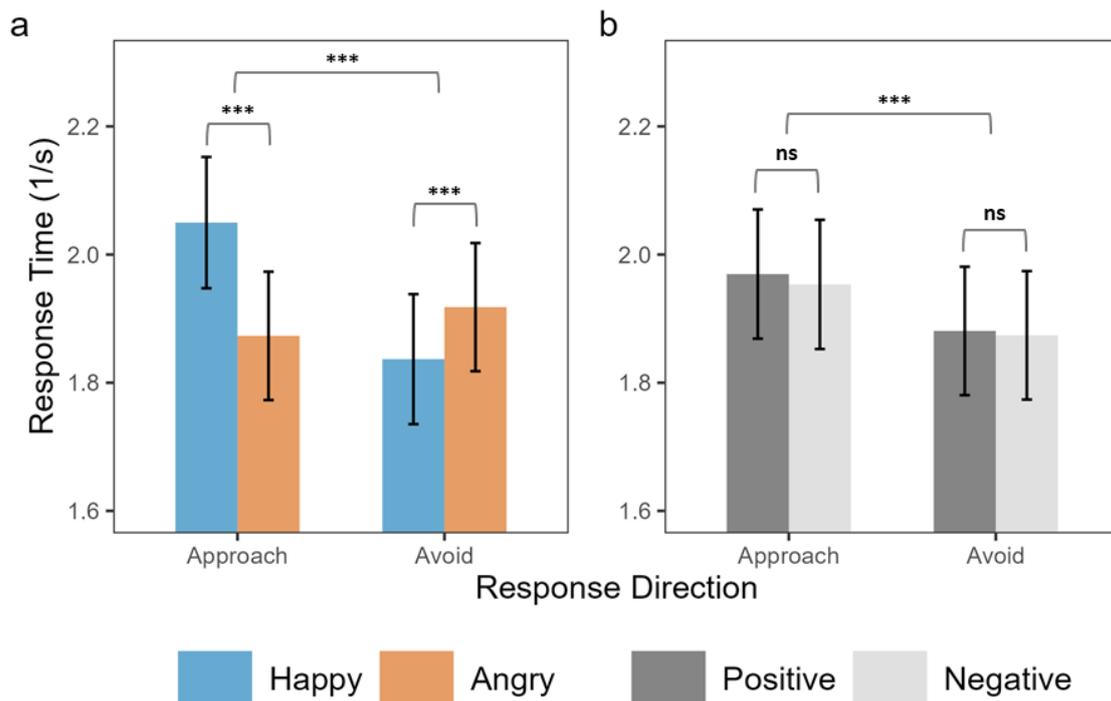
Main Analyses

Response Time. As hypothesised, results revealed a significant main effect of response direction, $F(1, 55.4) = 43.94, p < .001$, such that participants reacted faster when approaching ($M = 1.96, 95\% \text{ CI } [1.87, 2.05]$) than when avoiding stimuli ($M = 1.88, 95\% \text{ CI } [1.79, 1.96]$). Furthermore, there was also a significant main effect of facial expression, $F(1, 56.6) = 13.71, p < .001$, such that participants responded more quickly to happy expressions (i.e. reward smiles) ($M = 1.94, 95\% \text{ CI } [1.86, 2.03]$) than angry expressions ($M = 1.90, 95\% \text{ CI } [1.81, 1.98]$) across response directions, although this main effect was qualified by an interaction between response direction and facial expression, as shown in Figure 4.4a, $F(1, 7028.1) = 170.15, p < .001$. Specifically, happy expressions ($M = 2.05, 95\% \text{ CI } [1.96, 2.14]$) were approached more quickly than angry expressions ($M = 1.87, 95\% \text{ CI } [1.79, 1.96]$), $t(140.64) = -10.91, p < .001$, whereas angry expressions ($M = 1.92, 95\% \text{ CI } [1.83, 2.01]$) were avoided more quickly than happy expressions ($M = 1.84, 95\% \text{ CI } [1.75, 1.93]$), $t(143.95) = 4.98, p < .001$. The interaction between response direction and context valence was not significant, $F(1, 7023) = 0.22, p = .64$ (see Figure 4.4b). Finally, there was a significant interaction between facial expression and context valence, $F(1, 7022.9) = 4.41, p = .04$, such that participants responded more quickly to expressions in positive contexts ($M = 1.96, 95\% \text{ CI } [1.87, 2.05]$) than negative contexts ($M = 1.93, 95\% \text{ CI } [1.84, 2.02]$) when the expression shown was happy, $t(7024.11) = -2.31, p = .02$. In contrast, this difference was non-significant when the expression was angry, $t(7021.74) = 0.66, p = .51$. However, this finding is largely uninterpretable without the influence of response direction. No other main or interaction effects were significant (all $ps > .24$).

Exploratory analyses showed that neither target gender nor target ethnicity affected approach or avoidance response times.

Figure 4.4

Interactions Between Response Direction and (a) Facial Emotion and (b) Context Valence for Response Times to Categorise Facial Emotions in Study 7. Error Bars: 95% CI



Discussion

Study 7 showed that approach-avoidance tendencies towards prototypical emotional expressions were not influenced by situational context. This finding directly contrasts with Study 6's results, which showed that smiles were approached more quickly in positive contexts than in negative contexts.

Nonetheless, results also indicated that the task was easier than in Study 6. Notably, Study 7 had a quicker response time and higher response accuracy. Therefore, given that the stimuli were less ambiguous whilst the focus of the response (i.e. the face) remained the same

across Study 6 and Study 7, the disappearance of the context effect on RT is consistent with the reduced stimulus ambiguity explanation.

Study 8

Finally, Study 8 investigated whether either smile type or situational context affected participant's responses when both were "task-irrelevant". Participants were instructed to respond to an orthogonal response dimension – gender. Any influence of smile or context would suggest that this source of information is integrated into implicit responses to other social information.

Methods

Participants

An a priori power analysis indicated that I required 150 participants to detect a three-way interaction between smile type, context valence, and response direction with 90% power. Therefore, I recruited 150 participants (59 women, 90 men, 1 prefer not to say) from the United Kingdom. The majority were Caucasian (83.3%; 10 Asian, 9 Black, 5 Multiple ethnic groups, 1 other), aged 19-77 years ($M_{\text{age}} = 40.41$, $SD_{\text{age}} = 12.67$). Three additional participants were excluded from analyses because their performance failed to exceed the pre-determined 80% correct response threshold.

Procedure

Participants were instructed to push or pull their phone according to facial gender. Therefore, participants completed two blocks – "pull women" and "push women". In the pull women block, they were instructed to pull women toward themselves and to push men away from themselves. In the push women block, the instructions were reversed. The order of these blocks was counterbalanced across participants. During each block, participants saw each of

the three smile types (reward, affiliation, dominance) displayed by each of the 16 actors in both context types (positive, negative), yielding 96 trials per block. Breaks were offered to participants every 24 trials. All other procedures were the same as Study 5.

Results

Following Zech et al.'s (2020) criteria, 4.5% of the experimental trials completed were excluded from analyses.

Main Analyses

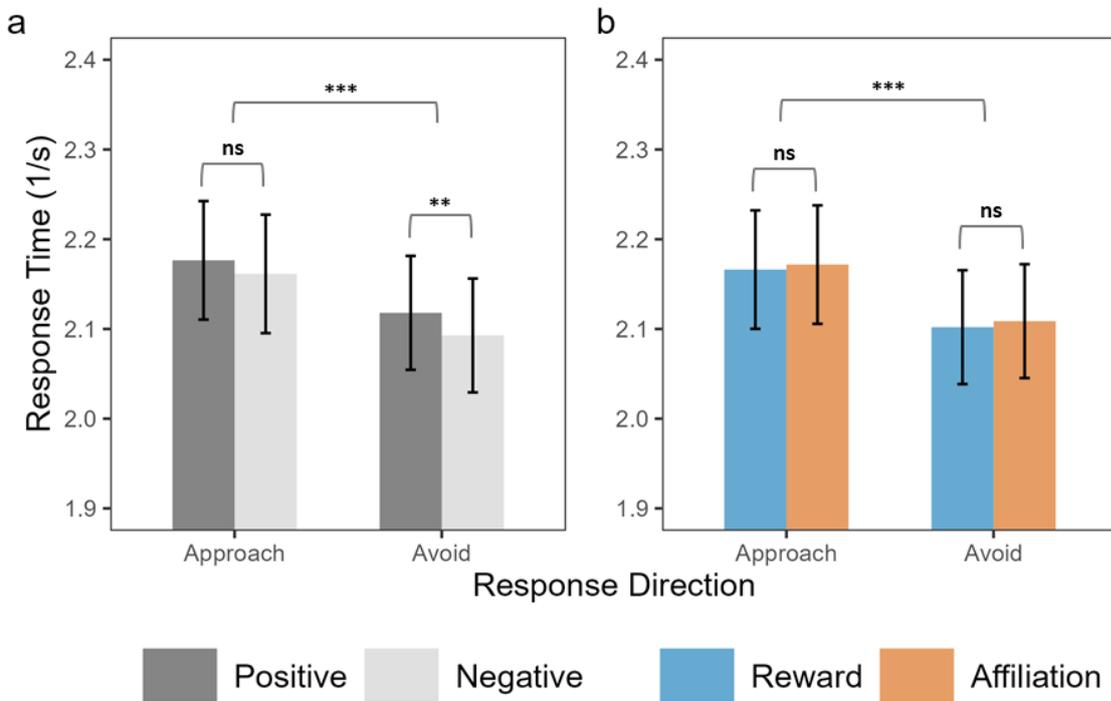
Response Time. Results revealed a significant main effect of response direction, $F(1, 148.8) = 48.04, p < .001$, such that participants reacted faster when approaching ($M = 2.17$, 95% CI [2.11, 2.23]) than when avoiding stimuli ($M = 2.11$, 95% CI [2.05, 2.16]). The main effect of context valence was also significant, $F(1, 17944.7) = 12.14, p < .001$, such that participants responded more quickly to smilers in positive contexts ($M = 2.15$, 95% CI [2.07, 2.18]) than in negative contexts ($M = 2.13$, 95% CI [2.09, 2.20]). Smile type did not significantly affect RT, $F(1, 17943.6) = 1.14, p = .29$, and there were no significant interactions (all $ps > .38$), as shown in Figure 4.5.

Exploratory Analyses

Exploratory analyses were then performed on the whole dataset (with dominance smiles included). New random effects structures were established using the same procedures described above. All effects reported above were retained, and no new main or interaction effects were found.

Figure 4.5

Interactions Between Response Direction and (a) Context Valence and (b) Smile Type for Response Times to Categorise Gender in Study 8. Error Bars: 95% CI



Discussion

Study 8 found no significant interaction effects, suggesting that smiles and situational contexts did not influence participants responses when discriminating smiler gender. Although previous research has found associations between specific facial expressions and gender categorisation (Hess et al., 2004), these studies used prototypical emotional expressions (e.g. fear and happiness) rather than different types of smiles. It is likely that none of my smile types selectively enhanced facial features associated with gender (Hess et al., 2004) and hence smile type did not influence gender discrimination.

I was unable to find any previous research showing that gender discrimination is affected by situational context. Overall, the results suggest that neither context nor expression

information automatically affects behavioural responses unless directly relevant to the participant's social goal.

General Discussion

Together, these findings show that a person's expression and their situational context can independently influence a perceiver's approach-avoidance response tendencies. However, these effects depend upon both the focus of the perceiver's response and the ambiguity of the facial expression. Supporting Hypothesis 1, participants reacted quicker when approaching versus avoiding stimuli across studies. Hypothesis 2 was only partially supported, such that participants approached reward smiles more quickly and avoided dominance smiles more quickly only when responding to the type of smile displayed. Smile type did not affect response speed when participants responded to situational valence. Hypothesis 3 was more strongly supported, such that participants approached positive situations more quickly than negative situations both when responding to the situation's valence and the smile type. However, situational context did not affect response speed when participants discriminated between distinct prototypical emotional expressions — less ambiguous social signals. I found no evidence to support Hypothesis 4 i.e. that the interaction between smile type and response direction would be stronger when smiles were in positive situations than when smiles were in negative situations.

Perhaps the most striking finding from this series of studies was the interaction between context valence and response direction in Study 6. Specifically, smiles seen in positive contexts were approached more quickly than smiles in negative contexts, whereas there was no significant difference for avoidance responses. This interaction suggests that situational context can implicitly affect behavioural responses to smiles, even when the situation is “task-irrelevant” and not the determinant of the participants' response. Once

again, this highlights the pervasiveness of context in facial expression processing (Aviezer et al., 2017; Wieser & Brosch, 2012), with effects that go beyond the conscious evaluative level (e.g. Brambilla et al., 2018). Furthermore, it implies that situational context may be important for the successful establishment of social interaction and subsequent interpersonal relationships, given the central role that approach behaviours play in this domain (Elliot et al., 2006; Gable, 2006; Zebrowitz & Collins, 1997).

Nonetheless, there is a crucial caveat to the above finding. Although situational context affected response tendencies to different smile types, results from Study 7 showed that it did not affect response tendencies to prototypical emotional expressions. This suggests that implicit behavioural responding to facial expressions automatically entails the integration of situational context *only* when expressions are ambiguous. Specifically, because different smile types are semantically more ambiguous than happy and angry emotional expressions (which more obviously contrast in valence), participants may automatically process additional contextual information (i.e. the surrounding situation) to disambiguate their meaning, and in turn guide their approach-avoidance response. This explanation is in line with previous research emphasising the importance of source clarity in determining the relative potency of expression and context information i.e. the "amount or type of information available to observers when they are exposed to a single source" (Ekman et al., 1972 p. 138). When the meaning of the target stimulus is less clear (i.e. when discriminating between different smile types) additional contextual information plays a larger role. In contrast, when the meaning of the target stimulus is more obvious (i.e. when discriminating between (a) happy and angry expressions or (b) positive and negative situations) then the influence of additional information is reduced (Chen & Whitney, 2019; Nakamura et al., 1990; Wallbott, 1988a; 1988b).

The effect described above has multiple implications. First, at a methodological level, it implies that the widespread use of prototypical Basic Emotion displays (Ekman et al., 1969) in prior context research may have downplayed the importance of context for evaluating facial expressions. In future, research examining context effects should present participants with more ambiguous expressions. Second, at a theoretical level, past research suggests that most facial expressions we encounter in social environments are likely to be more ambiguous than the Basic Emotion prototypes (e.g. Matsumoto et al., 2009). Consequently, when trying to derive meaning from an interaction partner's expressions during real-life social interactions, we may be even more reliant on context than previously indicated by psychological research.

This ambiguity-based explanation also has implications for understanding the automaticity of expression-context integration. Study 6's results suggest that situations can be automatically integrated into implicit responses to facial expressions—a finding that accords with a body of behavioural and ERP research (Brambilla et al., 2018; Hietanen et al., 2007; Ito et al., 2012; Righart & de Gelder, 2008a; 2008b). For example, expression-context congruency affects the amplitude of the N170 ERP component, which cannot be affected by conscious processing (Aguado et al., 2019; Dieguez-Risco et al., 2015). Similarly, Ito et al. (2012) found that emotion categorisation RT in a speeded-response task was significantly influenced by the congruency of target facial expressions with the embedded landscape sceneries. Intriguingly however, automaticity of context integration may also depend upon the nature of the participant's task. Notably, Barrett and Kensinger (2010) found that participants remembered contextual information more accurately when they were required to label facially expressed emotions than when they were asked to make an approach-avoidance judgement. The present findings somewhat correspond with this idea, by suggesting that the

automaticity of context integration depends upon whether participants are discriminating between more or less ambiguous stimuli.

In contrast to the findings from Chapter 2 and Chapter 3, I did not find that smiles influenced responses to situations. As well as the source clarity explanation, the absence of a smile effect may be explained by various other factors. First, it is possible that integrating facial information into situation processing requires some sort of conscious cognitive deliberation not available during a speeded AAT task. Notably, the Meaning of Emotional Expressions in Context (MEEC) model suggests that perceiving a facial expression within a situation often leads to a conscious re-engineered appraisal of the situation itself. (Hess & Hareli, 2017, p. 384). In comparison to the AAT where participants gave speeded responses, participants had unlimited time to respond in the explicit ratings tasks, which likely facilitated this type of reappraisal process.

Second, the response variable may also have played a role. In Chapter 2 and 3, participants rated situations on a continuous numerical scale rather than making binary approach-avoidance responses. The finer-grained nature of the numerical response may have encouraged participants to take the faces into account to a greater extent than a simple binary valence decision. Finally, stimulus differences may also have contributed to the discrepancy. The present studies used static photos of facial expressions because the AAT required a speeded response. In contrast, in Chapter 2 and Chapter 3 I used dynamic stimuli, which offer additional information such as the direction, quality, and speed of facial motion (see Krumhuber et al., 2013, Krumhuber, Skora, et al., 2023, for reviews). Hence, dynamic expressions are usually perceived as more intense and realistic than static expressions (Biele & Grabowska, 2006; Cunningham & Wallraven, 2009; Weyers et al., 2006). Accordingly, the reduced clarity of the static facial stimuli may also have contributed to the absence of a smile type effect in Study 5.

Unlike previous papers which have focused on prototypical emotional facial expressions (Marsh et al., 2005; Rotteveel & Phaf, 2004; Zech et al., 2020), Study 6 is the first to show approach-avoidance effects for functionally defined smile types. The idea that reward smiles facilitate approach tendencies whereas dominance smiles facilitate avoidance tendencies is consistent with the results of previous studies showing that reward smiles are more positively evaluated (Martin et al., 2018; 2021; Rychlowska et al., 2017; 2021). Indeed, in Chapter 2, I showed that reward smiles were rated more positively than affiliation / dominance smiles and encouraged greater investments with partners. Similarly, Martin et al. (2018) showed that different smile types exerted distinct influences on perceivers' physiological activity. Relative to reward and affiliation smiles, receiving a dominance smile from a confederate judge increased heart rate and salivary cortisol levels in participants who had unexpectedly been selected to give a speech. This effect was equivalent to negative verbal feedback. In contrast, when the confederate displayed reward and affiliation smiles, these smiles altered the speech-giver's autonomic activity in a way akin to positive social evaluation. Likewise, Study 5's finding that positive situations facilitated approach tendencies whereas negative situations facilitated avoidance tendencies accords with a range of previous studies which have investigated how scenes are approached / avoided (Lavender & Hommel, 2007; Rotteveel & Phaf, 2004, Study 3; Theodoridou et al., 2013).

There are limitations to the present research. Notably, a programming error in Study 5 meant that participants saw only half of the full set of stimuli in each of the two blocks of trials (i.e. 48 of the 96 faces-in-context per block). Consequently, there is a small possibility that any statistically significant results may be confounded by an imbalance in the identity, gender, and/or ethnicity of smilers seen across blocks and participants. Nonetheless, this error was mitigated by my pseudo-randomisation of stimuli in each sub-block, which meant that each smile type and context valence was presented with equal frequency within and between

participants. As a result, the key independent variables-of-interest remained balanced. Furthermore, by using linear mixed models with random effects, I limited potential problems associated with my unbalanced dataset. Finally, as argued by Miller (2023), for most RT effects, statistical power is greater in experimental designs consisting of more participants and fewer trials-per-participant rather than the reverse. In Study 5, I recruited a sample of 150 participants — three times larger than the sample needed to detect any of the hypothesised two-way interactions. Hence, the study should still have been adequately powered to detect these potential two-way interactions, even with a smaller number of trials.

