

FORAGING FOR FAMOUS FACES: EXPLORING THE INTERACTION BETWEEN
FACIAL EXPRESSION AND FACIAL IDENTITY PROCESSING.

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Abstract

This thesis aimed to investigate two ongoing debates within the face perception literature. The first debate revolves around the question of whether expression and identity processing interact when making decisions about faces. The second debate concerns the possibility of a valence bias during the processing of positive or negative facial expressions of emotion. We adopted a foraging paradigm to explore whether categorising an emotional expression is independent of facial identity in the context of multiple-target search. Stimuli consisted of AI generated images of Caucasian male celebrities, each providing 4 exemplars to fill a 2 (valence) x 2 (arousal) expression space. Specific expressions were characterised as: a slight smile, full laughter, a slight frown, or extreme anger. In separate trials, participants (N=12) searched on an iPad for positive amongst negative facial expressions (or vice versa) irrespective of the level of arousal (high or low) depicted in the images. Each display contained an array of 40 faces: 20 target expressions, 20 distractor expressions (4 images per identity). The crucial manipulation was whether all faces within a trial shared the same identity or whether identity varied, with images being sampled from the full set of celebrities. Data were analysed using a 2 (Identity: Same/Different) x 2 (Expression: Positive/Negative) factorial design. A near identical follow up experiment (N= 12) was conducted, the main change being the stimuli. Additional stimuli for each expression space were created to reduce stimuli repetition. Results from both experiments clearly indicated slower response time for multiple identity trials. Results also revealed a significant processing bias for positive valence facial expressions, with reduced response time for positive target trials compared to negative target trials.

Keywords: Face perception, facial identity, facial expression, foraging.

Table of Contents

1.0 Introduction	10
1.1 Research Aims	11
1.2 Overview of Chapters	11
2.0 Literature Review	13
2.1 The Processing of Facial Expression and Facial Identity	15
2.2 Positive or Negative: Are we Biased by Expression Valence?	21
2.3 Visual Search and Foraging	23
2.4 The Present Study	28
3.0 Experiment 1	29
3.1 Methodology	29
3.2 Results	47
3.3 Discussion	57
4.0 Experiment 2	58
4.1 Methodology	58
4.2 Results	63
4.3 Discussion	73
5.0 General Discussion	75
5.1 Overview of Results	76
5.2 Intersection Between Facial Expression and Facial Identity Processing	78
5.3 Valence Bias: The Face in the Crowd Effect	80
5.4 Limitations and Future Directions	81

FORAGING FOR FAMOUS FACES	4
6.0 Conclusion	84
References	86
Appendix A	99
Appendix B	102
Appendix C	103
Appendix D	107
Appendix E	108
Appendix F	109
Appendix G	115
Appendix H	116
Appendix I	117
Appendix J	118
Appendix K	119
Appendix L	120
Appendix M	121
Appendix N	122
Appendix O	123
Appendix P	124
Appendix Q	125
Appendix R	126
Appendix S	127
Appendix T	128

Table of Figures

Figure 1 Bruce and Young's (1986) Functional Model of Face Perception	16
Figure 2 The Distributed Human Neural System for Face Perception, Haxby et al (2000). .	18
Figure 3 Example of Feature Search.....	25
Figure 4 A Simple Example of Conjunction Search with a Single Target.....	26
Figure 5 Examples of a female (left) and male (right) MetaHuman avatar.....	33
Figure 6 Examples of female (left) and male (right) avatars generated using FaceGen.	34
Figure 7 A figure showing a raw image generated on Picsart (left), and the same image after editing shown on a grey background (right).....	36
Figure 8 All 24 stimuli used in experiment 1. Each row shows the four expression images for each identity used. From left to right, high intensity negative valence, low intensity negative valence, high intensity positive valence, low intensity positive valence.	37
Figure 9 Top panel shows a different identity trial, the bottom panel shows the single identity trial.	40
Figure 10 The recognition test sheet shows each of the 6 identities included in the experimental task.	43
Figure 11 Line graph showing median serial RT for each trial.	45
Figure 12 Boxplot showing Experiment 1 RT1 as a function of Identity Condition and Target Valence.....	48
Figure 13 Line graph showing Experiment 1 median RT1 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.....	48
Figure 14 Boxplot showing Experiment 1 RTT as a function of Identity Condition and Target Valence.....	50
Figure 15 A line graph showing Experiment 1 median RTT as a function of Target Valence and Identity Condition. Error bars show one standard error of the mean.	50
Figure 16 Boxplot showing Experiment 1 mean SRT as a function of Identity Condition and Target Valence.	52