Besides this error, the external validity of this research is limited by the use of static facial expressions presented on a phone screen, which does not reflect how faces are seen during everyday interaction (e.g. see Orłowska et al., 2018). Moreover, by allowing participants to use their own phones, I introduced variation associated with screen size and resolution, which may have affected the extent to which subtle differences between smile types were detected. Although Study 6 shows that participants were able to distinguish between these reward and dominance smiles, this differentiation may have been more difficult in Study 5 when participants were instructed to respond to the situation rather than the smile. To rectify these phone-related limitations, I propose that the present findings should be replicated in more ecologically valid tasks to show that the same psychological processes drive social behaviour in real life. For example, future research could test how context and expressions affect approach-avoidance behaviours towards virtual interactants using virtual reality environments.

Finally, although this research outlines how facial expressions and situational context affect the subsequent behaviour of perceivers, I focused only on how they influence speeded behavioural responses, and did not study their effects on more elaborate, deliberative behaviours. Admittedly, automatic integration of context may affect subsequent conscious

processing of smiles. For example, subliminally presented facial expressions influence participants' mood and subsequent evaluations of neutral stimuli (Winkielman et al., 1997). Similarly, the "mere exposure effect" indicates that unconscious processing of repeated stimuli may also affect subsequent cognitive judgements (Zajonc, 1968). This shows that affective cues, processed implicitly, can subtly guide later conscious appraisals. Nonetheless, in the present research I did not study the direct effect of my stimuli on deliberative conscious evaluations. Consequently, future research may investigate joint expression-context effects on deliberative behaviour e.g. via economic games. These designs have been used extensively in the past to show that facial expressions affect investment and sharing decisions (e.g. de Melo et al., 2014; Martin et al., 2021; Reed et al., 2012).

Conclusion

To conclude, the present research shows that approach-avoidance response tendencies can be influenced by both the type of smile a person displays and the situation that they are seen within. Importantly however, these effects depend upon what the person is responding to. Notably, whilst situational context implicitly affected responses to smiles, it did not affect responses to prototypical facial emotions. Moreover, smiles did not implicitly affect responses to situations. At a theoretical level, these findings advance our understanding of automatic social cue integration during interpersonal interaction by showing that this integration process depends upon the ambiguity of the information available as well as the nature of the person's task.

CHAPTER 5: CONTEXT INFLUENCES FACIAL MIMICRY WITHIN VIRTUAL ENVIRONMENTS

Abstract

Extant research shows that evaluations of expressions are affected by the situational context they are seen within. However, the effect of context on social processes that occur during real-life interactions has been less well studied. One such process is facial mimicry, which is thought to be both facilitated by and beneficial for interpersonal affiliation. To test whether facial mimicry is affected by either type of smile or situational context, I immersed participants ($n = 66$) into pleasant and unpleasant ambient virtual environments. They then came face-to-face with a virtual avatar, who displayed one of six different smile types ranging from more “prosocial” (e.g. reward / Duchenne smiles) to more “antisocial” (e.g. dominance / miserable smiles). Electrodes in the VR headset allowed me to measure the extent to which each smile was mimicked. As hypothesised, mimicry broadly declined as smiles became more antisocial. Moreover, smiles presented in pleasant contexts were mimicked more than those presented in unpleasant contexts. This context effect was mediated by ratings of interpersonal closeness towards the virtual avatar, which suggests participants felt closer to avatars when in pleasant contexts, which in turn facilitated greater mimicry of the smiles. Overall, the findings provide further support for the Emotional Mimicry in Social Context theory and suggest that effects established in earlier chapters can be generalised to immersive and embedded interactions. Furthermore, they indicate that interaction quality and ultimate affiliation with an interaction partner can be influenced by the situation the interaction occurs within.

Introduction

Both the type of expression and the situational context affect the way people respond to faces-in-context. This occurs for explicit evaluations of stimuli (Chapter 2 and 3), hypothetical investments (Chapter 2), cognitive deliberation (Chapter 3), and speeded approach-avoidance movements (Chapter 4). In the final chapter, I extend this research by investigating the extent to which these social cues influence facial mimicry, within a more realistic social environment.

Mimicry is a particularly important social process that is pervasive within social interaction (Dimberg, 1982; Hess & Blair, 2001; Hess & Fischer, 2013). For example, people mimic facial expressions (Hess & Fischer, 2013), body language (Bavelas et al., 1986), vocal expressions (Neumann & Strack, 2000), pupil dilations / constrictions (Kret et al., 2015), and gestures such as face touching (Chartrand & Bargh, 1999). In general, this mimicry happens automatically, and is difficult to suppress or fake (e.g., Arnold & Winkielman, 2020; Dimberg, et al., 2000; 2002; Dimberg & Thunberg, 1998; Korb et al., 2010; Philip et al., 2018). Dimberg and Thunberg (1998) found that when individuals view a smile, the *zygomaticus major* typically contracts within 500 milliseconds of the onset of the other person's smile. Likewise, Mojzisch et al. (2006) showed that observers automatically mimic smiles expressed by virtual avatars.

Accordingly, it has been hypothesised that facial mimicry plays a key role in understanding the facial expressions of others via an embodied simulation process. i.e. “simulation of a state in the motor, somatosensory, affective, and reward systems that represents the meaning of the expression to the perceiver” (Niedenthal et al., 2010, p. 418). In short, perceiving a facial expression triggers internal states associated with the facial emotion. In turn, these states are used to represent the meaning of the observed expression. Hence, facial mimicry influences emotion perception (Oberman et al., 2007; Niedenthal et al., 2017).

Some studies have supported this idea. For example, the injection of Botox (containing a paralysing toxin, botulinum) into facial muscles has been shown to reduce participants' accuracy at emotion recognition tasks (Lewis, 2018). On the other hand, a large body of research has failed to find a causal link between mimicry and facial emotion recognition accuracy (e.g. Blair et al., 1999; Hess et al., 1999; Hess & Blair, 2001). Moreover, participants who do not or cannot spontaneously mimic the expressions of others (i.e. people with autism or facial paralysis) regularly perform well at emotion recognition tests (e.g. Calder et al., 2000; Spezio et al., 2007).

As a result, it seems that mimicry isn't strictly *necessary* for facial emotion perception. Instead, facial mimicry likely plays a facilitatory role in this process. In support of this view, Stel and van Knippenberg (2008) showed that when mimicry was blocked, facial emotion categorisation accuracy was unaffected, but response speed slowed. This facilitatory effect seems to be particularly strong when the expression itself is less prototypical and more ambiguous. For example, Niedenthal et al. (2001) found that mimicry most affected emotion categorisation when the observed facial expression changed from one emotion to another.

The view that mimicry facilitates the identification of others' internal states partly inspired the recent development of the Simulation of Smiles (SIMS) model (Niedenthal et al., 2010; Rychlowska et al., 2017). As described in previous chapters, the SIMS smiles are classified functionally — i.e. in terms of how they affect people's behaviour in the service of fundamental tasks of social living. Moreover, according to the developers of this framework, mimicry plays a significant role in how these smile types are identified. In the original article, Niedenthal et al. (2010, p. 421) argued that perceivers can “distinguish between the three functional smile categories in terms of the feelings they generate in the perceiver.” This focus on mimicry is apparent even in the name of the model, which emphasises the importance of simulation to the smile interpretation process. Nonetheless, despite a substantial body of

empirical work into the social functions and meanings of these smiles (e.g. Rychlowska et al., 2017; 2021; Martin et al., 2018; 2021), only one study has assessed mimicry of these smiles, and this research manipulated mimicry via the pen-in-mouth procedure rather than measured it (Orlowska et al., 2018).

In addition to facial mimicry, the interpretation of facial expressions is also influenced by the context that they are seen within. During social interactions, faces of others are always encountered alongside or within some sort of context, including situational, vocal, bodily, and dispositional information. A large number of studies have shown that contextual information impacts emotion evaluations from faces (see Wieser & Brosch, 2012, for a review). Likewise, the meanings and interpretations of smiles are also influenced by context (Krumhuber, Hyniewska, et al., 2023; Namba et al., 2020; Mui et al., 2020). In previous chapters of this thesis I have shown that responses to SIMS smile types are influenced by situational context, at both an explicit and implicit level. Specifically, situational context influenced both (1) explicit socio-functional evaluations of these different smile types, and (2) speeded approach-avoidance movements towards them, even when irrelevant to the task.

Building on this work, in the present chapter I tested the extent to which context influenced facial mimicry of different smile types. This work was informed by the Emotional Mimicry in Social Context theory (Hess & Fischer, 2013; 2014; 2016; 2022), which proposes that the facial display of the person being mimicked (i.e. the mimickee) is first evaluated by the perceiver (i.e. the mimicker) through a social appraisal process. Consequently, facial mimicry is influenced by both bottom-up *and* top-down information (see also, Seibt et al., 2015). Specifically, it is top-down modulated by the incorporation of memorised information, such as knowledge about social norms and context elements, which forms an interpretation of the facial expression in context.

Further, Emotional Mimicry in Social Context theory proposes that mimicry is an affiliative process, which is “both influenced by and conducive to affiliation” (Hess & Fischer, 2013). I use the term affiliation to refer to all processes associated with the fundamental motive to connect with other people (e.g., Aron et al., 1992; Leary, 1958). The idea that mimicry is conducive to affiliation is well supported by extant literature. For example, mimicry is associated with various positive social outcomes, including increased perceived interaction quality (Mauersberger & Hess, 2019), empathy (Dimberg & Thunberg, 2012; Drimalla et al., 2019), and self-reported affiliation (Chartrand & Lakin, 2013; Hess, 2020; Hess & Fischer, 2022). Moreover, although less well studied, some evidence supports the converse idea that mimicry is influenced by affiliation. Notably, Hess and Fischer (2022) showed that the affiliative intent of the mimicker influenced both the frequency and intensity of facial mimicry.

The idea that mimicry is influenced by affiliation has two key implications. First, we would expect greater mimicry of more affiliative prosocial facial expressions relative to non-affiliative antisocial expressions (see Bourgeois & Hess, 2008; Surakka & Hietanen, 1998). Second, we should also expect facial mimicry to depend upon the context that the expression is seen within. As established, context can substantially alter the appropriateness of an expression, and this in turn should influence the extent to which the expression is perceived as affiliative. In addition, we also expect that pleasant situations facilitate social interaction more than unpleasant situations and hence increase one’s tendency to affiliate with others. This prediction accords with Rosa’s (2021) Resonance theory, which suggests that desirable relationships with other beings (i.e “resonance”) develop more easily in spaces that allow people to be in a positive state without being distracted, avoidant, or withdrawn.

An emerging body of research has provided strong support for the Emotional Mimicry in Social Context theory, focusing mostly on emotional expressions. Kirkham et al. (2015)

presented facial expressions that were either consistent or inconsistent with concurrently presented non-social situations. They found that participants smiled less when viewing a smiling face in the presence of a negative situation than when viewing a smiling face in the presence of a positive situation. They therefore concluded that incongruent, affectively deviant expressions are less likely to be mimicked. This conclusion was later strengthened by Kastendieck et al. (2021), who presented participants with either happy or sad expressions embedded within either a wedding or funeral scene. Again, mimicry was influenced by perceived affective deviance, although this effect was also moderated by perceived interpersonal closeness. Specifically, deviant expressions were more likely to be mimicked when the mimicker felt closer to the expresser. This suggests that multiple contextual factors may interact when determining the extent to which an expression is mimicked. Similarly, Mauersberger et al. (2022) found that observers mimicked laughter to a lesser extent when the laugh reflected *schadenfreude* as opposed to benign joy. Again, the appropriateness of the expresser's reaction affected how close observers felt to the expresser, which in turn affected the extent to which they mimicked the laughter.

Nevertheless, consistent with almost all previous studies investigating how context affects smile processing, the research described above and in previous chapters of my thesis involved presenting participants with stimuli on a screen. Although an important step in understanding these processes, it doesn't reflect how social stimuli are experienced in real life, and therefore may miss certain aspects of actual face-to-face behaviour which drive social outcomes. Most notably, social interactants are always embedded within and coupled with an external environment (Thompson, 2010), which provides the interactant with "affordances" i.e. opportunities encountered as they traverse and manipulate the world around them (Gibson, 1986). In addition, social cognition is also embodied and depends to some

extent upon “non-mental” physiological bodily processes. Neither of these features of social interaction are fully captured by my thesis so far, or by other past research (see Slater, 2003).

To test whether effects occur in real life, researchers could organise interactions between pairs of participants in a testing lab. However, this method is problematic. First, it is difficult to appropriately manipulate situational context in a lab environment, where physical space and ethical conditions constrain the scope of the interaction. Furthermore, it is also difficult to manipulate the facial expressions displayed by participants. On one hand, researchers can instruct participants to produce certain expressions, but this limits the interaction’s naturalness and relies upon the acting ability of participants. Alternatively, researchers could passively record instances of facial expressions and then correlate their frequency with outcome variables. However, (a) there is no guarantee that the expressions-of-interest will be displayed, and (b) these correlations would be highly influenced by external uncontrolled variables. For example, expression reciprocity during live social interactions would likely introduce large amounts of unwanted noise that would reduce the clarity of any facial expression effect (Heerey, 2015).

Consequently, in the present chapter I tested whether the context and smile effects established previously could be replicated in more naturalistic, less abstract environments. Specifically, I used a virtual reality (VR) experimental set-up. This allowed me to embed participants within an interactive context, whilst also standardising the situational context and the smiles displayed within and between participants. Relative to studies that rely upon actual face-to-face interactions, the VR set-up enabled me to retain a much larger level of control over my independent variables and potential extraneous variables. In addition, although the realism of the social interaction is not as high as during real-life face-to-face conversations, it still represents a significant improvement compared to studies which present stimuli on computer or phone screens (Kothgassner & Felnhofer, 2020; Slater & Sanchez-Vives, 2016).

Therefore, this study allowed me to assess whether previous findings generalise to more real-world settings.

Present Research

The present study investigates how smile type and situational context influence a perceiver's smile ratings and subsequent facial mimicry. To explore this, participants were embedded into an ambient virtual environment that was either positive (a green park) or negative (a noisy construction site). After a brief familiarisation period, participants came face-to-face with a virtual avatar, who displayed one of six different smile types (reward, Duchenne, affiliation, non-Duchenne, dominance, miserable). During each virtual encounter, electrodes in the VR headset recorded the electrical activity in various face muscles, which allowed measurement of the extent to which each expression was mimicked. Importantly, previous research has shown that people tend to imitate virtual avatars to a similar extent as real humans (Likowski et al., 2008). After each encounter, participants then rated the smile and their perceived closeness to the virtual interaction partner.

In addition to the three SIMS smile types, I also included Duchenne, non-Duchenne, and miserable smiles, as described by Hess et al. (2002). These additions intended to better capture potential subtle functional differences that may exist within the SIMS smile types. For example, it could be argued that whilst the SIMS reward smile corresponds more to "liking", the strong Duchenne smile signals more "enjoyment". Likewise, whereas the SIMS affiliation smile seemed to best represent "greeting/acknowledging", the non-Duchenne smiles perhaps better reflects "inviting". Finally, the miserable smile was proposed to reflect a function not mentioned by the SIMS model: recruiting sympathy and support.

Hypotheses

First, in line with the results of previous chapters, I hypothesised that reward/Duchenne smiles would be mimicked more than affiliation/non-Duchenne smiles, which in turn would be mimicked more than dominance/miserable smiles (*Hypothesis 1*). Likewise, I predicted that smiles presented in pleasant contexts would be mimicked more than those presented in unpleasant contexts (*Hypothesis 2*). Furthermore, I predicted an interaction between context and smile type, such that the effect of smile type on mimicry would be stronger in pleasant contexts than unpleasant contexts (*Hypothesis 3*).

With regards to smile ratings, I hypothesised that reward/Duchenne smiles would be rated as conveying more joy and more liking than all other smile types (*Hypothesis 4*). Moreover, I predicted that affiliation/non-Duchenne smiles would be rated as conveying more politeness and more acknowledgment than all other smile types (*Hypothesis 5*). In addition, I predicted that dominance smiles would be rated as conveying more condescension than all other smile types (*Hypothesis 6*), whilst miserable smiles would be rated as conveying more concern than all other smile types (*Hypothesis 7*).

With regards to interpersonal closeness, I hypothesised that reward/Duchenne smiles would lead to higher interpersonal closeness than affiliation/non-Duchenne smiles, which would induce higher interpersonal closeness than dominance/miserable smiles (*Hypothesis 8*). Similarly, I expected that pleasant contexts would lead to higher interpersonal closeness than unpleasant contexts (*Hypothesis 9*). Finally, I also predicted a further interaction between smile type and context, such that the effect of smile type on interpersonal closeness would be stronger in pleasant contexts than unpleasant contexts (*Hypothesis 10*). Finally, given that mimicry should be facilitated by motive to affiliate (Hess & Fischer, 2013), I also conducted exploratory mediation analyses to assess the extent to which any smile or context effects were mediated by ratings of interpersonal closeness.

Study 9

Methods

Participants

I aimed for a sample size of 50-70 (80-90% power) based on a power simulation for linear mixed models conducted using the R package *simr* (<https://box.hu-berlin.de/d/d19527d5df13464a8c3d/>). Beta coefficients and random effect variances were estimated based on data from a previous mimicry study (Kastendieck et al., in preparation).

Overall, I recruited 66 participants (42 women, 24 men) living in Germany. Participants were aged 19-45 years ($M_{age} = 26.59$, $SD_{age} = 6.82$). The majority ($n = 55$) were students. Exactly half ($n = 33$) had used a VR headset previously. Participants had normal or corrected-to-normal vision. The majority of participants ($n = 59$) chose to do the study in German, with a small minority choosing the English language option. On a 0-100 scale, the mean rating of headset comfort was 62.74 ($SD = 24.30$). 11 participants reported mild balance impairment and 12 reported mild nausea, although post-experiment debriefings revealed that neither caused severe problems.

Participants were recruited via the psychology department's participant recruitment system, posters, and word of mouth. Participants were compensated at a rate of €10 per hour or with course credits. An additional six participants were excluded from analysis because of technological malfunctions. The study was approved by the university's research ethics committee.

Design

The experiment used a 2 (contexts: pleasant vs unpleasant) x 6 (smile types: reward, Duchenne, affiliation, non-Duchenne, dominance, miserable) within-subjects design.

Materials

Virtual Reality Environments

The experiment used two virtual environments created previously by Kastendieck et al. (in preparation) in Unreal Engine 5.0. Both were situated in a city park.

The pleasant environmental context was a tranquil and picturesque park. It was adorned with sakuras (cherry trees), fountains, lakes, monuments, artworks, a vibrant café, a street violinist (playing Schubert's Ständchen in C major), a public piano (with a pianist playing Schumann's Träumerei in F major), and a vintage carousel. The faces of the musicians were not visible.