Figure 17 Line graph showing Experiment 1 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.	52
Figure 18 Boxplot showing Experiment 1 mean high arousal choice proportion as a function of Identity Condition and Target Valence.....	54
Figure 19 Line graph showing Experiment 1 mean high arousal choice proportion as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.....	54
Figure 20 Boxplot showing Experiment 1 mean run count as a function of Identity Condition and Target Valence.	56
Figure 21 Line graph showing Experiment 1 mean run count as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.	56
Figure 22 Stimulus set for Tom Cruise used in Experiment 2, each column shows a different expression class.	60
Figure 23 A comparison of the single identity trial in Experiment 1 (top panel) and Experiment 2 (bottom panel).	62
Figure 24 Boxplot showing Experiment 2 RT1 as a function of Identity Condition and Target Valence.....	64
Figure 25 Line graph showing Experiment 2 median of RT1 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.	64
Figure 26 Line graph showing Experiment 2 median of RTT as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.	66
Figure 27 Boxplot showing Experiment 2 RTT as a function of Identity Condition and Target Valence.....	66
Figure 28 Boxplot showing Experiment 2 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence.....	68

- Figure 29** Line graph showing Experiment 2 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.68
- Figure 30** Boxplot showing Experiment 2 high arousal choice proportion as a function of Identity Condition and Target Valence.....70
- Figure 31** Line graph showing Experiment 2 high arousal choice proportion as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.70
- Figure 32** Boxplot showing Experiment 2 mean run count as a function of Identity Condition and Target Valence.72
- Figure 33** Line graph showing Experiment 2 mean run count as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.72

Table of Tables

Table 1 The number of images for each expression class shown on any given experimental trial.	39
Table 2 Table showing mean RTT difference between Identity Conditions (single and multiple) for Experiment 1 & 2.	73

List of Abbreviations

FE: Facial Expression

FI: Facial Identity

PRH: Parallel Route Hypothesis

RT: Response Time

SRT: Serial Response Time

1.0 Introduction

This thesis presents two experiments designed to investigate mechanisms of face perception. Specifically, it describes two foraging experiments which required participants to identify facial expressions of a particular valence, either positive or negative. Each experiment included two different types of trials, some trials with multiple identities, and others with only a single identity, which allowed us to investigate whether variation in identity impacts the processing of facial expressions.

While there has been extensive research on the relationship between facial expression and facial identity, the topic is still highly debated. Early research, for example Young and Bruce (1986), tended to argue that the processes are entirely independent of one another, and occur in parallel. However more recently there has been a shift in understanding that the relationship is far more complex and nuanced than previously thought (see Calder & Young, 2005; Young & Bruce, 2011). Today, it is understood that facial expression processing is influenced in some way by facial identity processing (see Rhodes et al., 2015). The current thesis aims to further contribute to this debate by introducing a new task and by creating novel stimuli, as detailed below.

Another area of ongoing controversy in the face perception literature, is whether there is a processing bias for either negative or positive facial expressions. Extensive research has been conducted in this area, however different paradigms tend to yield different results (Kauschke et al., 2019). Therefore, more research is needed to further understand the issue. This thesis aims to further contribute to this debate by analysing the differences in how participants performed when they were required to identify positive or negative facial expressions during a foraging task.