In contrast, the unpleasant environment was a noisy construction site in another location of the park. It contained portable toilets, construction vehicles, an air ambulance helicopter flying overhead, ambulances with sirens blaring, cranes lifting containers, tree stumps, and a descending jumbo jet approaching a nearby airport (reminiscent of the old Tempelhof Airport in Berlin), intended to induce auditory stress.

These contexts were designed to evoke contrasting emotional responses (as pre-tested by Kastendieck et al. (in preparation) with an independent sample). Environmental sound assets were licensed from Envato Elements and merged into two separate soundscapes in Ableton Live 11. The music was bought from Qobuz or produced with Ableton Live 11.

In the post-experiment debrief, participants were asked to rate the realism of the environmental contexts on a 0-100 scale. Overall, environments were perceived as mostly realistic ($M = 70.20$, $SD = 17.41$).

Avatars and Smile Types

Using MetaHuman Creator by Epic Games, I created realistic virtual avatars displaying six different types of smile. Facial movements were programmed using templates provided by Unreal animations, which are guided by but do not fully correspond to the action units of the Facial Action Coding System (FACS — Ekman & Friesen, 2002). Each smile type was programmed to align broadly with their associated FACS action units, as established by previous research (e.g. Hess et al., 2002; Martin et al., 2018; Rychlowska et al., 2017).

A pre-test of these smile types was conducted by asking participants ($n = 109$) to rate and describe videos of avatars displaying these smiles in neutral contexts. First, I created a pool of 28 pilot stimuli (7 smile types x 4 avatars). Two avatars were male and two were female. All were white. All smiles unfolded for 1.5 seconds and then remained at “apex” intensity for 2 seconds.

The pre-test was hosted by the website Soscisurvey.de and completed online by participants recruited on the platform Prolific.org. The pre-test was programmed such that each participant saw just two smiles (one male avatar, one female avatar), and that the same type of smile could not be repeated. Participants were asked:

1. *How positive was the facial expression?* (1 – 100)
2. *How likable was the virtual avatar?* (1 – 100)
3. *What message do you think this avatar was trying to convey?* (Open text response)

As expected, a linear mixed model analysis revealed that the more prosocial smiles were rated as broadly more positive than the less prosocial smiles, $F(6, 187.47) = 24.59, p < .001$, (Reward ($M = 84.20, SE = 4.11$) > Duchenne ($M = 79.10, SE = 3.91$) > Non-Duchenne ($M = 72.90, SE = 3.91$) > Affiliation ($M = 59.80, SE = 3.91$) > Miserable ($M = 37.90, SE = 4.05$) > Dominance ($M = 35.60, SE = 3.97$)). A similar pattern was found for avatar likability,

$F(6, 193.5) = 5.49, p < .001$, although most between-smile differences were not significant on this measure. Moreover, participants' responses to the open question aligned closely to the proposed social functions of each smile type. An additional smile type ("weak") was included in the pre-test but not used in the final VR study because of concerns about study length and lack of distinctiveness relative to affiliation smiles.

In the post-experiment debrief, participants were asked to rate the realism of the avatars on a 0-100 scale. Overall, avatars were rated as moderately realistic ($M = 64.12, SD = 16.90$).

Dependent Variables

The EMG equipment measured the activity of the *orbicularis oculi* (the muscle that creates the wrinkles around the eye in smiling), *zygomaticus major* (the muscle that pulls the corner of the lips up), and the *corrugator supercilii* (the muscle that pulls the eyebrows down in a frown).

Participants were told not to apply makeup to the area covered by the *zygomaticus major* electrode site. Skin was prepared using alcohol swabs to remove skin oils. Impedances were below 25k Ω . The signal was recorded at 1000 Hz. The raw EMG signal was notch-filtered at 50 Hz and bandpass-filtered with the predefined filtering algorithm provided by Emteq with a range of 100 to 450 Hz, with a 50 Hz notch filter. It was then rectified and smoothed via a routine written in MATLAB, and merged with the rating and time marker data from a csv file provided by pluginstools in Unreal (easyCSV and Runtime DataTable). Data were baseline-corrected (pre-stimulus baseline) and within-subjects z-standardized (see Hess et al., 2017; Hess & Lipp, 2024) in R using base R (R Core Team, 2022) and the tidyverse package (Wickham et al., 2019). EMG activity was then aggregated within segments of each trial. My analyses focused on EMG activity at the apex segment.

In addition to mimicry, I also measured ratings of each smile across six socio-functional dependent variables on 0-100 scales. Consistent with Chapter 3, participants were asked:

"To what extent is this person expressing...?"

- *Joy*
- *Liking*
- *Acknowledgement*
- *Politeness*
- *Concern*
- *Condescension*

In the German version of the experiment, the question was:

"Inwieweit drückt diese Person aus?"

- *Freude*
- *Zuneigung*
- *Anerkennung*
- *Höflichkeit*
- *Besorgnis*
- *Herablassung*

This translation was proposed by a bilingual German- and English-speaking member of Hess Lab, then discussed and agreed upon during a lab meeting with multiple other bilingual lab members.

Finally, perceived interpersonal closeness was measured using an adapted version of the Inclusion of the Other in the Self (IOS) scale (Aron et al., 1992), using a continuous 0-

100 slider. Participants were asked to choose the position of a circle representing themselves relative to another circle representing the target person.

Procedure

The study was conducted in the virtual reality testing room of the Social Psychophysiological Lab (Hess Lab) at the Department of Psychology at the Humboldt-Universität zu Berlin. Participants sat in a comfortable armchair. The room lights were dimmed and blinds were shut (to reduce the interference of sunlight with the infrared trackers used by the VR headset). Room temperature ($M = 26.47$, $SD = 2.85$, $Min = 21$, $Max = 31$) and humidity ($M = 42.42$, $SD = 9.07$, $Min = 32$, $Max = 69$) were measured via a Xiaomi Smart Air Purifier 4. Participants provided informed consent (including an explanation about the use of sensor technology) before providing verbal answers to the experimenter's demographic questions (age, gender, occupation) and session protocol questions (e.g. previous VR headset use). The experimenter then fitted participants with HTC Vive Pro Eye headsets with integrated Emteq electromyography dry sensors and photoplethysmography (PPG). The data was monitored in real time using the Emteq SuperVision application. The experimenter guided the participants through a 2-minute baseline (for heart rate) and a subsequent calibration phase. The experimenter then read the instructions which included information about the walk-in-the-park scenario and the concept of avatars. Participants then underwent a short VR familiarisation phase before being randomly assigned to either a pleasant-unpleasant or unpleasant-pleasant block order (counterbalanced across participants).

The context conditions were blocked, with 24 trials per block (four of each smile type), meaning that the experiment consisted of 48 trials in total. Each trial started with a pre-stimulus fixation cross shown for 1.5 seconds on a black board that appeared in the park. The stimulus consisted of 7.5 sec of the park scene, before another fixation cross board (1.5 sec) was shown. Next, the avatar appeared as a passerby approaching the participant. The avatar

first showed a neutral expression for 1.5 sec, followed by a 1.5 sec smile onset and then a 2.0 sec smile apex. Finally, the trial concluded with a post-stimulus black board embedded into the space (1.5 sec). Participants were then presented with a black board embedded into the scene displaying the six smile rating questions, followed by another black board showing the IOS rating scale. Participants responded to these questions by using the laser pointer of their controller to click on the sliding scales, before moving on to the next trial. Participants were not allowed to speak during the experiment but could interrupt during each rating phase via a call button if they had any questions or problems.

Following the experiment, participants were thoroughly debriefed with a debriefing interview. Finally, participants were compensated and thanked for their participation.

Data Analysis

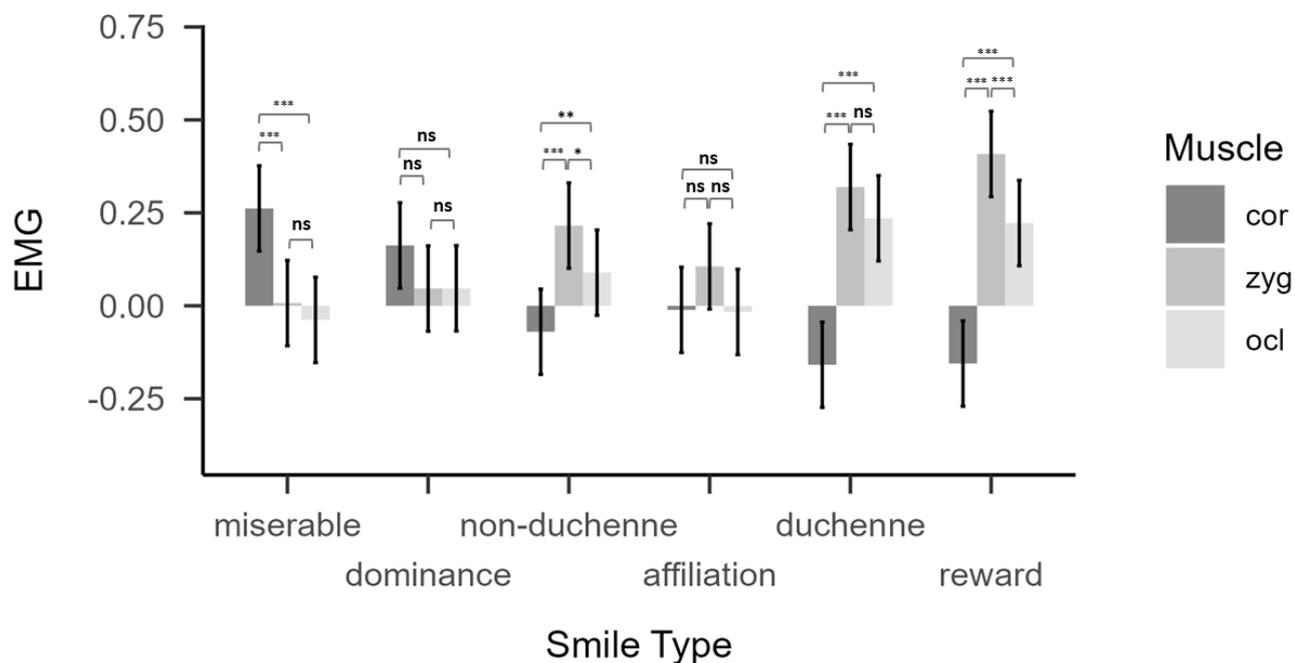
The mimicry dependent variable was informed by a preliminary linear mixed model analysis, which compared muscle activity across smile types. This revealed a significant interaction between smile type and muscle, $F(10, 9278) = 20.33, p < .001$. As anticipated, mimicry of reward and Duchenne smiles was characterised by greater zygomaticus and orbicularis activity relative to other smile types. In contrast, mimicry of dominance and miserable smiles was characterised by greater corrugator activity relative to other smile types. Non-Duchenne and affiliation smiles were characterised by medium levels of activity across each of these muscles. See Figure 5.1 for relevant means and CIs.

Data Availability

The design, methodology, and analysis techniques used in the present chapter were pre-registered. The pre-registration, data, analysis code, and research materials for Study 9 are available at https://osf.io/tw9d2/?view_only=bc8c9c2d3cd84ecaabcce33bf8da6d86.

Figure 5.1

Mean EMG Activity across Different Muscles and Smile Types



Therefore, I conducted two separate mimicry analyses. First, I examined the effect of context and smile type on the mean of zygomaticus and orbicularis activity. Next, the same analysis was also conducted on corrugator activity.

Results

Ratings

Using the same approach as previous chapters, LMMs were constructed to assess the effect of both smile type (six levels: reward vs Duchenne vs affiliation vs non-Duchenne vs dominance vs miserable) and context category (two levels: pleasant vs unpleasant) on each of the six rating dependent variables.

Joy. Results revealed a main effect of smile type on joy ratings, $F(5, 77.83) = 97.49, p < .001$, such that joy ratings declined as smiles became more “antisocial”. All pairwise comparisons were significant (see Table 5.1). Moreover, there was a main effect of context

category, $F(1, 64.09) = 6.24, p = .015$, such that smiles in pleasant contexts ($M = 50.59$, 95% CI [47.39, 53.78]) were rated as more joyful than smiles in unpleasant contexts ($M = 48.56$, 95% CI [45.55, 51.56]). Finally, the interaction between smile type and context category was also significant, $F(5, 2725.05) = 2.86, p = .014$. Specifically, Duchenne smiles ($p = .007$) and non-Duchenne smiles ($p < .001$) were rated as more joyful in pleasant contexts than unpleasant contexts, but this difference was not significant for all other smile types (all $ps > .43$). See Figure 5.2 for relevant means and CI's.

Table 5.1

Inferential Statistics for Comparisons across Smile Types for Joy Ratings

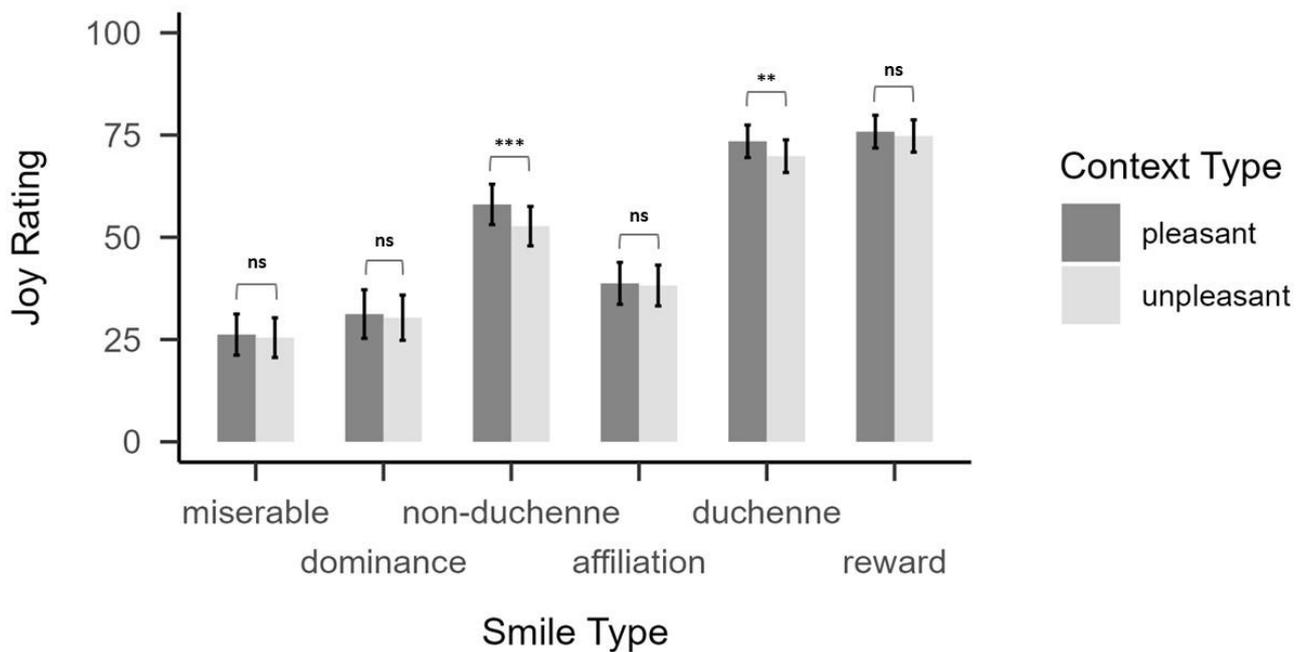
Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	-4.95	2.16	-11.52	1.63	-2.29	.025
Miserable - Non-Duchenne	-29.55	2.08	-35.89	-23.21	-14.21	<.001
Miserable - Affiliation	-12.63	1.35	-16.75	-8.51	-9.35	<.001
Miserable - Duchenne	-45.82	2.36	-53.00	-38.63	-19.43	<.001
Miserable - Reward	-49.47	2.37	-56.68	-42.25	-20.90	<.001
Dominance - Non-Duchenne	-24.60	2.41	-31.96	-17.24	-10.19	<.001
Dominance - Affiliation	-7.69	2.12	-14.16	-1.21	-3.62	.001
Dominance - Duchenne	-40.87	2.42	-48.25	-33.49	-16.89	<.001
Dominance - Reward	-44.52	2.54	-52.28	-36.76	-17.50	<.001
Non-Duchenne - Affiliation	16.91	1.64	11.93	21.90	10.34	<.001
Non-Duchenne - Duchenne	-16.27	1.53	-20.92	-11.61	-10.65	<.001
Non-Duchenne - Reward	-19.92	1.52	-24.55	-15.29	-13.11	<.001
Affiliation - Duchenne	-33.18	2.12	-39.63	-26.73	-15.69	<.001

Affiliation - Reward	-36.83	2.14	-43.35	-30.32	-17.24	<.001
Duchenne - Reward	-3.65	0.85	-6.17	-1.14	-4.29	<.001

Note. SE = standard error; CL = confidence limit.

Figure 5.2

Interaction Between Context Category and Smile Type for Ratings of Smile Joy. Error Bars: 95% CI



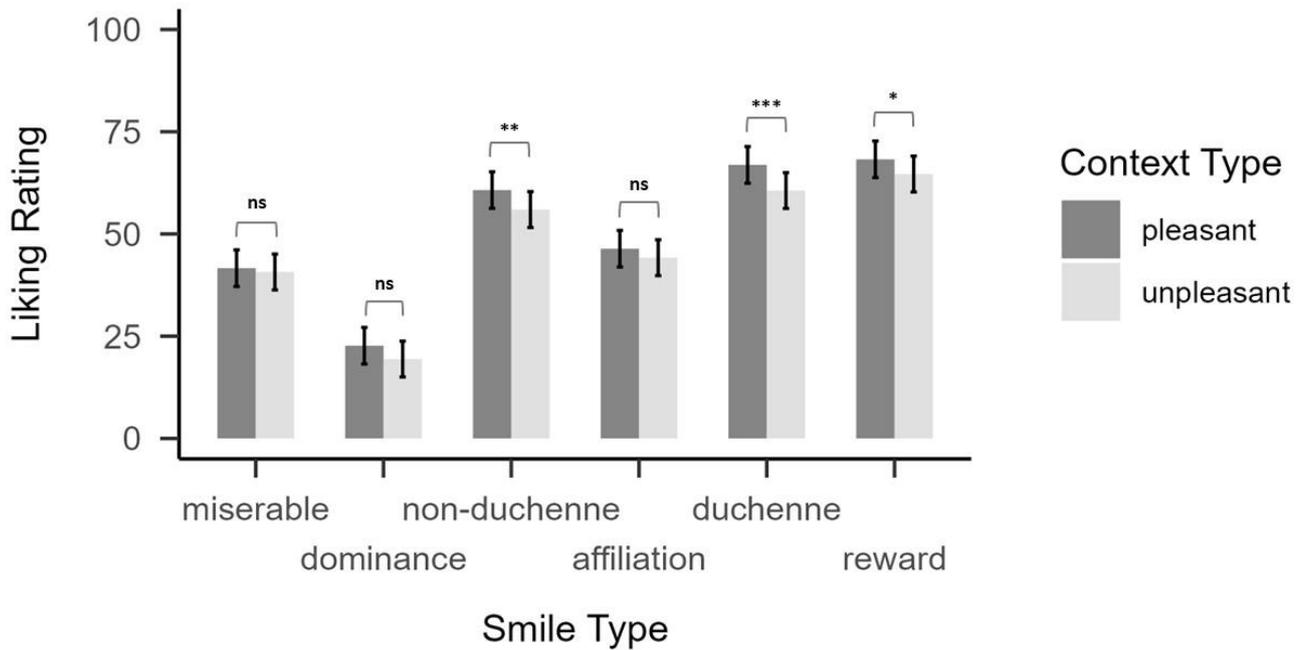
Liking. Results revealed a main effect of smile type on liking ratings, $F(5, 2980.52) = 434.67, p < .001$, such that liking ratings declined as smiles became more “antisocial”. All pairwise comparisons were significant (see Table 5.2). Moreover, there was a main effect of context category, $F(1, 63.99) = 12.48, p < .001$, such that smiles in pleasant contexts ($M = 51.10, 95\% \text{ CI } [47.77, 54.43]$) were rated as showing more liking than smiles in unpleasant contexts ($M = 47.59, 95\% \text{ CI } [44.36, 50.82]$). The interaction between smile type and context category was not significant ($p = .26$). See Figure 5.3 for relevant means and CI’s.