Another interesting aspect to this study is the use of artificial face stimuli. Various methods for developing such stimuli were explored, but text to image artificial intelligence generated images were used in the final task. Exploring how novel technology can be applied to research is of great importance, both for creating more efficient methods of developing

stimuli, but also to further the understanding of how such technologies may be limited in their application.

1.1 Research Aims

This study has four main aims. The first is to contribute to the ongoing debate surrounding the processing relationship between facial identity and facial expression. The second is to contribute further to the debate surrounding facial expression valence bias. The third is to investigate these factors using a foraging paradigm, allowing us to further ascertain its applicability to investigate face perception, given that the literature on using foraging to investigate face perception is limited. Finally, it will hopefully allow us to evaluate the applicability of AI generated stimuli in face perception research.

1.2 Overview of Chapters

This thesis is divided into five chapters. Chapter 2 provides an overview of the literature relating to the field of face perception, the specific research aims of this study, and the experimental paradigm. It begins by providing a general background on face perception, outlining why face perception research is important, and some information on the unique processing of faces. It then moves on to give a detailed account of the debate surrounding the relationship between facial identity and facial expression processing. The ongoing debate surrounding facial expression valence bias is then described, with specific emphasis on how different paradigms yield different results and explores why such paradigms may yield the results they do. Next, is a brief review of visual search and foraging, emphasizing the different types of tasks utilized in research, and how foraging paradigms have been used for the study of complex visual stimuli. Finally, the current the study is placed within the context of the reviewed literature.

Chapter 3 describes Experiment 1. It begins with a brief introduction and description of the experiment. The methodology section outlines the methods adopted. Specifically, it describes in detail the process of developing the stimuli, participant recruitment, participant

demographics, the experimental task, the procedure for data collection, and finally data analysis. The results of Experiment 1 are then presented, including boxplots and line graphs as visual aids, the statistical results, and brief interpretation of the result. Finally, a brief discussion interprets the results, and explains the motivation for conducting Experiment 2. Chapter 4 describes Experiment 2. It is identical in structure to Chapter 3, with a brief introduction, a methodology section, description of results, and a brief discussion of the results, with emphasis on comparing results with those of Experiment 1.

Chapter 5 concludes the thesis, with an in-depth discussion of the entire study, outlining the results within the context of other research, and suggesting directions for future research. It begins by reiterating the aims of the study, with a brief description of the experiments conducted. It then provides an overview of the results of both Experiment 1 and Experiment 2, with emphasis on comparing the outcomes of both experiments. It then moves on to focus on the debate surrounding facial identity and facial expression processing, and how the results of this study fit into the literature, with emphasis on providing potential explanations for the results found. The same is done for the debate surrounding facial expression valence, again focusing on how the results of this study compare to the literature and exploring explanations for the results obtained. Next, this chapter is concluded by exploring potential limitations of the study, with focus on limitations in experimental design and the issues with using AI generated stimuli. Finally, Chapter 6 provides a brief conclusion outlining the overall results, and potential future directions is provided.

2.0 Literature Review

The human face is a highly complex, three-dimensional visual stimulus (Rossion, 2014). Every human face is made up of the same basic features, making all faces extremely similar to one another. Despite this, we are remarkably adept at differentiating between faces based on small individual differences in facial architecture. Our ability to process human faces far outperforms our ability to process any other complex visual stimuli (Barton et al., 2016), for example cars. In fact, even newborns show a preference for human faces over other complex visual stimuli (Simion et al., 2011), this is indicative of an innate, or unlearned, predisposition for the processing of faces.

The human face conveys a vast amount of information, this includes gender, age, mood, health, and identity (Young, 2018). Being able to discern this information about an individual within less than a few seconds provides huge benefits and has likely been central to social success (see Haxby et al., 2000; Calder and Young, 2005), both at an individual level, and as a species. Given the significant role face perception plays in social interaction and communication, it can be argued that the human face likely evolved in ways to better communicate the above-mentioned information. For example, the significant decrease in the size of the brow ridge (Godinho et al., 2018) between early homonins and *Homo sapiens*, is believed to have allowed for more dynamic facial movement in humans (Lacruz et al., 2019), giving rise to the more complex facial expressions that we so heavily rely upon for communication.

Needless to say, face perception has been the focus of extensive research. One of the earlier indicators that faces were processed differently to other visual stimuli was disorders of face recognition. Prosopagnosia is a neurological disorder characterised by a difficulty in recognizing faces (Corrow et al., 2016). The severity of this deficit can range significantly between individuals, some may only have trouble recognizing familiar faces, while others may be entirely unable to pick out a face from a selection of objects (see Grüter et al., 2008). These individuals often retain all other aspects of visual processing, suggesting specific neural mechanisms for the visual processing of faces (see Corrow et al., 2016).

The way faces are processed, as opposed to other complex objects, has also been a focus of attention, as it further indicates the uniqueness of faces as a visual stimulus. The most prominent theory argues that faces are processed holistically. The idea is that faces are processed as a whole or composite unlike non-face objects (Tsao & Livingstone, 2008). In short, the whole of a face is greater than the sum of its parts. Various effects have been demonstrated over the years that support the holistic processing of faces. Yin (1969) presented the face inversion effect, which describes the interruption of facial processing when faces are presented upside down (Gerlach et al., 2023), arguing that unless presented upright, faces cannot be processed holistically. The composite face illusion is another example of this, first presented by Young et al. (1987), it occurs when the top half of a face is aligned exactly with the bottom half of another, the illusion of an entirely new face is produced (Murphy et al., 2016). The effect also disappears when the composite face is inverted (Young et al., 1987), further pointing to an affinity for processing faces holistically. Faces are also identified more easily when presented as a whole than when parts of a face are presented alone (Tanaka & Farah, 1993).

There is also evidence that faces are processed through unique neural mechanisms, different to other complex visual stimuli. Using a variety of face perception tasks, early PET (positron emission tomography) studies showed the fusiform gyrus to be associated with face processing (Haxby et al., 1991; Sergent et al., 1992). In the years following this, fMRI studies further uncovered the specificity of these anatomical regions for faces, specifically fusiform regions were found to show more activation for faces than letter strings and textures (Puce et al., 1996), and houses and hands (Kanwisher et al., 1997). This area, found on the right mid-fusiform gyrus, has been termed the fusiform face area (FFA) (Kanwisher et al., 1997).

While only a brief outline on the background behind perception, mainly focusing on seminal works, has been described here, it is evident that face perception involves specific mechanisms separate to those used for the processing of other visual stimuli. Furthermore, given the social importance of the face, our impressive abilities to process faces, and the

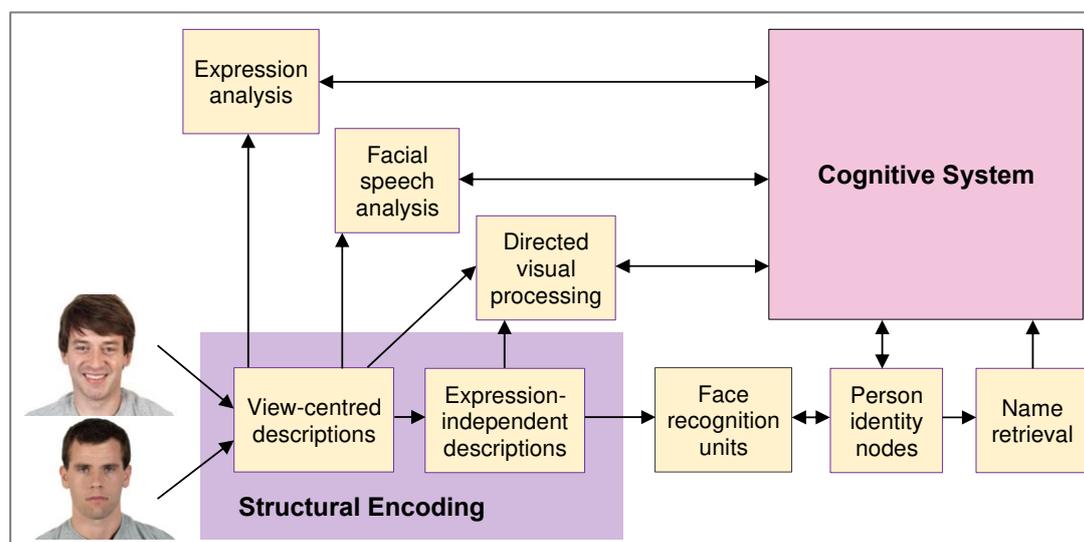
apparent complexity of facial processing mechanisms, it is no surprise that face perception has been a focus of research for several decades now.