Table 5.2*Inferential Statistics for Comparisons across Smile Types for Liking Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	20.12	1.16	16.71	23.53	17.33	<.001
Miserable - Non-Duchenne	-17.18	1.16	-20.59	-13.77	-14.80	<.001
Miserable - Affiliation	-4.13	1.16	-7.54	-0.72	-3.56	.001
Miserable - Duchenne	-22.59	1.16	-26.00	-19.18	-19.45	<.001
Miserable - Reward	-25.29	1.16	-28.70	-21.87	-21.78	<.001
Dominance - Non-Duchenne	-37.30	1.16	-40.71	-33.89	-32.12	<.001
Dominance - Affiliation	-24.25	1.16	-27.66	-20.84	-20.88	<.001
Dominance - Duchenne	-42.70	1.16	-46.11	-39.29	-36.78	<.001
Dominance - Reward	-45.40	1.16	-48.81	-41.99	-39.10	<.001
Non-Duchenne - Affiliation	13.05	1.16	9.64	16.46	11.24	<.001
Non-Duchenne - Duchenne	-5.41	1.16	-8.82	-1.99	-4.66	<.001
Non-Duchenne - Reward	-8.10	1.16	-11.52	-4.69	-6.98	<.001
Affiliation - Duchenne	-18.46	1.16	-21.87	-15.04	-15.89	<.001
Affiliation - Reward	-21.16	1.16	-24.57	-17.74	-18.22	<.001
Duchenne - Reward	-2.70	1.16	-6.11	0.71	-2.33	.020

Figure 5.3

Interaction Between Context Category and Smile Type for Ratings of Smile Liking. Error Bars: 95% CI



Acknowledgement. Results revealed a main effect of smile type on acknowledgement ratings, $F(5, 64.01) = 55.83, p < .001$, such that acknowledgement ratings broadly declined as smiles became more “antisocial”. All pairwise comparisons were significant (see Table 5.3). Moreover, there was a main effect of context category, $F(1, 64.01) = 17.00, p < .001$, such that smiles in pleasant contexts ($M = 44.53, 95\% \text{ CI } [40.19, 48.86]$) were rated as showing more acknowledgement than smiles in unpleasant contexts ($M = 40.89, 95\% \text{ CI } [36.46, 45.31]$). Finally, the interaction between smile type and context category was also significant, $F(5, 2662.39) = 2.73, p = .018$. Specifically, whilst four smile types were rated as showing significantly more acknowledgement in pleasant contexts than unpleasant contexts, this difference was not found for either miserable or dominance smiles (both $ps > .33$; see Table 5.5). See Figure 5.4 for relevant means and CI’s.

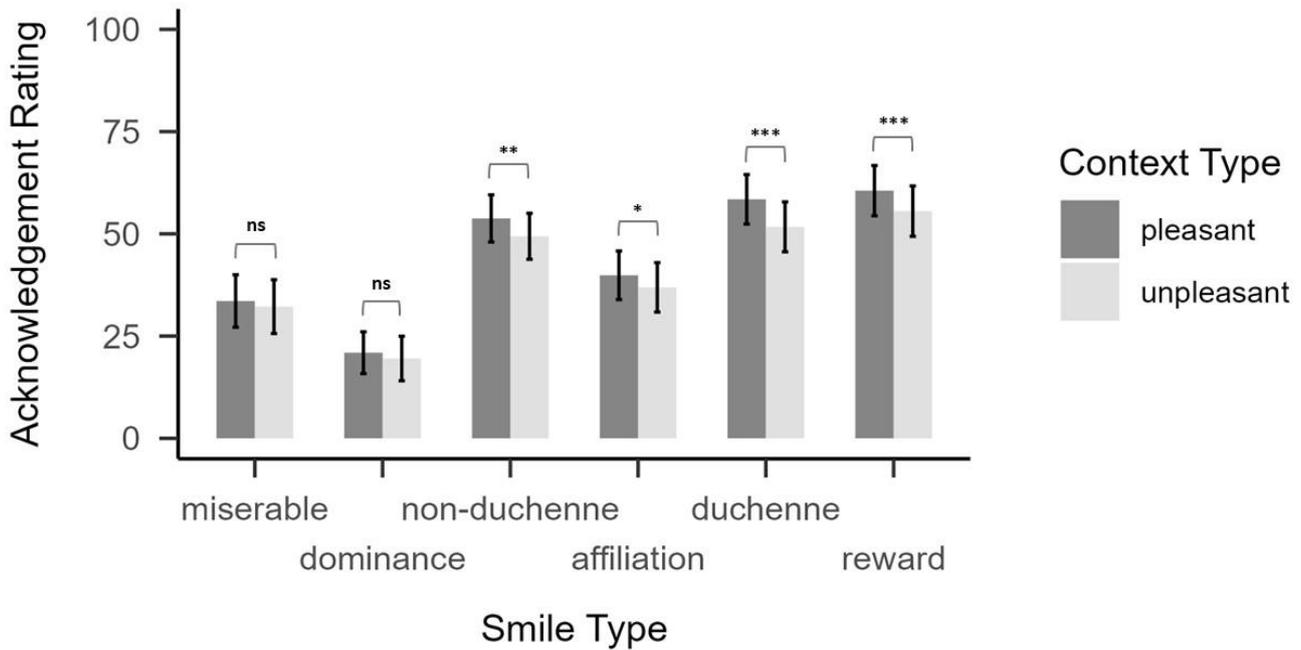
Table 5.3*Inferential Statistics for Comparisons across Smile Types for Acknowledgement Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	12.66	2.34	5.54	19.79	5.42	<.001
Miserable - Non-Duchenne	-18.70	1.97	-24.71	-12.68	-9.48	<.001
Miserable - Affiliation	-5.50	1.45	-9.91	-1.09	-3.80	.001
Miserable - Duchenne	-22.19	2.46	-29.70	-14.68	-9.01	<.001
Miserable - Reward	-25.16	2.49	-32.74	-17.58	-10.12	<.001
Dominance - Non-Duchenne	-31.36	2.18	-38.01	-24.71	-14.38	<.001
Dominance - Affiliation	-18.16	2.18	-24.80	-11.52	-8.35	<.001
Dominance - Duchenne	-34.85	2.23	-41.65	-28.05	-15.63	<.001
Dominance - Reward	-37.83	2.42	-45.20	-30.46	-15.65	<.001
Non-Duchenne - Affiliation	13.20	1.46	8.74	17.65	9.03	<.001
Non-Duchenne - Duchenne	-3.49	1.33	-7.54	0.55	-2.63	.011
Non-Duchenne - Reward	-6.47	1.44	-10.87	-2.06	-4.48	<.001
Affiliation - Duchenne	-16.69	1.92	-22.56	-10.82	-8.67	<.001
Affiliation - Reward	-19.67	1.99	-25.75	-13.59	-9.86	<.001
Duchenne - Reward	-2.98	1.01	-6.06	0.11	-2.94	.009

Figure 5.4

Interaction Between Context Category and Smile Type for Ratings of Smile Acknowledgement.

Error Bars: 95% CI



Politeness. Results revealed a main effect of smile type on politeness ratings, $F(5, 77.61) = 105.96, p < .001$, such that politeness ratings broadly declined as smiles became more “antisocial”. All pairwise comparisons were significant, apart from those between reward, Duchenne, and non-Duchenne smiles (see Table 5.4). Moreover, there was a main effect of context category, $F(1, 64.00) = 4.26, p = .043$, such that smiles in pleasant contexts ($M = 55.06, 95\% \text{ CI } [51.98, 58.14]$) were rated as more polite than smiles in unpleasant contexts ($M = 53.01, 95\% \text{ CI } [49.90, 56.11]$). Finally, the interaction between smile type and context category was also significant, $F(5, 2724.87) = 5.57, p < .001$. Specifically, reward smiles ($p = .008$) and Duchenne smiles ($p < .001$) were rated as more polite in pleasant contexts than unpleasant contexts, but this difference was not significant for all other smile types (all $ps > .08$). See Figure 5.5 for relevant means and CI’s.

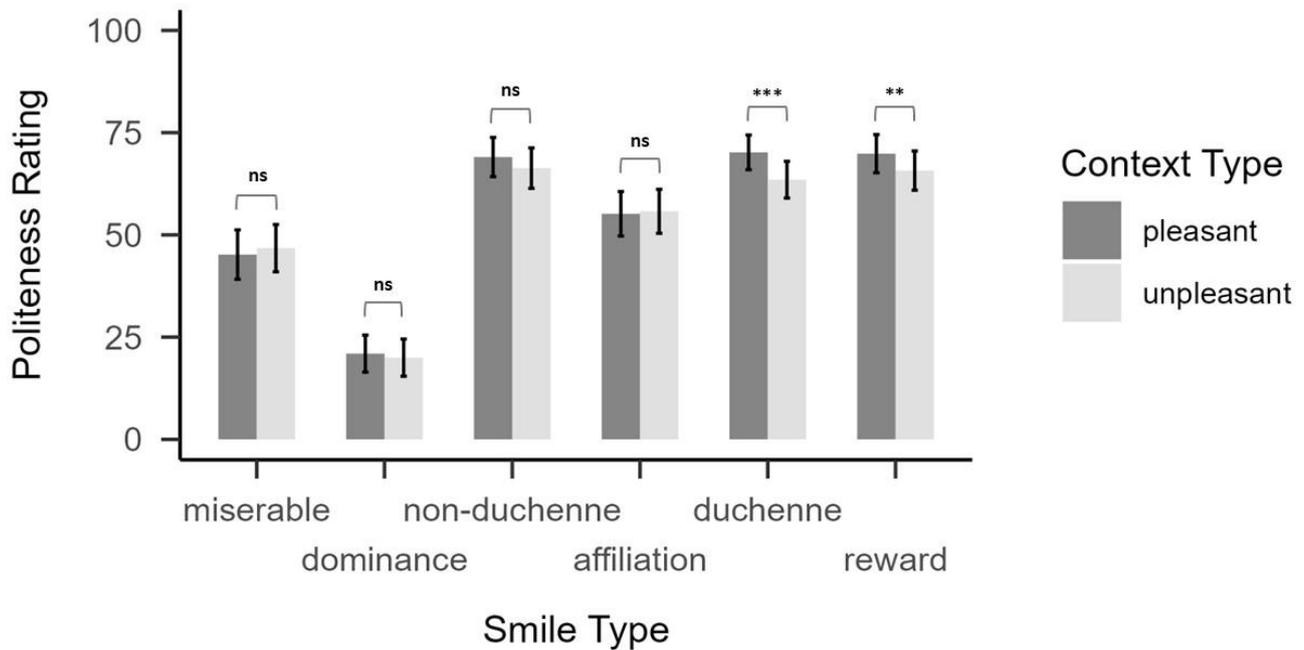
Table 5.4*Inferential Statistics for Comparisons across Smile Types for Politeness Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	25.49	2.92	16.58	34.41	8.72	<.001
Miserable - Non-Duchenne	-21.71	2.44	-29.14	-14.28	-8.91	<.001
Miserable - Affiliation	-9.49	1.88	-15.24	-3.75	-5.04	<.001
Miserable - Duchenne	-20.87	2.52	-28.56	-13.17	-8.27	<.001
Miserable - Reward	-21.82	2.65	-29.91	-13.74	-8.23	<.001
Dominance - Non-Duchenne	-47.20	2.53	-54.92	-39.49	-18.65	<.001
Dominance - Affiliation	-34.99	2.73	-43.33	-26.65	-12.79	<.001
Dominance - Duchenne	-46.36	2.08	-52.70	-40.02	-22.30	<.001
Dominance - Reward	-47.32	2.27	-54.24	-40.39	-20.83	<.001
Non-Duchenne - Affiliation	12.22	1.85	6.57	17.86	6.60	<.001
Non-Duchenne - Duchenne	0.84	1.53	-3.81	5.49	0.55	1.000
Non-Duchenne - Reward	-0.11	1.60	-5.00	4.78	-0.07	1.000
Affiliation - Duchenne	-11.37	1.96	-17.36	-5.39	-5.79	<.001
Affiliation - Reward	-12.33	2.22	-19.10	-5.56	-5.55	<.001
Duchenne - Reward	-0.95	1.01	-3.97	2.06	-0.95	1.00

Figure 5.5

Interaction Between Context Category and Smile Type for Ratings of Smile Politeness. Error

Bars: 95% CI



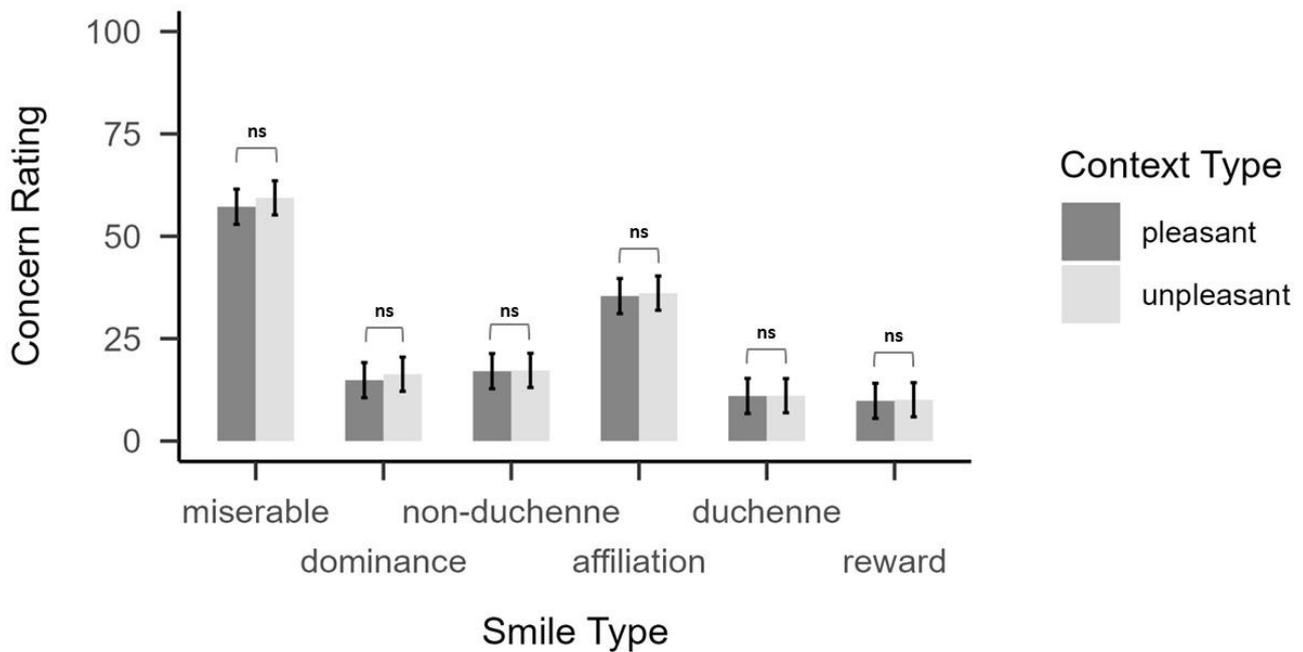
Concern. Results revealed a main effect of smile type on concern ratings, $F(5, 2980.75) = 600.45, p < .001$. Most notably, miserable smiles were rated as showing more concern than all other smile types, although most pairwise comparisons were significant (see Table 5.5). Neither the main effect of context category ($p = .31$) nor the interaction between context category and smile type ($p = .92$) were significant. See Figure 5.6 for relevant means and CI's.

Table 5.5*Inferential Statistics for Comparisons across Smile Types for Concern Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	42.71	1.09	39.50	45.92	39.06	<.001
Miserable - Non-Duchenne	41.14	1.09	37.93	44.35	37.62	<.001
Miserable - Affiliation	22.54	1.09	19.33	25.75	20.61	<.001
Miserable - Duchenne	47.25	1.09	44.04	50.47	43.21	<.001
Miserable - Reward	48.35	1.09	45.14	51.56	44.22	<.001
Dominance - Non-Duchenne	-1.57	1.09	-4.78	1.64	-1.44	.303
Dominance - Affiliation	-20.17	1.09	-23.38	-16.96	-18.44	<.001
Dominance - Duchenne	4.55	1.09	1.33	7.76	4.16	<.001
Dominance - Reward	5.64	1.09	2.43	8.86	5.16	<.001
Non-Duchenne - Affiliation	-18.60	1.09	-21.81	-15.39	-17.01	<.001
Non-Duchenne - Duchenne	6.12	1.09	2.90	9.33	5.59	<.001
Non-Duchenne - Reward	7.21	1.09	4.00	10.43	6.60	<.001
Affiliation - Duchenne	24.71	1.09	21.50	27.93	22.60	<.001
Affiliation - Reward	25.81	1.09	22.60	29.02	23.60	<.001
Duchenne - Reward	1.10	1.09	-2.12	4.31	1.00	.316

Figure 5.6

Interaction Between Context Category and Smile Type for Ratings of Smile Concern. Error Bars: 95% CI



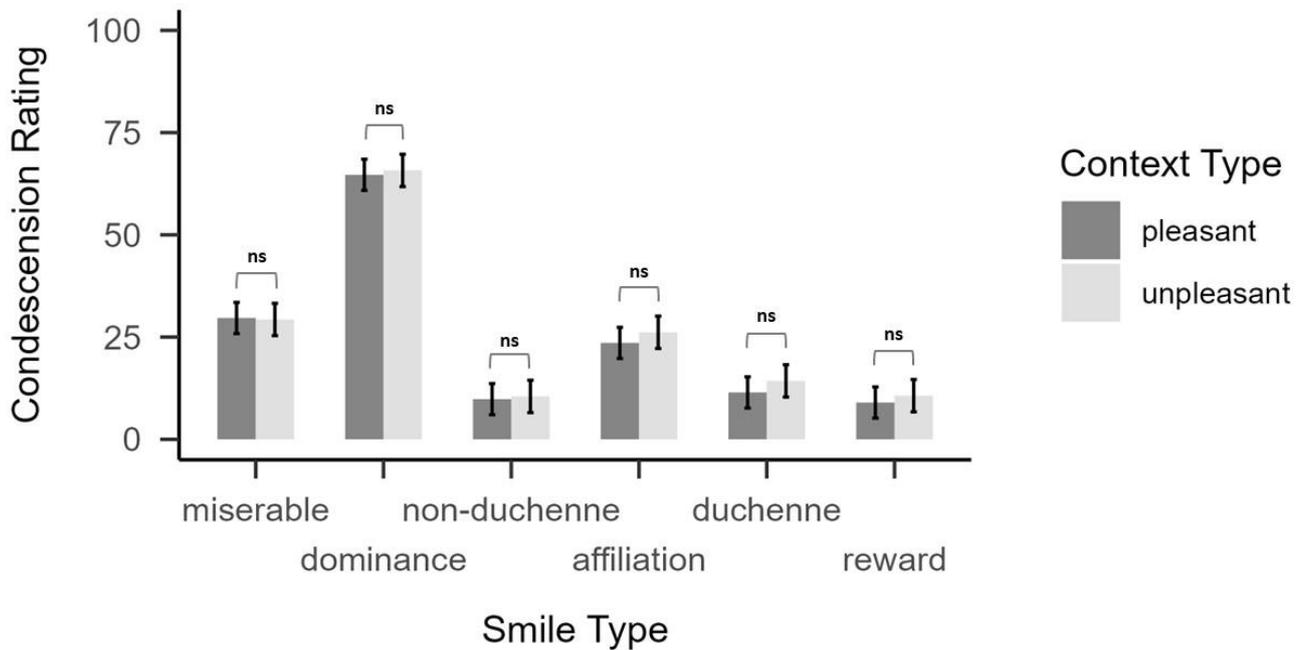
Condescension. Results revealed a main effect of smile type on condescension ratings, $F(5, 2980.70) = 636.39, p < .001$. Most notably, dominance smiles were rated as more condescending than all other smile types, although most pairwise comparisons were significant, apart from those between reward, Duchenne, and non-Duchenne smiles (see Table 5.6). Neither the main effect of context category ($p = .15$) nor the interaction between context category and smile type ($p = .76$) were significant. See Figure 5.7 for relevant means and CI's.