Despite this, there remain many unanswered questions within this area of study. This study is focused on addressing two ongoing debates within the field. The first, is the debate surrounding the relationship between facial expression (FE) and facial identity (FI) processing. The second, is the debate surrounding FE valence, and whether a processing bias exists for FEs on one end of the valence continuum. This study aims to contribute to both these debates by employing an experimental foraging task. The following sections will outline the relevant literature behind these two debates, and discuss the background behind foraging tasks and visual search.

2.1 The Processing of Facial Expression and Facial Identity

In recent years, our understanding of how FE and FI may overlap or interact during processing remains largely ruled by early models of face perception. Most early works focusing on face perception supported the parallel route hypothesis (PRH). First presented in the Bruce and Young (1986) functional model of face perception, the PRH purports that the processing of facial expression and facial identity occur entirely independently of one another and in parallel (See Figure 1).

The specifics of the Bruce and Young model are beyond the scope of this review, but the evidence they cited to support their argument for the PRH are quite relevant to understanding the ongoing debate. At the time, various neuropsychological case studies provided most of the evidence for the PRH. Documented cases of patients with intact expression perception, but a complete inability to recognise familiar faces (see Shuttleworth et al., 1982; Bruyer et al., 1983), and vice versa (Kurucz & Feldmar 1979), were referenced by Bruce and Young (1986) as evidence for a complete dissociation between FE and FI processing.

Figure 1*Bruce and Young's (1986) Functional Model of Face Perception**Note: Face images from Chicago Face Database (Ma et al., 2015)*

The Bruce and Young (1986) model set the scene for the decades of face perception research that have since followed. Other influential models of face perception that followed also provided arguments in favour of the PRH. A prime example of this is the Haxby et al (2000) neural model of face perception. This paper proposed a model for the distributed neural system of face perception. They provided evidence from single cell recordings in monkeys that showed different areas of the brain responded to different aspects of the face (see Hasselmo et al., 1989). The superior temporal sulcus showed more activation for changeable aspects of the face (like expression), and the inferior temporal cortex, which was shown to be more involved in the perception of FI. Haxby et al. (2000) also provided evidence from human fMRI studies which showed areas in the lateral fusiform gyrus to be involved in processing of identity (George et al., 1999; Hoffman & Haxby, 2000), and areas in the superior temporal sulcus to be involved in processing changeable aspects of the face (Hoffman & Haxby, 2000; Puce et al., 1998). Overall, the model argued that invariant (identity) and changeable (expression, eye gaze) aspects of the face have distinct representations within the brain. While

the model did not explicitly rule out interaction between the processing of expression and identity, the model presented by Haxby et al. (2000) further supported the popular PRH.

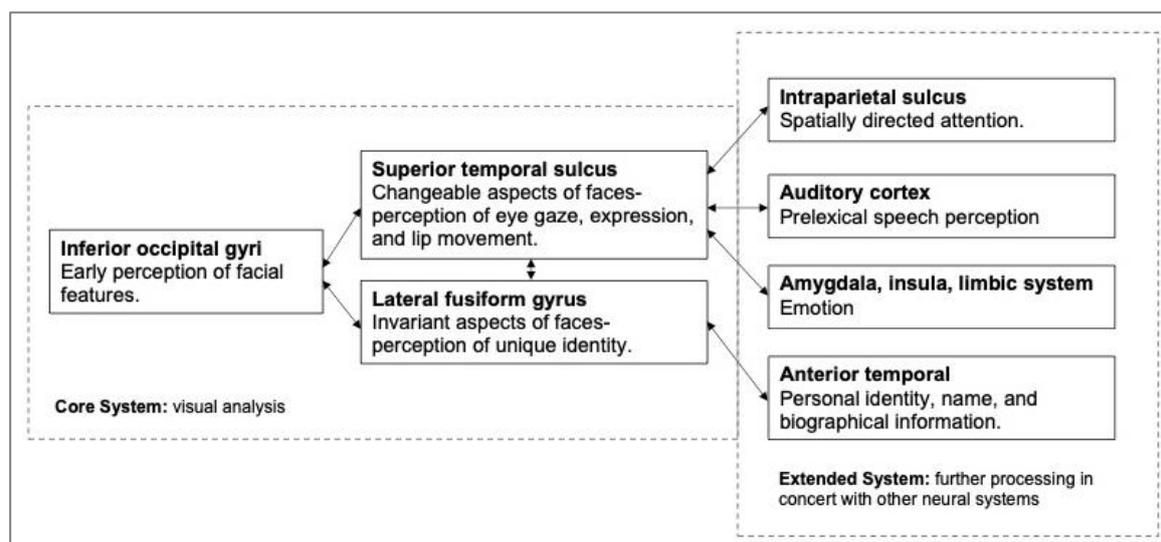
Overall, both models argue that there exist separate pathways for the processing of expression and identity, the key difference between the two is that Bruce and Young (1986) theorised a dedicated system for processing of expression, while Haxby et al. (2000) argued that it is processed alongside other changeable aspects of the face, like eye gaze and speech.

The arguments presented in these models have been challenged extensively, and so there remains lively debate surrounding the issue. Today, it is well understood that the PRH is an oversimplification of what has since been recognised as being a rather complex system (Calder and Young, 2005; Young & Bruce, 2011). Calder and Young (2005) argued that both models based their premise on reliable evidence showing dissociations between FE and FI in processing, however the issue they noted was with the conclusions made about the meaning of those dissociations. Case studies on patients with impaired functions relating to face perception have been a major source of evidence in understanding the mechanisms behind face perception, particularly for the Bruce and Young (1986) model. Calder and Young (2005) noted that the majority of patients suffering from acquired prosopagnosia do not retain the ability to recognise FEs, and those who do appear to retain the ability to process FEs, rarely perform well when evaluated using formal and validated measures of expression perception. In cases where patients maintain the ability to recognise expressions but not identity, the cause of the inability to discern identity is a key factor that has often been overlooked (Calder and Young, 2005). If difficulty in recognising faces is the result of, for example, deficits in semantic memory, one cannot conclude that the maintenance of normal expression processing is evidence of a functional dissociation between FE and FI. Calder and Young (2005) found that upon excluding all case studies that did not utilise validated or rigorous methods to evaluate face perception abilities, only two cases studied offered evidence for intact expression perception and impaired FI recognition (see Bruyer et al., 1983; Tranel et al., 1988), and even those were found to have some methodological issues.

Since the development of fMRI in the 1990s, the focus has shifted toward evidence from neuroimaging studies, in addition to the typical neuropsychological and behavioural evidence. As described earlier, the Haxby et al (2000) model used fMRI evidence showing that different brain areas, the fusiform face area (FFA) and the posterior superior temporal sulcus (pSTS), were functionally and independently linked to FI and FE processing, respectively (see Figure 2). However, further fMRI studies looking at the relationship between FI and FE processing found that the FFA is also involved to some extent in the processing of FE (see Bernstein & Yovel, 2015 for a review). This further points to a more complex relationship between FE and FI processing, and further discredits the notion of a complete neural dissociation between the two.

Figure 2

The Distributed Human Neural System for Face Perception, Haxby et al (2000).