Table 5.6*Inferential Statistics for Comparisons across Smile Types for Contempt Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	-35.73	1.18	-39.21	-32.25	-30.16	<.001
Miserable - Non-Duchenne	19.33	1.18	15.85	22.81	16.31	<.001
Miserable - Affiliation	4.61	1.18	1.13	8.09	3.89	<.001
Miserable - Duchenne	16.61	1.18	13.13	20.09	14.02	<.001
Miserable - Reward	19.65	1.18	16.17	23.13	16.58	<.001
Dominance - Non-Duchenne	55.06	1.18	51.58	58.54	46.47	<.001
Dominance - Affiliation	40.34	1.18	36.86	43.83	34.05	<.001
Dominance - Duchenne	52.34	1.18	48.86	55.82	44.17	<.001
Dominance - Reward	55.38	1.18	51.90	58.86	46.74	<.001
Non-Duchenne - Affiliation	-14.72	1.19	-18.20	-11.24	-12.42	<.001
Non-Duchenne - Duchenne	-2.72	1.18	-6.21	0.76	-2.30	.043
Non-Duchenne - Reward	0.32	1.19	-3.16	3.80	0.27	.788
Affiliation - Duchenne	11.99	1.18	8.51	15.48	10.12	<.001
Affiliation - Reward	15.04	1.19	11.56	18.52	12.69	<.001
Duchenne - Reward	3.04	1.18	-0.44	6.52	2.57	.031

Figure 5.7

Interaction Between Context Category and Smile Type for Ratings of Smile Condescension. Error Bars: 95% CI



Inclusion of Other in Self (IOS). Results revealed a main effect of smile type on IOS ratings, $F(5, 64.00) = 49.38, p < .001$, such that IOS ratings declined as smiles became more “antisocial”. All but two pairwise comparisons were significant (see Table 5.7). Moreover, there was a main effect of context category, $F(1, 63.99) = 7.76, p = .007$, such that smiles in pleasant contexts ($M = 28.18, 95\% \text{ CI } [25.12, 31.24]$) received higher IOS ratings than smiles in unpleasant contexts ($M = 25.82, 95\% \text{ CI } [22.82, 28.82]$). The interaction between smile type and context category was not significant ($p = .18$). See Figure 5.8 for relevant means and CI’s.

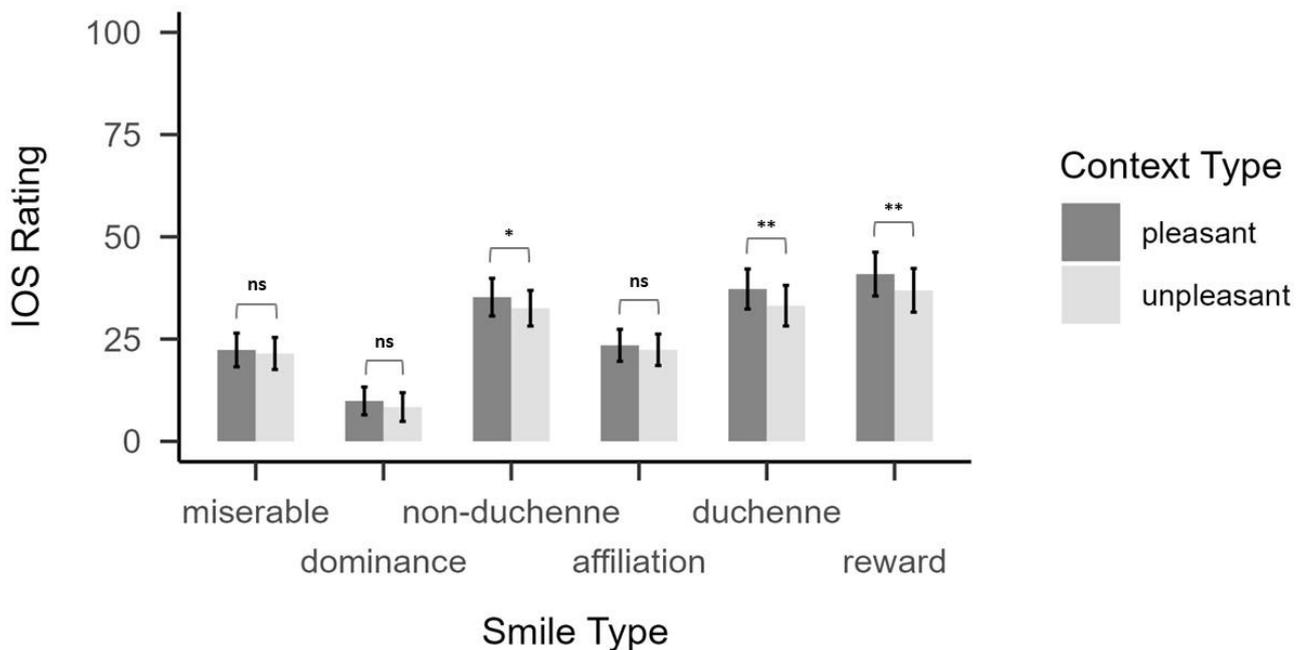
Table 5.7*Inferential Statistics for Comparisons across Smile Types for Inclusion of Other in Self (IOS)**Ratings*

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	12.78	1.35	8.67	16.89	9.48	<.001
Miserable - Non-Duchenne	-11.99	1.59	-16.83	-7.14	-7.54	<.001
Miserable - Affiliation	-1.02	1.13	-4.47	2.44	-0.90	.741
Miserable - Duchenne	-13.29	2.07	-19.60	-6.98	-6.42	<.001
Miserable - Reward	-17.00	2.09	-23.38	-10.62	-8.13	<.001
Dominance - Non-Duchenne	-24.77	1.75	-30.10	-19.43	-14.16	<.001
Dominance - Affiliation	-13.80	1.32	-17.81	-9.78	-10.48	<.001
Dominance - Duchenne	-26.07	1.91	-31.89	-20.26	-13.67	<.001
Dominance - Reward	-29.78	2.16	-36.35	-23.20	-13.81	<.001
Non-Duchenne - Affiliation	10.97	1.29	7.03	14.90	8.50	<.001
Non-Duchenne - Duchenne	-1.31	1.45	-5.72	3.11	-0.90	.741
Non-Duchenne - Reward	-5.01	1.48	-9.52	-0.51	-3.39	.004
Affiliation - Duchenne	-12.27	1.68	-17.39	-7.16	-7.32	<.001
Affiliation - Reward	-15.98	1.77	-21.39	-10.57	-9.01	<.001
Duchenne - Reward	-3.71	1.06	-6.94	-0.47	-3.49	.004

Figure 5.8

Interaction Between Context Category and Smile Type for Inclusion of Other in Self (IOS)

Ratings. Error Bars: 95% CI



Mimicry

LMMs were constructed to assess the effect of both smile type (six levels: reward vs Duchenne vs affiliation vs non-Duchenne vs dominance vs miserable) and context category (two levels: pleasant vs unpleasant) on (1) the mean of zygomaticus and orbicularis mimicry, and (2) corrugator activity.

Zygomatic and Orbicularis. A main effect of context category was found, $F(1, 3044.2) = 4.47, p = .035$, such that smiles in pleasant contexts ($M = 0.17, 95\% \text{ CI } [0.09, 0.25]$) were mimicked to a greater extent than smiles in unpleasant contexts ($M = 0.10, 95\% \text{ CI } [0.02, 0.19]$). In addition, there was a main effect of smile type on mimicry, $F(5, 3044.0) = 13.51, p < .001$. Results broadly showed that mimicry declined as smiles became more “antisocial”. For example, reward ($M = 0.32, 95\% \text{ CI } [0.22, 0.41]$) and Duchenne ($M = 0.28,$

95% CI [0.18, 0.38]) smiles were mimicked to a greater extent than affiliation ($M = 0.04$, 95% CI [-0.06, 0.14]) and dominance ($M = 0.05$, 95% CI [-0.05, 0.15]) smiles. Similarly, non-Duchenne ($M = 0.15$, 95% CI [0.05, 0.25]) smiles were mimicked more than miserable smiles ($M = -0.02$, 95% CI [-0.12, 0.08]). See Table 5.8 for inferential statistics and p-values of comparisons. The interaction between smile type and context category was not significant ($p = .95$). See Figure 5.9 for relevant means and CIs.

Table 5.8

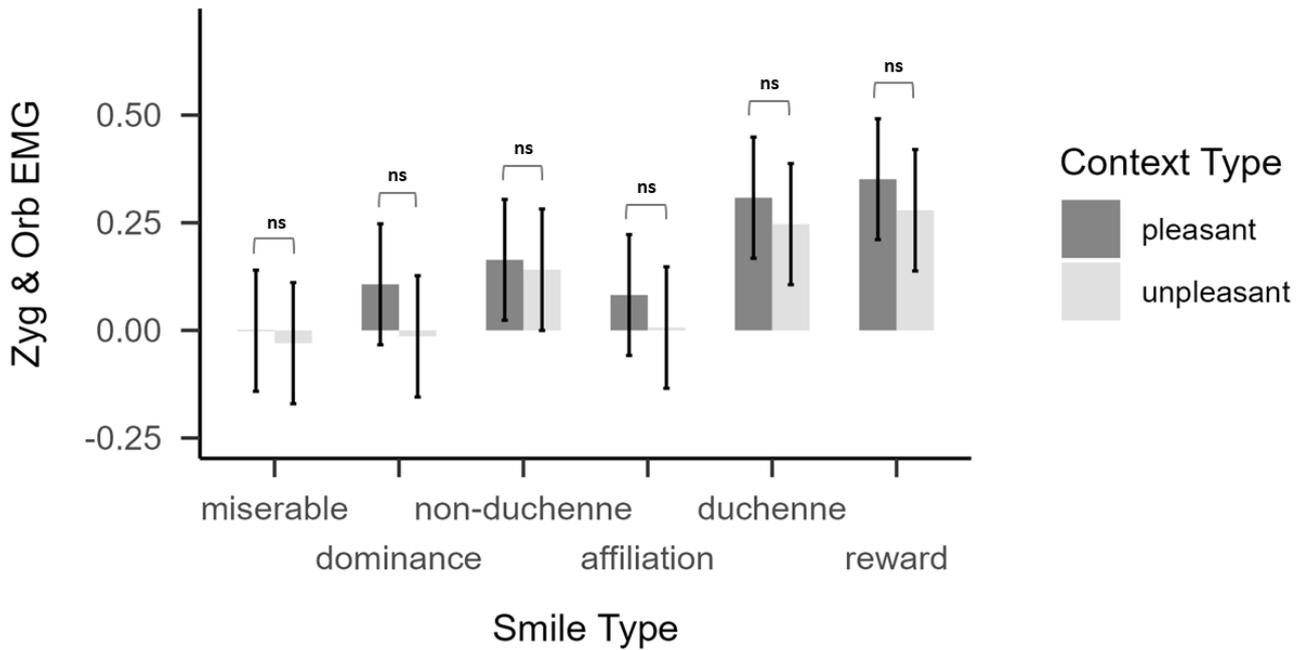
Inferential Statistics for Comparisons across Smile Types for the Mean of Zygomaticus and Orbicularis EMG Activity

Comparison	Estimate	SE	Lower CL	Upper CL	<i>t</i>	<i>p</i>
Miserable - Dominance	-0.06	0.05	-0.21	0.09	-1.19	.942
Miserable - Non-Duchenne	-0.17	0.05	-0.32	-0.01	-3.22	.012
Miserable - Affiliation	-0.06	0.05	-0.21	0.09	-1.15	.942
Miserable - Duchenne	-0.29	0.05	-0.45	-0.14	-5.62	<.001
Miserable - Reward	-0.33	0.05	-0.48	-0.18	-6.34	<.001
Dominance - Non-Duchenne	-0.10	0.05	-0.26	0.05	-2.03	.229
Dominance - Affiliation	0.00	0.05	-0.15	0.16	0.04	.966
Dominance - Duchenne	-0.23	0.05	-0.38	-0.08	-4.43	<.001
Dominance - Reward	-0.27	0.05	-0.42	-0.12	-5.16	<.001
Non-Duchenne - Affiliation	0.11	0.05	-0.05	0.26	2.07	.229
Non-Duchenne - Duchenne	-0.13	0.05	-0.28	0.03	-2.40	.115
Non-Duchenne - Reward	-0.16	0.05	-0.32	-0.01	-3.12	.014
Affiliation - Duchenne	-0.23	0.05	-0.39	-0.08	-4.48	<.001
Affiliation - Reward	-0.27	0.05	-0.42	-0.12	-5.20	<.001

Duchenne - Reward -0.04 0.05 -0.19 0.12 -0.72 .942

Figure 5.9

Mean of Zygomaticus and Orbicularis EMG Activity by Smile Type and Context Category. Error Bars: 95% CI



Corrugator. A main effect of context category was found, $F(1, 3044.2) = 7.07, p = .008$, such that smiles in pleasant contexts ($M = 0.04, 95\% \text{ CI } [-0.03, 0.12]$) were mimicked to a greater extent than smiles in unpleasant contexts ($M = -0.04, 95\% \text{ CI } [-0.11, 0.04]$). In addition, there was a main effect of smile type on mimicry, $F(5, 3044) = 22.15, p < .001$. Results broadly showed that corrugator mimicry increased as smiles became more “antisocial”. For example, miserable ($M = 0.26, 95\% \text{ CI } [0.17, 0.36]$) and dominance ($M = 0.16, 95\% \text{ CI } [0.07, 0.26]$) smiles led to greater corrugator mimicry than reward ($M = -0.16, 95\% \text{ CI } [-0.25, -0.06]$), Duchenne ($M = -0.16, 95\% \text{ CI } [-0.25, -0.06]$), affiliation ($M = -0.01, 95\% \text{ CI } [-0.11, 0.08]$), and non-Duchenne ($M = -0.07, 95\% \text{ CI } [-0.16, 0.02]$) smiles. See Table 5.9 for inferential statistics and p-values of comparisons. The interaction between smile

type and context category was not significant ($p = .97$). See Figure 5.10 for relevant means and CIs.

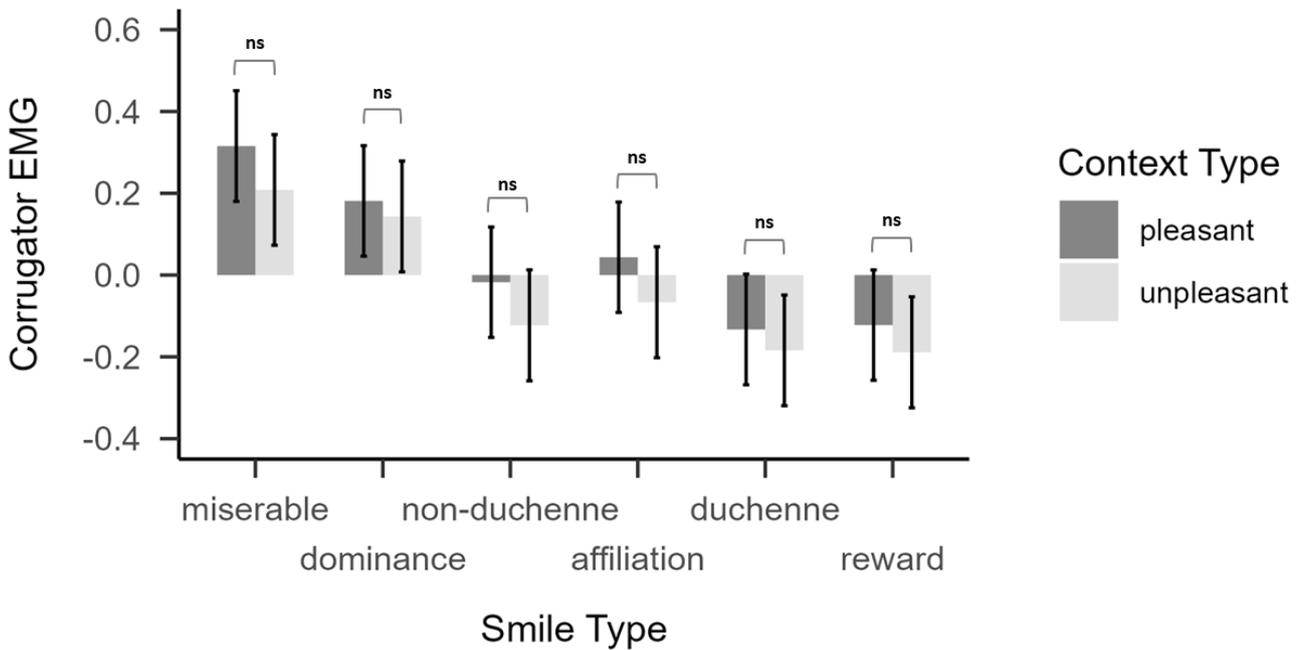
Table 5.9

Inferential Statistics for Comparisons across Smile Types for Corrugator EMG Activity

Comparison	Estimate	SE	Lower CL	Upper CL	t	p
Miserable - Dominance	0.10	0.05	-0.05	0.25	1.91	.277
Miserable - Non-Duchenne	0.33	0.05	0.18	0.48	6.40	<.001
Miserable - Affiliation	0.27	0.05	0.12	0.43	5.27	<.001
Miserable - Duchenne	0.42	0.05	0.27	0.57	8.10	<.001
Miserable - Reward	0.42	0.05	0.26	0.57	8.04	<.001
Dominance - Non-Duchenne	0.23	0.05	0.08	0.39	4.48	<.001
Dominance - Affiliation	0.17	0.05	0.02	0.33	3.35	.007
Dominance - Duchenne	0.32	0.05	0.17	0.47	6.18	<.001
Dominance - Reward	0.32	0.05	0.17	0.47	6.13	<.001
Non-Duchenne - Affiliation	-0.06	0.05	-0.21	0.09	-1.13	.515
Non-Duchenne - Duchenne	0.09	0.05	-0.06	0.24	1.70	.355
Non-Duchenne - Reward	0.09	0.05	-0.07	0.24	1.64	.355
Affiliation - Duchenne	0.15	0.05	-0.01	0.30	2.84	.032
Affiliation - Reward	0.14	0.05	-0.01	0.30	2.78	.033
Duchenne - Reward	0.00	0.05	-0.16	0.15	-0.06	.954

Figure 5.10

Corrugator EMG Activity by Smile Type and Context Category. Error Bars: 95% CI



Exploratory Analyses

Finally, multiple exploratory three-way LMMs were constructed with additional predictor variables, in order to assess potential extraneous influences on the mimicry of zygomaticus and orbicularis activity.