Behavioural evidence from experiments run with both normal populations and those with neuropsychological deficits have also been a central source of information contributing to the ongoing debate. Furthermore, they have also been vital in fuelling discourse surrounding the nature of the underlying relationship. A common experimental paradigm used to investigate the relationship between FE and FI is the Garner paradigm. This is a speeded categorisation task first presented in Garner and Felfoldy (1970), that was later expanded upon by Garner in 1976. By comparing response times, the Garner paradigm assesses the ability to direct selective attention to a specific dimension of a stimulus, for example FI, while ignoring irrelevant dimensions, for example FE. By doing this, the Garner task allows us to determine whether one stimulus dimension can be processed independently of another, and vice versa.

Schweinberger and colleagues utilised a Garner speeded classification task in a series of studies to assess the relationship between FE and FI. In both of these studies, they found interference from FI to FE, but interference from FE to FI was rarely observed (Schweinberger and Soukup, 1998; Schweinberger et al., 1999). These results led to the asymmetric relations hypothesis, which argued that FI is perceived and processed independently of FE, however FI may exert some influence over the processing of FE (see Wang et al., 2013).

In another follow up study, interference from FE to FI was rarely found, but was especially uncommon in cases of unfamiliar faces (Kaufmann & Schweinberger, 2004). Similarly, in a study by Ganel and Goshen-Gottstein (2004) which also made use of a Garner speeded classification task, it was concluded that familiarity with a face increases the interconnectedness of FE and FI processing. Challenging the previous notion of an asymmetric relationship outlined by Schweinberger et al. (1999), the researchers proposed the structural-reference hypothesis. The structural-reference hypothesis posits that individuals possess the ability to efficiently interpret FEs by relying on the inherent connection between a face's structure (identity) and its unique expression (Ganel and Goshen-Gottstein, 2004). This hypothesis suggests that when confronted with a specific FE, it becomes easier for perceivers to deduce the associated FI, as only a limited set of facial structures can produce that

expression in a precise manner. Essentially, the hypothesis highlights a reciprocal relationship between facial structure and expression processing, with FI facilitating more effective recognition and understanding of FEs.

However not all studies that utilised a Garner paradigm have come to the same conclusions. A study by Wang et al. (2013) argued that the apparent relationship between FE and FI found in studies using a Garner paradigm have had more to do with the discriminability of stimuli, rather than the nature of face processing itself. They conducted four experiments, controlling for the discriminability of FE and FI, and found that discriminability of FI and FE “mediates Garner interference” (Wang et al., 2013). By modifying the discriminability of both FE and FI in the different experiments, they found differences in Garner interference. This may call into question the applicability of Garner paradigms for use in investigating more complex stimuli, like faces, where discriminability may play an important role in performance.

The visual adaptation paradigm has also been used extensively to investigate this relationship. Visual adaptation is commonly described as a short-lived adjustment in sensitivity or perception upon exposure to a novel stimulus, along with the aftereffects that persist after the stimulus is no longer present (Webster, 2015). A study by Fox and Barton (2007) used a visual adaptation paradigm to investigate the neural representation of facial expression. The results of two experiments indicated the existence of two neural representations of FEs, an identity dependent representation and an identity independent representation. In a follow up visual adaptation study (Fox et al., 2008) they concluded that FI aftereffects are unaffected by variations in expressions. This finding further supports the argument of an asymmetric relationship between FE and FI processing. Another study by Campbell and Burke (2009) produced similar findings, they found significant aftereffects both when FI varied and when it didn't. However, these aftereffects were larger when the identity of the adapting and test stimuli were the same, indicative of some identity dependent representations of expression. Ellamil et al. (2008) argued that expression adaptation is dependent on certain perceptual features central to identity processing, indicative of the existence of some asymmetric overlap

between FE and FI processing. Rhodes et al. (2015) argued for a common dimension in the processing of FE and FI, specifically at higher levels of visual processing.