Inclusion of Other in the Self (IOS). Results revealed a main effect of IOS ratings on mimicry, $F(1, 2587) = 18.34, p < .001$, such that mimicry was significantly higher when participants gave higher IOS ratings. Moreover, after adding IOS as an additional predictor, neither the main effect of smile type ($p = .13$) nor the main effect of context category ($p = .09$) remained significant. No interactions were significant (all $ps > .65$).

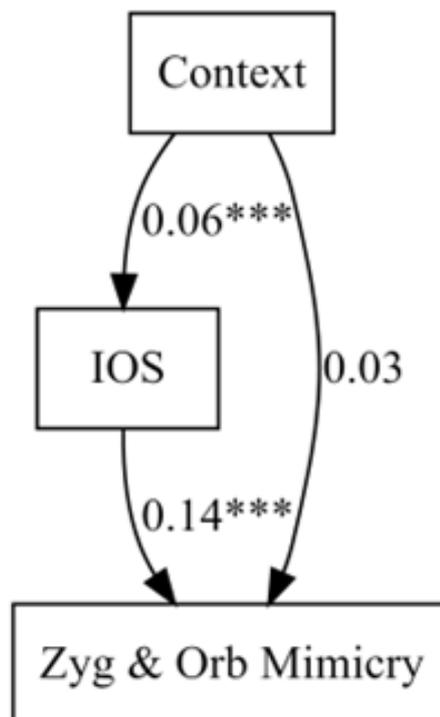
No other exploratory predictors had significant effects on mimicry pattern scores. This included participant gender, avatar gender, avatar realism ratings, environmental realism ratings, and headset fit.

Multi-Level Mediation Analyses

Context Effect. Given the significant effects of IOS on zygomaticus/orbicularis mimicry, I conducted a multilevel mediation analysis using structural equation modelling (SEM) in lavaan (Rosseel, 2012) to examine whether IOS scores mediated the relationship between context category and mimicry. The direct effect of context category on mimicry was not statistically significant ($p = .106$). However, context category significantly predicted IOS ratings ($p < .001$) and IOS ratings significantly predicted mimicry ($p < .001$). Consequently, the indirect effect of context category on mimicry via IOS was statistically significant ($p = .001$), indicating that IOS partially mediated this relationship. These findings suggest that while context does not directly influence mimicry, it indirectly enhances mimicry through increased interpersonal closeness. See Figure 5.11 for a diagram of this mediation.

Figure 5.11

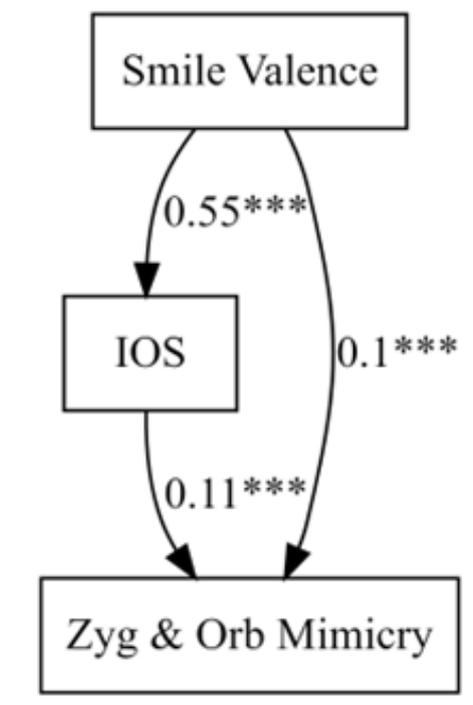
Mediation of Context Effect by IOS Rating. All Values Standardised



Smile Effect. In addition, I also conducted a further multilevel mediation analysis to examine whether IOS scores mediated the relationship between smile type and mimicry. To do this, I grouped Duchenne and reward smiles into one category (“positive valence”) and dominance and miserable smiles into another category (“negative valence”). The model showed that smile valence significantly predicted IOS ratings ($p < .001$), and IOS ratings significantly predicted mimicry ($p < .001$). Consequently, the indirect effect of smile valence on mimicry via IOS was significant ($p < .001$), indicating that IOS mediated this relationship. Moreover, the direct effect of face valence on mimicry also remained significant ($p < .001$), indicating that face valence influenced mimicry independently of IOS. These results suggest that IOS partially mediates the relationship between face valence and mimicry, with participants being more likely to mimic positive faces both due to increased perceived closeness and a direct effect of valence. See Figure 5.12 for a diagram of this mediation.

Figure 5.12

Mediation of Smile Effect by IOS Rating. All Values Standardised



General Discussion

Overall, these findings show that situational context influences participant responses to smiles, both in terms of mimicry and socio-functional evaluations. This supports the idea that the smile and context effects established in previous chapters are generalisable to real-world social environments. Supporting Hypothesis 1, I found that zygomaticus and orbicularis mimicry broadly declined as smiles became more “antisocial”, whereas corrugator mimicry increased. Importantly, Hypothesis 2 was also supported, as smiles presented in pleasant contexts were mimicked more than those presented in unpleasant contexts, across all muscles. Contrary to Hypothesis 3, there was no interaction between smile type and context category.

Regarding the socio-functional evaluations, Hypotheses 4, 6, and 7 were all supported. Reward/Duchenne smiles were rated as conveying more joy and more liking than all other smile types, whilst dominance smiles and miserable smiles respectively conveyed more condescension and more concern than all other smile types. Hypothesis 5 was not supported, as affiliation/non-Duchenne smiles did not convey more politeness or more acknowledgment than reward and Duchenne smiles. Importantly, context significantly influenced ratings of joy, liking, acknowledgement, and politeness, such that smiles were rated higher across all these measures when seen in pleasant contexts than unpleasant contexts.

In line with Hypothesis 8, reward/Duchenne smiles led to higher interpersonal closeness than affiliation/non-Duchenne smiles, which in turn led to higher interpersonal closeness than dominance/miserable smiles. In support of Hypothesis 9, pleasant contexts led to higher interpersonal closeness than unpleasant contexts. However, contrary to Hypothesis 10, there was no interaction between smile type and context category on IOS ratings.

Together, these findings lend further support to Hess and Fischer's (2013; 2014; 2016; 2022) Emotional Mimicry in Social Context theory, which proposes that mimicry is an affiliative process that is both influenced by and facilitates affiliation motivation (Hess & Fischer, 2013). First, as anticipated, I observed greater mimicry of more prosocial facial expressions relative to more antisocial expressions (Bourgeois & Hess, 2008; Surakka & Hietanen, 1998) — at least in terms of zygomaticus and orbicularis activity. This relationship was partly mediated by Inclusion of the Other in the Self (IOS) ratings (Aron et al., 1992), such that participants were more likely to mimic the more positive prosocial smiles due to the feeling of increased perceived closeness facilitated by these smile types. However, smile valence also directly affected subsequent mimicry even without IOS mediation, suggesting that the more positive smiles can automatically facilitate facial mimicry, regardless of one's motive to affiliate with the expresser. This is consistent with a large body of previous work showing the strong positive social power of Duchenne and reward smiles (e.g. Campos et al., 2015; Chang et al., 2014; Shore & Heerey, 2011). Moreover, it adds to the growing body of research — including previous chapters of this thesis — indicative of clear differences between different socio-functionally defined smile types (e.g. Martin et al., 2018; 2021; Rychlowska et al., 2017; 2021). Notably, I found that participants approached reward smiles faster than dominance smiles but avoided them more slowly. The present study complements the latter research by showing differences between smile types along another non-explicit response variable: mimicry. Both the extent and nature of the mimicry was affected, as my preliminary muscle-by-muscle EMG analysis showed different patterns of face muscle activity when mimicking different smile types. Broadly, mimicry of the more prosocial smiles involved greater corrugator and orbicularis activity, whereas mimicry of the more antisocial smiles involved greater corrugator activity.

Interestingly, participants mimicked smiles to a greater extent when immersed within pleasant virtual environments than unpleasant virtual environments. This builds on Kirkham et al. (2015) and Kastendieck et al. (2021), to show that context influences mimicry of more nuanced and naturalistic expressions as well as prototypical emotional expressions. This context effect also aligns with Hess and Fischer's model, which predicts that smiles should be mimicked more in pleasant contexts. Specifically, it is likely that when smiles were perceived within pleasant contexts: (1) the smile was interpreted as more congruent with the environment, and hence more affiliative than when seen in unpleasant contexts (see Brambilla et al., 2018), and (2) the environment was more suited towards facilitating affiliation with an expresser (Fredrickson, 1998; Rosa, 2021). Given that dominance and miserable smiles are not especially congruent with pleasant contexts, the latter explanation likely explains mimicry of the more antisocial smile types, whilst the former likely explains mimicry of the prosocial smile types.

The overall importance of affiliative motive for subsequent mimicry was further supported by the mediation of the context effect on zygomaticus and orbicularis mimicry by participant ratings on the IOS scale. This analysis indicates that when placed within pleasant contexts, participants felt closer / more affiliated to expressers than when placed within unpleasant contexts. In turn, this closeness facilitated greater mimicry of the smiles.

Although the IOS mediation determines the extent to which interpersonal closeness affects subsequent mimicry, it does not fully elucidate the automaticity of the context effect. On one hand, given that the effect was mediated by a latent variable ("closeness") measured using an explicit numerical rating, it is possible that the mediating effect of interpersonal closeness was at least partly conscious. Such a process would be entirely plausible given that mimicry happens across a timescale of a few seconds (e.g. Chartrand & Bargh, 1999), which leaves time available for conscious cognitions to influence facial activity. This process is also

consistent with a body of previous evidence including Chapter 2 and 3, showing that context affects explicit evaluations of smiles when participants are given unlimited time to respond (e.g. Gagnon et al., 2022; Mui et al., 2020; Namba et al., 2020). In particular, as shown in Chapter 3, some of these studies have demonstrated that context effects clearly depend upon cognitive deliberation, whereby the meaning of the facial expression is consciously interpreted in light of the context (e.g. see also: Hess & Hareli, 2016).

On the other hand, the IOS mediation more likely reflects an unconscious drive to affiliate, facilitated by the positive virtual environment. A wealth of evidence indicates that imitation responses are usually quick and automatic (e.g., Arnold & Winkielman, 2020; Dimberg, et al., 2000; 2002; Dimberg & Thunberg, 1998; Korb et al., 2010; Philip et al., 2018). In addition, empirical work suggests that face-context integration can occur very quickly, without time for conscious processing. For example, expression-context congruency affects the amplitude of the N170 ERP component, which occurs fewer than 200 ms after stimulus onset (Aguado et al., 2019; Dieguez-Risco et al., 2015). Likewise, in Chapter 4 I found that context affected reaction times of speeded approach-avoidance responses to different smile types. As a result, it is possible that an automatic computation of face-context congruency implicitly affected the desire to affiliate, which in turn affected participants' subsequent mimicry responses. Additionally, the increased interpersonal closeness may have been automatically primed by the positive context itself (irrespective of the facial expression), which in turn predisposed affiliative motivation without relying on conscious thought (e.g. Rosa, 2021). The current study is unable to differentiate between these mechanisms.

There are potential problems with some of these interpretations. First, one could argue that because mimicry is conducive to affiliation as well as influenced by it, participants rated themselves as closer to the expressers in pleasant contexts *because* they mimicked them

more. The mediation analysis cannot easily distinguish between these two explanations. Relatedly, because the IOS measure is post hoc and reliant upon self-reflection, it may not be entirely reliable (e.g. Robinson & Clore, 2002). However, regardless of the exact contributions of different psychological mechanisms, the important and novel finding remains that the situational context influences the mimicry of smiles.

Even though the rest of my thesis has focused on the three SIMS three smile types — reward, affiliation, and dominance (Niedenthal et al., 2010; Rychlowska et al., 2017) — the present study presented an additional three smile types that had previously been described by Hess et al. (2002) — Duchenne, non-Duchenne, and miserable. As with the SIMS classification, these additions were intended to potentially capture additional social functions that may exist either within or outside of the categories proposed by the SIMS model. As shown by the ratings data, both the non-Duchenne and miserable smiles appeared to be processed differently to other smile types. The non-Duchenne smile was rated as significantly more joyful, liking, polite, and acknowledging than the affiliation smile, but less concerned and less condescending. Likewise, the miserable smile was rated as displaying far more concern than any other smile type. Therefore, whilst the present study provides further evidence of meaningful differences between how the SIMS smiles are processed, it also highlights a key limitation of any smile classification system. Specifically, deciding how many smile categories to include in a model is a somewhat arbitrary decision given the overlap between smile types (see Ekman, 1985, for discussion). However, as outlined by the original proponents of the SIMS smile set, the three smile types align with fundamental human needs that arise within the social environment and thus have a conceptual coherence.

In line with previous work (e.g. Niedenthal et al., 2001; Stel and van Knippenberg., 2008), the present findings offer partial support for the traditional Embodied Simulation theory of facial expression recognition. In particular, the muscle-by-muscle analysis showed

that mimicry of the different smile types was characterised by different patterns of face muscle activity, both in terms of its extent and nature. These mimicry patterns corresponded with the patterns of muscle activation that characterised the smiles displayed by the avatars themselves. For example, mimicry of the miserable smile involved high levels of corrugator activity relative to zygomaticus, whereas mimicry of the reward smile showed the opposite pattern. This is somewhat in-line with the suggestion of Niedenthal et al. (2010, p. 421), who argued that perceivers can “distinguish between the three functional smile categories in terms of the feelings they generate in the perceiver”. Although this study was not able to quantify the relative contributions of mimicry versus cognition in enabling participants to identify the social meanings of the smiles they saw, it is certainly possible that mimicry played a role in this process.

Methodologically, the present study represents a significant improvement on past research, which typically involves presenting static stimuli on a screen. This traditional set-up fails to tap into certain aspects of actual face-to-face behaviour which drive social outcomes (Slater, 2003; Thompson; 2010). Using VR embeds participants within the external environment and therefore provides them with “affordances” — opportunities encountered as they traverse and manipulate the world around them (Gibson, 1986). In addition, using EMG to measure mimicry enables assessment of the influence of embodied “non-mental” physiological bodily processes. VR as a methodology has the advantage of retaining a high level of control — a common shortcoming of face-to-face experimental set-ups (Kothgassner & Felnhofer, 2020; Slater & Sanchez-Vives, 2016).

Furthermore, this research has practical real-world relevance. Mimicry has various positive effects on social interaction (e.g. Dimberg & Thunberg, 2012; Drimalla et al., 2019), and when mimicry is blocked or disturbed, the smoothness of the interaction (“interactional flow”) is harmed (Oberman et al., 2007; Mauersberger & Hess, 2019; Rychlowska et al.,

2014). These findings suggest that alterations of situational ambience or “vibe” could have considerable effects on social interaction quality (see Dai & Zheng, 2021), likely mediated by mimicry. Future research should study how manipulating context in this way affects downstream social outcomes.

There are some limitations of the present experimental set-up. First, smile expressions were programmed onto the faces of avatars, rather than using videos/images from smile databases. Moreover, to ensure consistency across trials, each expression unfolded over the same length of time (1.5 seconds). This masked any effects of variations in expression length, such as differences in onset/offset times (see Krumhuber et al., 2013, Krumhuber et al., 2023, for reviews). Together, these two constraints meant that the smiles seen by participants were more artificial than those seen in everyday life. In turn, this may have contributed to an “uncanny valley” effect (Mori et al., 2012), which a small number of participants mentioned in the post-experiment debrief. This suspicion is somewhat supported by participants’ lukewarm ratings of avatar realism ($M = 64.12$). The uncanny valley effect may have in turn reduced facial mimicry of expressions.

In addition, a considerable proportion of participants reported discomfort from wearing the heavy VR headset, which was weighed down by internal EMG equipment. This is reflected by the participants’ relatively low ratings of headset fit ($M = 62.74$). During pre-experiment piloting I noted that headset comfort substantially declined over time and therefore I limited the number of trials per participant to 48. One disadvantage of this decision was that it limited the statistical power available for within-smile comparisons, given that participants saw only four instances of each smile type within each virtual context. Low power may explain why — despite finding a main effect of context — none of the within-smile context comparisons were significant. The present paper represents a

methodological advancement in this field, however further research testing these ideas in dyadic in-person face-to-face experimental set-ups is needed to provide convergent evidence.

Conclusion

To conclude, the present research shows that mimicry of smiles depends upon both the social function of the smile, as well as the situational context that the observer perceives the smile within. Specifically, smiles are mimicked to a greater extent when their function is more prosocial and affiliative. Moreover, mimicry is increased when the surrounding environment is pleasant rather than unpleasant. Importantly however, the influence of the situation on mimicry may be mediated by the observer's feelings of closeness towards the expresser. Overall, these findings provide convincing support for the Emotional Mimicry in Social Context theory, which proposes that mimicry is an intrinsically affiliative process.

CHAPTER 6: GENERAL DISCUSSION

Overall Summary

For this thesis, I conducted a series of experiments which investigated the broad research question: **how do morphological and contextual cues combine to influence the processing of social smiles?** To do this, I presented reward, affiliation, and dominance smiles from the Simulation of Smiles (SIMS) face set (Niedenthal et al., 2010; Rychlowska et al., 2017) within either positive, polite, or negative situational contexts, across a variety of experimental paradigms.

In Chapter 2, I investigated how contextual cues affected explicit social evaluations of smiles, as well as how different smile types affected explicit evaluations of situational contexts. This was tested using both simple rating scales and an economic Trust Game (Berg et al., 1995). In Chapter 3, I attempted to uncover the underlying psychological mechanisms that influence how smiles and contexts are combined by recording participants' attentional eye fixations and response times as they viewed face-in-context videos. In Chapter 4, I assessed whether morphological and contextual cues implicitly affected subsequent behavioural responses to smiles. To do this, I conducted four speeded approach-avoidance experiments, whilst changing the dimension of the stimulus that participants were instructed to respond to. Finally, in Chapter 5, I determined whether the effects of context and morphology found in previous chapters could be generalised to scenarios more equivalent to real-life social interactions. Participants were immersed into pleasant or unpleasant virtual environments, and I measured the extent to which they mimicked the smiles displayed by virtual avatars.

Taken together, the results of these studies showed that morphological and contextual cues jointly influence explicit and implicit evaluations of smiles. Moreover, as anticipated,

situational context and smiles are reciprocally related, with the potential to influence the interpretation of one another. However, the influence of face and context information depends to a considerable extent upon the relative ambiguity of the different social cues, as well as the nature of the context and the demands of the situation upon the perceiver.

The following General Discussion chapter addresses the specific findings of each empirical chapter and then places the results within the context of existing psychological literature.

How do morphological and contextual cues affect explicit social evaluations of smiles and contexts?

My first empirical chapter investigated how different situational contexts affected explicit ratings of different types of smiles. This research question was inspired by a body of work showing that context substantially affects participants' ratings and categorisations of facial expressions (see Wieser & Brosch., 2012, for a review). To build on this literature, I intended to obtain initial evidence showing that social evaluations of socio-functionally defined smile types were also susceptible to the influence of situational context. In addition, I also aimed to determine the extent to which evaluations of different situations were influenced by types of smiles seen within them (i.e. the reverse relationship). This question was motivated by a related body of research showing that the relationship between context and facial expressions is likely bidirectional (Hess et al., 2020). Emotional facial expressions have been shown to influence evaluations of body language (e.g. Kret et al., 2013; Lecker et al., 2020) and the behaviours of others (Hess et al., 2018; 2020).

This research was important because almost all previous work had investigated how context affects emotional evaluations of prototypical “Basic Emotion” expressions (Ekman et al., 1969) rather than smiles — even though the former do not occur often (e.g. Reisenzein et

al., 2006) and the latter are seen more frequently seen within naturalistic social interaction (e.g. Hess & Bourgeois, 2010). Moreover, of the few studies that investigated context effects on smile ratings, only one examined the effects of context across different smile types, and these authors manipulated dispositional rather than situational information (Gagnon et al., 2022). Similarly, no previous study had investigated whether smiles affect evaluations of situational context, and it remained unclear how these evaluations may differ across smile types.

To address effects on explicit evaluations, I conducted three separate studies. In Study 1, participants rated reward, affiliation, and dominance smiles along a range of social dimensions. I tested whether ratings of these smiles altered when the smile was seen within either positive, neutral, or negative contexts. In Study 2, I presented participants with the same stimuli, but they rated the situations rather than expressions using equivalent rating scales. Finally, in Study 3, I tested whether any effects of context or smile type would be more apparent when participants played a “Trust Game” with hypothetical interaction partners. During the game, participants were given the opportunity to invest some proportion of points with a smiling partner, based on the understanding that (1) the investment would be tripled, and (2) that the hypothetical partner would have the opportunity to return some proportion of the invested points.

Findings

In sum, I found the hypothesised bidirectional relationship between smiles and contexts. In Study 1, context significantly affected participants’ explicit social evaluations of smiles. Conversely, in Study 2, participants’ evaluations of situational contexts were significantly influenced by the smile type that accompanied them. Finally, a similar pattern of results was found for hypothetical investments in Study 3. Importantly, although smile type had an independent effect on explicit ratings and investment decisions, in both Study 2 and

Study 3 the effect of smile type was absent or attenuated in negative situations. This suggested that the social influence of smiles was limited by the surrounding negative context.

What psychological mechanisms influence how smiles and contexts are combined?

My second empirical chapter investigated the psychological mechanisms underlying the integration of smiles with their accompanying situational context. While Chapter 2 revealed how context affected evaluations of different smiles and situations, the experimental design did not allow for the underlying psychological mechanisms to be elucidated. As a result, in Chapter 3, I investigated whether the moderation of smile effects by negative contexts was driven by either (1) variation in one's allocation of attention to the face versus situation, or (2) by enhanced cognitive deliberation triggered by face-context incongruity. To do this, I recorded both eye-gaze and decision time of participants as they evaluated each stimulus.

Findings

The results of Chapter 3 did not support the idea that the reduced social influence of smiles in negative contexts was attributable to the enhanced attentional demands of negative contexts. Although participants spent a greater proportion of each trial fixating on negative contexts than polite or enjoyment contexts, this difference was not significant when aggregated across both tasks.

Instead, the results suggested that the integration of smiles and contexts likely depended mostly upon a process of conscious cognitive reinterpretation. The extra cognitive deliberation required when seeing smiles in negative contexts was indexed by slower decision times. Across both tasks, stimuli containing reward smiles were rated more quickly than both other smile types, *apart from* when they were seen within negative contexts. Instead, the presence of a negative context significantly slowed response times. The moderation of smile

effects by negative contexts was likely driven by the incongruity of reward smiles seen within negative situations, which subsequently influenced how the context itself was evaluated. In particular, when participants rated the politeness/civility of situations, the differential effects of reward and affiliation smiles were found most clearly for negative contexts and were less apparent or absent in ratings of enjoyment and polite contexts. This contrasted with the explicit ratings of politeness in Chapter 2, where differential smile effects were not found in negative contexts.

Do morphological and contextual cues implicitly affect subsequent behavioural responses to smiles?

My third empirical chapter investigated the extent to which morphological and contextual information affected participants' implicit responses, specifically the speed to approach or avoid smile-in-context stimuli. Previously, much research — including both of my first two empirical chapters — had investigated how context influences subsequent explicit responses to facial expressions (or vice versa). However, very little work had looked at how these sources of information may affect more automatic low-level behavioural responses (see Brambilla et al., 2018). This oversight is puzzling given that a large proportion of our social judgements and behaviours rely upon implicit and unconscious processing of various social cues (e.g. Bargh, 2013; Dijksterhuis, 2006; Greenwald et al., 1998; Kahneman, 2011; Zajonc, 1968). Of these social judgements, perhaps the most basic is deciding whether to approach or avoid a stimulus, which has been proposed to represent a fundamental valence evaluation (Lewin, 1935; Osgood, 1953; Lang et al., 1990). Consequently, I conducted a series of four studies using a mobile approach-avoidance app. Participants were instructed to push or pull their phone as quickly as they could, responding to either situational valence

(Study 5), smile type (Study 6), facial emotion (Study 7), or smiler gender (Study 8). I then measured whether their response times were affected by different aspects of the stimulus.

Findings

Overall, I found that both morphological and contextual cues implicitly affected subsequent approach-avoidance behavioural responses. Importantly however, these effects depended upon the aspect of the stimulus that the participant was responding to. Notably, whilst situational context implicitly affected the speed of responses to smiles, it did not affect responses to prototypical facial emotions. Moreover, smiles did not implicitly affect speeded responses to situations. This suggests that automatic integration of contextual information depends upon the ambiguity or “source clarity” of the information available.

Do morphological and contextual cues influence social responses in scenarios more equivalent to real-life social interactions?

My fourth empirical chapter investigated whether the effects of context and smile type could be generalised to more realistic social interaction scenarios. To address this research question, I used a virtual reality set-up to embed participants within ambient virtual environments that were either pleasant (a park) or unpleasant (a noisy construction site). Participants then came face-to-face with a virtual avatar, who displayed one of six different smile types. Using electromyography, I measured the extent to which these different smiles were mimicked by the participant, and whether mimicry was affected by the environment the participant was in. Mimicry is an index of affiliation and interaction quality (Hess & Fischer, 2013). Participants also rated the smiles along various social dimensions after each trial.

Importantly, using VR enabled me to test whether the effects found in previous chapters replicated in a setup which better represented how social stimuli are processed in

real life, as it included aspects of actual face-to-face behaviour which drive social outcomes (Gibson, 1986; Thompson, 2010).

Findings

As hypothesised, zygomaticus and orbicularis mimicry broadly declined as smiles became more “antisocial”. More importantly, mimicry was also affected by context, such that smiles presented in pleasant contexts were mimicked more than those presented in unpleasant contexts across all face muscles measured. The mimicry results were largely replicated in the ratings data, which again showed that situational context influenced explicit evaluations of smiler joy, liking, acknowledgement, and politeness. Similarly, pleasant contexts led to higher interpersonal closeness than unpleasant contexts. Consequently, it is likely that both morphological and contextual cues influence mimicry in real-life social interactions.

Broad Theoretical Considerations

How Does Context Exert its Influence on Facial Expression Processing?

My thesis expands upon existing knowledge of how context influences the processing of facial expressions. First, it is overwhelmingly apparent that context exerts its influence at both the explicit level and the implicit level. Context category significantly affected participants’ explicit evaluations of smiles in Chapter 2, Chapter 3, and Chapter 5. Specifically, smiles seen within in positive contexts were rated as more positive, joyful, and polite than smiles in negative contexts, but less superior than smiles in negative contexts. Similarly, context also affected hypothetical investments with smilers in Chapter 2, such that participants were willing to invest more points with people in positive contexts than neutral or negative contexts. This replicated the explicit evaluation results.

At the implicit level, in Chapter 4, smiles were approached more quickly when seen within positive contexts than negative contexts during a speeded approach-avoidance task. Similarly, in Chapter 5, smiles were mimicked to a greater extent in pleasant virtual environments than unpleasant virtual environments. This effect on mimicry was likely mediated by both implicit and explicit processes. Consequently, I propose a two-stage model whereby context impacts both the early and late stages of expression processing via different mechanisms (unconscious and deliberative processing respectively).

Whilst context can independently affect both automatic and deliberative responses to smiles, it is likely that the two stages are reciprocally connected. First, research in similar areas suggests that the automatic integration of context may affect later conscious processing of smiles. Winkielman et al. (1997) demonstrated that subliminally presented facial expressions influenced participants' mood and subsequent evaluations of neutral stimuli, even when participants were unaware of the emotional primes. This shows that affective cues, processed implicitly, can subtly guide later conscious appraisals. Similarly, Zajonc's (1968) work into the classic "mere exposure effect" indicated that unconscious affective responses to repeated stimuli can enhance preferences and influence conscious evaluations. These empirical findings align with dual-process theories (e.g. Kahneman, 2011), which suggest that unconscious "System 1" processing provides the foundation for conscious "System 2" deliberations. Applied to the present findings, this research suggests that implicit contextual associations — such as whether a smile occurs in a friendly or hostile context — may facilitate or bias subsequent deliberative social judgments. For instance, a perceiver may implicitly note an incongruency between a facial expression and its situational context, which may then trigger or alter the explicit re-evaluation of either the smile's meaning or the situation's meaning.

Conversely, the extent to which context is automatically integrated into smile processing may be affected by top-down cognitive input. In Chapter 4, I showed that the automaticity of context integration during an approach-avoidance task depended on whether participants were discriminating between prototypical emotional facial expressions or different smile types. This finding is consistent with further evidence indicating that the automaticity of context integration may be dependent upon perceiver goals. Notably, Barrett and Kensinger (2010) found that participants remembered contextual information more accurately when they were required to label emotion in a face than when they were asked to make an approach-avoidance judgement. Moreover, modulation of the early unconscious N170 ERP component by contextual congruency also depends on task demands. For example, N170 modulation is not found in tasks where participants make emotion recognition judgements or when context is presented simultaneously with the facial expression (e.g. Aguado et al., 2019; Dieguez-Risco et al., 2013) but is observed when participants make explicit congruency judgements (e.g. Aguado et al., 2019; Dieguez-Risco et al., 2015). This aligns with extensive evidence indicating that the N170 can be influenced by various top-down, controlled processes (Blechert et al., 2012; Cauquil et al., 2000; Goffaux et al., 2003; Rellecke et al., 2012; Wronka & Walentowska, 2011). Consequently, the available evidence suggests that automatic context integration is more likely when the contextual information is more useful or relevant to social goals. This again implies a connection between the early low-level processing stage and the later top-down processing stage.

Throughout the thesis, my data consistently supported Ekman et al.'s (1972) "Source Clarity" theory of contextual influence. This model suggests that the relative extent to which the expression and the situational context contributes towards an overall impression of the expresser's intention depends on the "amount or type of information available to observers when they are exposed to a single source" (p. 138). This seems to be the case at *both* the early

and the late stage of context integration. For example, at the later explicit level, the effect of negative contexts overwhelmed the influence of smile type on investment decisions in Chapter 2. I propose that the unambiguous nature of the aversive situations presented to participants (fires, rubbish dumps, cemeteries) forced them to reinterpret the social meaning of the smiles they were seeing, rather than perform the opposite re-evaluation (i.e. reinterpret the situation in light of the smile).

Similarly, at the implicit level, Study 6 showed that context affected the speed of approach responses when participants discriminated between reward and dominance smiles. However, Study 7 did not find this same context effect when participants discriminated between happy and angry faces. I argue that the additional contextual information from the surrounding situation was integrated into speeded responses when the meaning of the target expression was less clear. In contrast, when the meaning of the target expression was less ambiguous (i.e. when discriminating between happy and angry expressions) then the influence of additional information was reduced. Therefore, although source clarity doesn't provide a full explanation for observed context effects on facial expression evaluations (see Aviezer et al., 2008a), it does explain why the more unambiguous a source of information is, the more effect it has on participant's judgements relative to an unclear source.

Nevertheless, it must also be noted that our understanding of how context exerts influence on facial expression processing is limited to some extent by a lack of consensus within the empirical and theoretical literature concerning what the term "context" actually means, and how to operationalise it. Throughout the present thesis, I have referred to the background situations as "contexts", because they provide additional information external to the face. However, in some of my studies participants rated the situations themselves, and hence it feels suboptimal to refer to the focus of their ratings as context per se. Instead, it could have been more appropriate to consider the smiles as "context" for the rating of the

situation. If so, one could reconceptualise the manipulation of smile morphology as a manipulation of context. Alternatively, Banziger et al. (2009) argues that we should conceive of both facial expressions and body postures as distinct emotion signals that contribute towards an overall evaluation or response, and not merely as a context for each other. If I took this view, it would not be appropriate to refer to any of the effects described throughout this thesis as “context effects”. Nonetheless, for the purposes of the present thesis, I decided to keep referring to the situations as “contexts” in order to align with the bulk of past research, which has focused on responses to facial expressions.

Differences Between Processing Faces Versus Situations

In addition to expanding our knowledge of how situational context influences smile processing, this thesis also developed our understanding of how smiles affect processing of situations. Specifically, I found that participant’s ratings of situational contexts were affected by the type of smile expressed within the scene. However, the type of smile displayed did not affect implicit approach-avoidance responses when responding to situational valence.

This dissociation between the effects of smile type on explicit and implicit responses is intriguing and I have speculated that this discrepancy could be attributed to the cognitive demands required to integrate facial information into processing of situations. Specifically, integrating facial information when responding to situations likely requires a form of cognitive deliberation — called “reverse engineering” (Hareli & Hess, 2019) — not available during the speeded AAT. Hess and Hareli (2017, p. 384) argue that perceiving a facial expression within a situation often leads to a conscious reappraisal of the situation itself. Using the example of an expresser showing a fearful response to a kitten, these authors suggest that a rational observer may invent additional information about the expresser or the situation in order to reconcile any potential incongruity. For instance, they may speculate that the expresser is cat-phobic, or that there is a growling dog behind the kitten. This form of

reasoning clearly requires conscious deliberation and therefore would not affect responses in an approach-avoidance task.

However, this explanation does not accord with the implicit context effects found in Study 6, when participants discriminated between reward and dominance smiles in the speeded AAT. The speed of approach responses towards these smiles were influenced by the context they were seen within, even though participants lacked the time needed for conscious deliberation. The most plausible account of this discrepancy is that there is no implicit automatic mechanism via which facial expressions are integrated into the processing of situations, whereas there is an implicit mechanism for integrating situations into the processing of facial expressions. Intuitively, this makes sense given the relative frequencies at which we process faces (which are always changing and requiring re-evaluation) relative to situations (which tend to stay relatively stable over longer time periods). It is well established that humans process faces in a specialised manner (e.g., Bjornsdottir et al., 2017; Fletcher-Watson et al., 2008; Valentine, 1988) and we are largely accustomed to interpreting faces based on the context in which they are perceived. An automatic context integration mechanism is therefore likely to develop. In contrast, specific processing of situations likely happens far less often, and hence a specialised mechanism for integrating faces into scene processing is unlikely to have the opportunity to develop. This account somewhat echoes the methodological criticism of the classic Goodenough and Tinker paradigm made by Fernandes-Dols et al.'s (1991), who proposed that verbal vignettes lacked influence on later emotion categorisations because — unlike with faces — participants lacked real-life experience in categorising situations using emotional terms. Alternatively, it could be argued that our positive and negative contexts in Study 5 were not ambiguous enough to facilitate an implicit effect of smile type. Future research would be needed to distinguish between these competing theories.

Interestingly, the results from Chapter 2 suggest that when deliberation time is available, the influence of smile type on situation ratings actually exceeds the reciprocal influence of context on smile ratings. I argue that this finding likely reflects further differences between the nature of processing of faces and situations. Specifically, the situation is not an active part of the facial expression, and therefore only contributes *indirectly* to face evaluations — perhaps by indicating an increased likelihood that a person may be feeling or communicating a certain emotion or social motive. Although unlikely, the face may be entirely unaffected by the context (e.g. Izard, 1994). In contrast, the face is a major part of the situation itself, which cannot be separated from the facial expression. When a person smiles widely, the nature of the situation changes entirely relative to when a person sneers mockingly, even if the location remains the same. Therefore, smiles contribute *directly* to evaluations of the situational context (see Hess & Hareli, 2016). This direct effect overcomes the natural advantage conferred by our regular practice at integrating context into face processing (Fernandez-Dols et al., 1991).

Moderating Effect of Negative Situations

Another theme of this thesis is that the effects of reward and affiliation smiles on explicit evaluations were moderated by negative situational contexts. This finding is particularly important at a theoretical level because it demonstrates limits to the social power of smiles. In Chapter 2, participants typically rated situations paired with reward smiles more positively than situations paired with affiliation smiles. This pattern repeated when participants were required to invest in smiling partners during a hypothetical Trust Game. Nonetheless, in both cases, the more positive influence of reward smiles was absent when smiles were presented in negative contexts. In Chapter 3, this interaction between smile type and context was again observed across all dependent variables (albeit in slightly different patterns).

I hypothesised two possible explanations for this interaction. First, I theorised that the moderating effect of negative situational context may have an attentional origin, such that the ratio of attention towards the face relative to the context was reduced when encountering an aversive negative situation. Previous eye tracking studies have found that people direct greater levels of attention towards more aversive stimuli (e.g. Chajut & Algom, 2003; Hancock & Warm, 2003). In turn, reduced attention towards the face may have affected subsequent processing of smile meaning. Alternatively, the moderating effect of negative context could also have had a cognitive origin, such that a cognitive re-evaluation of both the facial expression and the situation is triggered when smiles are seen within unexpected or incongruent situations. This echoed the cognitive reappraisal process outlined in Hareli and Hess' (2016; 2017) Meaning of Emotional Expressions in Context (MEEC) model.

To discern between these competing theories, I analysed both eye gaze and decision time while participants rated smile-in-context stimuli. Although participants fixated on negative contexts marginally more often than other context categories, the combined results supported the cognitive explanation more strongly than the attentional explanation.

Specifically, any context-related changes to the contrasting social effects of different smile types were largely attributable to the incongruity of reward smiles seen within negative situations. This incongruity subsequently influenced how the context itself was evaluated, and the extra cognitive deliberation required was indexed by slower decision times. Consequently, this chapter provides additional support for Hess and Hareli's (2016) MEEC model, and their associated idea of "reverse engineered" appraisals (Hareli & Hess, 2010; 2019).

Intriguingly however, the moderating effect of negative context was not found in some studies. For example, it was not present when participants explicitly rated smiles in Chapter 2, and the effect of smile type was not moderated by context for either approach-

avoidance or mimicry responses. For the implicit variables, this is likely explained by there not being enough time for cognitive deliberation to occur. However, the absence of this moderating effect of negative context on explicit smile ratings in Chapter 2 is harder to explain, especially given that this interaction was also observed in the subsequent Trust Game study, as well as in the smile ratings of Chapter 3. On the basis of the other findings of this thesis, it is possible that this was simply a false negative result.

Does the SIMS Model Accurately Categorise Smiles?

My thesis supports previous work suggesting that smiles should be classified according to their social functions (Niedenthal et al., 2010; Rychlowska et al., 2017) in accordance with the Behavioural Ecology approach to studying facial expressions (Carroll & Russell, 1996; Fridlund, 1991; 1994). Niedenthal et al. (2010) proposed the existence of three separate smile types, each serving a different basic human need that arise within the social environment. Specifically, “reward” smiles help reinforce desired behaviours in the perceiver, “affiliation” smiles aid the formation and maintenance of mutually beneficial social bonds, whilst “dominance” smiles assert superiority over other social interactants. Visually, each is characterised by activation of different facial muscles, which leads to contrasting morphological configurations (Rychlowska et al., 2017). Although some studies using the SIMS classification system had previously been conducted (Martin et al., 2018; 2021; Rychlowska et al., 2017; 2021), this smile set is under-researched. For instance, no studies had investigated implicit responses to these different smile types, nor the relative extents to which the smiles are mimicked. Likewise, no study had investigated whether / how context altered their interpretation.

As anticipated, differences between these putative smile types were consistently found across all studies presented in this thesis. This included explicit social ratings, investment decisions, conscious decision times, speeded approach-avoidance response times,

and facial mimicry. These differences were broadly in line with the purported functions of the smiles. Reward smiles were rated as more genuine and more joyful than the other smile types. They received higher investments, were approached more quickly, avoided more slowly, and mimicked with more zygomaticus and orbicularis activity. At the other end of the scale, dominance smiles were rated as more superior/condescending, approached more slowly, avoided more quickly, and mimicked with more corrugator activity. Affiliation smiles were rated as more polite than other smile types and were generally responded to less positively than reward smiles, but more positively than dominance smiles.

Although there were clear differences between how these three smile types were responded to, deciding how many smile categories to include in a model is a somewhat arbitrary decision (see Ekman, 1985, for discussion). Within each category, it would no doubt be possible to define subcategories associated with slightly differing social functions. For example, Ekman (1985) described 18 different smile types, including categories as diverse as compliant, contemptuous, dampened, miserable, and flirtatious, but suggested the existence of potentially upwards of 50 smile categories. Alternatively, other researchers have since proposed fewer smile categories defined according to different criteria — typically emotion-based. Notably, Keltner (1995) suggested the existence of three separate smile types reflecting amusement, shame, and embarrassment. More recently, de Kok and Heylen (2011) analysed a video corpus of face-to-face social interactions using a machine learning algorithm, which suggested the existence of amused, polite, and embarrassed smile types. These categories parallel a similar previous categorisation system suggested by Ambadar et al. (2009). Furthermore, others have proposed the existence of distinct smiles reflecting anxiety (Harrigan & O’Connell, 1996), greeting (Eibl-Eibesfeldt, 1972), scheming (Ohman, Lundqvist, et al., 2001; Tipples et al., 2002), pride (Tracy & Robins., 2007), winning (Kraus & Chen, 2013), frustration (Hoque et al., 2012), and defiance (Darwin, 1872). Nonetheless, I

used the SIMS model because it defines smiles according to broad social functions that can be easily distinguished from one another in accordance with the Behavioural Ecology approach to facial expressions (Fridlund, 1991a; 1994).

By defining smile categories according to their social functions, this research does not test the influence of emotion in determining facial expressions. This is in contrast to a large body of facial expression literature centred around the Basic Emotions (Ekman et al., 1969; Ekman & Friesen, 1972). Nonetheless, the present classification system does not mean that emotions have no relation to smiles. In fact, positive emotions such as happiness likely correlate strongly with smile displays, especially reward smiles. However, it remains the case that (1) reward smiles can be displayed without the experience of underlying happiness, and (2) happiness can be experienced without the display of a reward smile. Consequently, this thesis takes the view that the reward smile — like nearly all facial expressions — is instead better characterised as having a social function. Specifically, it reinforces the behaviours of others.

At an even broader level, the research presented in this thesis shows that regardless of the specific muscles activated or the discrete term used to label an expressions, evaluations of and responses towards facial expressions are still somewhat relativistic, in the sense that inferred meaning is derived from a combination of both the expression and its surrounding context.

Value of Convergent Methodological Techniques

This thesis highlights the value of using a range of different methodological techniques to study social psychological phenomena in order to ensure a balance between internal and ecological validity. All experimental methods that test social and affective processes must make a frustrating trade-off between experimental control and task realism

(see Levenson, 2003). Tasks with high ecological validity (e.g. dyadic interactions) are associated with difficulties in measuring participant responses and controlling for extraneous variables. However, tasks with tight experimental control (e.g. numerical ratings of faces on a screen) don't represent how facial expressions are naturally displayed or perceived. In the present thesis, I started by conducting studies with well-controlled experimental set-ups in order to establish core findings that could be further investigated using more ecological methods. I then increased the extent to which the experimental set-up reflected real-life social interaction. First, I determined whether the significant effects in Study 1 and Study 2 of Chapter 2 would be found when reframing the dependent variable, such that participants were instructed to think of themselves as playing a consequential game with the smiler (Study 3). In Chapter 4, I assessed whether smile and context affected approach and avoidance response tendencies. Finally in Chapter 5, I tested whether these effects would be found when participants were embedded within more realistic embodied virtual environments. Overall, I believe that I appropriately balanced the competing demands for both internal and ecological validity. This balance ensures that effects are robust and can be confidently attributed to a manipulated variables (i.e. smile type or context category), whilst also reflecting a process that actually occurs during social interaction.

Additionally, I was able to utilise methodologies that allowed the psychological mechanisms underlying these findings to be explored. Specifically, by measuring eye gaze and decision time data I was able to distinguish between attentional and cognitive explanations for the smile-by-context interaction. Furthermore, I was able to determine the automaticity of context integration by measuring approach-avoidance responses and facial mimicry. This led me to postulate a two-stage context integration model whereby effects occur at both an early implicit level and a later explicit level.

Limitations

There are some limitations to this research which may reduce the extent to which findings can be generalised to everyday social and affective processing.

Participant Representativeness

First, although my participants were not filtered by culture or ethnicity, all of my samples were comprised predominantly of White/Caucasian people from Western cultures (i.e. the United Kingdom and Germany). As a result, it is possible that my samples may not be fully representative of how smiles and contexts are processed across cultures.

A body of empirical work suggests that a more demographically diverse participant sample may have produced different results. Although context effects have traditionally focused on aspects related to the *expresser*, characteristics of the *observer* of a facial expression also affect how they are evaluated. For example, two large studies (comprising of approximately 700,000 face ratings in total) recently examined the respective extent to which (1) observers and (2) expressers contributed to trait impressions of others. Both found that observer characteristics drove trait impressions more than expresser characteristics (Hehman et al., 2017; Xie et al., 2019).

Although we know less about the relative effects of observer-based contextual cues on facial expression evaluations, it is likely that demographic characteristics of the observer impact facial expression evaluation. Notably, it is well established that an observer's ethnicity can influence how they interpret facial expressions. For example, researchers have found substantial differences between European Canadians, Gabonese, and Chinese immigrants to Canada in their use of the Duchenne marker when rating the authenticity of smiles (Thibault et al., 2012). Specifically, European Canadians rated smiles without the marker as less authentic than those with the marker, but Gabonese participants did not. Furthermore, for

Chinese immigrants to Canada, the extent to which the Duchenne marker indicated smile authenticity was correlated with their length of stay in Canada. This suggests that the interpretation of facial muscle movements may be ethnicity specific. It is therefore possible that the SIMS smiles utilised in my research would not be recognised as having the same meanings in Black or East Asian samples, because their morphological characteristics are less useful as social cues. Instead, people with different ethnicities may use different facial muscle movements/patterns to confer these social messages.

In addition, previous research has also suggested that an observer's culture can affect the extent to which context is integrated into face processing. Studies outside of the face domain have suggested that contextual influence is likely to differ across cultures. Masuda and Nisbett (2001) found that when asked to report what they saw in underwater scenes, Americans emphasised focal objects (e.g. fish), whereas Japanese participants reported more background information (e.g., rocks, colour of water, small non-moving objects). Likewise, using the classic Rod-and-Frame task, Ji et al. (2000) found the orientation of the frame influenced Chinese participants' rod orientation judgments more than American participants. In accord, cultural differences in context effects have been found for facial expression evaluation. Masuda et al. (2008) presented a cartoon of a target expresser surrounded by four other people expressing either congruent or incongruent emotions. As hypothesised, the surrounding people's expressions influenced Japanese but not Westerners' evaluations of the target. Furthermore, whilst both cultural groups focused on the central target initially, Japanese participants broadened their scanning more quickly than Westerners did. Such a finding was later replicated in a study that (1) used real photographs rather than cartoons, (2) reduced the saliency of the target, and (3) allocated participants a set observation time (Masuda et al., 2012). Given that my participants were predominantly Western, it is likely that the effect of context on participants' judgements found is smaller than the corresponding

effect in East Asians. As a result, in future, researchers may study how the effects of context found across my thesis may be generalised to these more culturally diverse samples.

Furthermore, in some studies there was a far higher proportion of females than males (e.g. Study 1, Study 4, and Study 9), whilst in other studies there was the reverse gender split (e.g. Study 3, Study 5, and Study 8). These imbalances may affect the extent to which results can be generalised, given that some studies have found gender differences in how facial expressions are evaluated and processed. For example, Hall (1978) found that women were more accurate at recognising some facial emotions than men. Future research could study whether effects of morphology or context differ between genders.

Stimulus Validity

Smiles

In addition to the potential issue of participant representativeness, I have some concerns about the validity and representativeness of the stimuli presented to participants across studies.

First, there are potential issues with the face stimuli used. In Chapter 2 and Chapter 3, I presented participants with videos of smiles taken from the Simulation of Smiles (SIMS) set (Rychlowska et al., 2017). This is the only available face set which contains the reward, dominance, and affiliation smiles. The use of stimuli from this particular set represents an improvement over much of the previous research in this area, as video stimuli better represent how smiles are seen in everyday life. Specifically, they contain a variety of additional perceptual cues such as the direction, quality, and speed of facial motion (see Krumhuber et al., 2013, Krumhuber, Skora, et al., 2023, for reviews). However, the set contains smiles posed by just 18 actors, meaning that only 54 smile videos were available for me to use in total (although in some cases the database contained two videos per smile type per actor,

which allowed me some degree of choice). This limited the possible number of trials per experiment without repeating stimuli. Therefore, in some experiments each smile was repeated multiple times per participant in order to present a sufficient number of trials (e.g. for eye tracking data). This could have potentially facilitated repetition effects, whereby participants' ratings are affected by their previous judgements (Tversky & Kahneman, 1974). Moreover, of the 18 actors in the SIMS set, six are Black. Apart from in Chapter 4, I excluded these stimuli because I did not want to introduce potential ethnicity effects. This ultimately limits the extent to which interpretations of smiles can be generalised to the global population as a whole, especially given previous research showing that people of Black and East Asian ethnicities rely less upon certain morphological features than White people (see Thibault et al., 2012). Finally, across such a small number of stimuli, the noise created by differences in the actors' posing ability, attractiveness, facial structure, or other uncontrolled variables may have systematically affected participant ratings. Therefore, researchers may want to develop a larger database of SIMS smiles.

For the approach-avoidance study I was unable to use videos because of the speeded nature of the task. Instead, I used static screenshots of the video stimuli, which may have reduced smile-related approach-avoidance differences (see Krumhuber et al. 2013; 2023, for a discussion of the role of facial dynamics for expression meaning). Moreover, although the smiles displayed by the avatars in Chapter 5 were standardised, my use of virtual avatars rather than videos of real people introduced issues concerning expression artificiality. Specifically, there may have been an "uncanny valley" effect (Mori et al., 2012), which could have affected the extent to which participants processed the smiles as conveying the intended social meaning.

Contexts

The contexts used in this thesis were more realistic stimuli than the contexts used in previous research. Most previous studies have manipulated situational context by using verbal vignettes, which means that faces are typically presented in isolation (e.g. Krumhuber, Hyniewska, et al., 2023; Maringer et al., 2011; Mui et al., 2020). Moreover, of the studies that have used visual contexts, almost all have presented static photos of situations rather than dynamic videos (e.g. Namba et al., 2020; Righart & de Gelder, 2006; 2008). These often look unnatural when joined with the face (see Reschke et al., 2018 for a criticism). As a result, in this thesis I used videos from Envato Elements as context stimuli, which more naturally matched the dynamic smile videos. On one hand, this increased the realism of the context manipulation, and therefore likely increased the probability of observing context effects (see Fernandez-Dols et al., 1991; Wallbott, 1988a; 1988b). On the other hand, Envato Elements contains a limited pool of video contexts, which meant there was a small subset of different scenarios for each context category. Some of these scenarios may have lacked realism. In particular, for the negative contexts, I used videos of either rubbish dumps, fires, or cemeteries, which are not often encountered in real life. Moreover, the likelihood of observing another person smiling within these situations during everyday life is low. Consequently, it is possible that the situations that smilers were seen in lacked believability, which may have either reduced task engagement or encouraged demand characteristics. Nonetheless, given that context effects were found across all experimental paradigms — both explicit and implicit — it seems unlikely that this problem significantly impacted participant behaviour.

In the final study, participants were immersed into ambient virtual environments. Whilst this addressed limitations concerning context engagement, the unpleasant environment (a construction site) was not an everyday situation, nor one where observing a smiling

stranger is typical. Hence, this study also may have had a believability issue. In addition, the VR immersion required participants to wear a heavy headset often rated as uncomfortable during the debriefing, which may have impacted mimicry and ratings of the smiles. Future studies could overcome these limitations by conducting field studies in the real world. However, smile and context effects are very difficult to explore in everyday life scenarios due to the noise around these factors with a lack of experimental control.

Lack of Social Complexity

A final methodological issue is the lack of social complexity within my stimuli. Such complexity has been largely ignored by social psychologists but has been highlighted by the computational field of Social Signal Processing (SSP – e.g. Brunet et al., 2009; 2011). SSP researchers argue that by focusing on the isolated contribution of single variables, researchers lack the information required to build more powerful and comprehensive models of social behaviour. Instead, they recommend that multiple cues are measured and recorded at the same time.

In the present thesis, I made a start towards this goal by investigating interactions between different types of expressions and different types of situational context. Nevertheless, during everyday exchanges, people integrate a much larger array of cues relevant to understanding the feelings and intentions of an interaction partner. This includes linguistic content, tone of voice, body language, eye gaze, history of interactions, physiological indicators, personality traits, gender, age, ethnicity, social group membership, etc.

Whilst these variables may have additive effects, combining to strengthen an impression, interactions between variables are inevitable. For example, if a person tells us that they are feeling happy, we may take this utterance at face value and believe that the

person is experiencing happiness. Nevertheless, if their statement is combined with blushing, stuttering, and gazing at their feet, the person is most likely not happy at all but is trying to mask embarrassment (Brunet et al., 2009). Accordingly, some empirical work has demonstrated that responses to facial expressions are heavily altered by perceived dispositional traits of the expresser. For example, smiles on more affiliative looking faces are perceived as more appropriate than smiles on less affiliative faces displaying the same muscle movements (Hess et al., 2005). Likewise, Gagnon et al. (2022) showed that smiles were rated as more genuine when displayed by someone thought to be more likely to return favours.

In addition, relationships between these cues may be bidirectional, as social signals emitted are constantly modified according to how they have been interpreted (Barrett, 2017). Although I investigated the reciprocal relationship between faces and situational contexts, I was unable to study all such relationships. Notably, people often make enduring dispositional judgements from brief facial displays (Bar et al., 2006; Harker & Keltner, 2001; Knutson, 1996; Montepare & Dobish, 2003; Todorov et al., 2009; Todorov & Uleman, 2003; Willis & Todorov, 2006). For example, individuals with happy expressions tend to be seen as high in affiliation, whereas individuals with angry expressions are seen as low in affiliation.

On one hand, it is extremely challenging to manipulate (or control) a long list of potentially important social cues whilst attempting to identify meaningful effects that can be attributed to specific factors. Even the most ambitious studies conducted so far have managed to manipulate just three different variables. Notably, Reschke and Walle (2021) attempted to determine the relative effects of (1) facial expression, (2) body posture, and (3) visual scene on emotion attributions. Whilst cutting edge, this still only represents a fraction of the potential factors that influence people's social inferences from smiles. Consequently, it is possible that the research in my thesis does not represent real-world social complexity and thus does not fully engage the systems or mechanisms utilised during social interaction. In

turn, this may affect the extent to which findings can be generalised to neuroatypical groups such as autistic people. For example, it has been argued that social interaction is particularly impaired in autism because of its heightened complexity relative to non-social behaviours (see Minshew & Goldstein 1993; 1998; Minshew & Hobson, 2008).

In sum, the research presented in this thesis captures only a small subset of the multitude of factors that may influence facial expression processing during social interaction. Future research should study how a wider array of social cues influence social behaviour.

Overall Conclusion

Across four empirical chapters, this thesis aimed to improve our understanding of how morphological and contextual cues combine to influence the processing of socially defined smiles. I found that situational context and smiles are reciprocally related, with the potential to influence the interpretation of one another. Moreover, context can influence the processing of smiles at both an early implicit stage and a later explicit stage. However, its influence depends to on the relative ambiguity of the different social cues, as well as the valence of the context and the situational demands faced by the perceiver. These effects likely occur in real-life social interactions by influencing subsequent behaviours and facial mimicry of others. With this thesis, I join a growing body of researchers highlighting the pervasiveness and importance of context in face processing. I also hope to encourage the development of a more socio-functional approach to understanding and studying smiles.

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