Overall, the takeaway from research over the past two decades is that there is some overlap between FE and FI processing, with most findings suggesting an asymmetric relationship in which variation in identity impacts the processing of expression, but variation in expression has little to no effect on the processing of identity. However, despite extensive evidence against the PRH, the early models of face perception discussed earlier continue to dominate the narrative surrounding FE and FI processing. More research focusing on the relationship between FE and FI processing is needed, with particular attention to the validity and reliability of tasks and stimuli. This present study hopes to contribute to our understanding of this topic, and help to expand the current body of literature.

2.2 Positive or Negative: Are we Biased by Expression Valence?

Almost all stimuli have some element of emotional valence. Emotional valence is the qualitative value associated with a stimulus expressed as a point on a continuum between positive and negative (Russell, 2003). Things like music, words, faces, sounds, or images all have emotional valence (Kauschke et al., 2019). One question surrounding the emotional valence of stimuli is whether being positioned to a particular end of the continuum (positive or negative) results in preferential processing (Kauschke et al., 2019).

The continuous theory of facial expressions, initially presented by Russell (1980), argues that facial expressions exist within circumplex model. More specifically, facial expressions exist within two continuous dimensions. The first dimension is arousal, with high arousal and low arousal at the opposite ends of the spectrum. The second dimension is emotional valence, with positive and negative being the extremes of this dimension, as described above. Emotions and expressions can exist at any point within this circumplex model. Within the current context, the question at hand is whether there exists some bias for the processing of either positive FEs or negative FEs on the emotional valence continuum. In

this case, bias refers to some advantage in processing a stimulus positioned on one end of the valence continuum over a stimulus on the other end of the continuum, this could be a faster response time, or a lower error rate on tasks designed to evaluate FE performance.

Positivity bias has been found for a variety of stimuli, including facial expressions. For example, Leppänen and Hietanen (2003) demonstrated a response time advantage for classifying positive FEs over negative or neutral faces. Walden and Field (1982) found that fewer errors were made when recognising positive FEs, and that this finding was consistent in both children and adults. Svärd et al. (2012) also found similar bias for positive expressions across different age groups. Several explanations have been suggested for this positivity bias. One theory is that positive FEs are encountered far more frequently than negative, and that this higher rate of exposure results in the visual system being more proficient in processing positive expressions (Somerville & Whalen, 2006). Another explanation is that positive expressions, particularly happy expressions, are more visually distinct than negative or neutral expressions. Specifically, a discernible smile is a key feature of positive expressions that is not found in other facial expressions (Calvo et al., 2010; Calvo et al., 2012), thus functioning as a cue for the visual system, making the identification of positive expressions more efficient.

However, there is conflicting research which points to a negativity bias in FE processing. Essentially, both positivity and negativity biases have been found for FEs, but it is dependent on the experimental paradigm used (Kauschke et al., 2019). More specifically, an advantage has been found for recognising angry or threatening FEs over positive or neutral expressions in experimental tasks where different FEs are presented together, for example in visual search tasks (Pinkham et al., 2010). When participants are required to identify a target expression among multiple distractor stimuli exhibiting non target expressions, a negativity bias in the form of shorter response times tends to be found. Such a negativity bias has been found using both schematic faces (Fox et al., 2000; Öhman et al., 2001), and real faces (Horstmann & Bauland, 2006; Pinkham et al., 2010). This is known as the Face in the Crowd Effect, and it has been proposed that this negativity bias may be an evolutionary adaptive function (Pinkham et al., 2010). As mentioned earlier, FEs are a major source of non-verbal

communication, and negative FEs are a salient cue to possible danger. An angry face could be a predictor of aggression in others, and a fearful face could indicate the presence of danger in the immediate environment (Öhman et al., 2001). Being able to process these expressions more rapidly, could allow for a faster and more effective response to hazardous situations.

The main takeaway from the research on FE valence bias is that different experimental paradigms yield conflicting results. More specifically, studies using paradigms where stimuli are presented individually typically show a positivity bias, while studies presenting target stimuli among distractors (a visual search task, for example) tend to show a negativity bias. This study aims to further contribute to this debate.

2.2.1 A note on arousal bias

Another aspect to consider, while not central to this current study, is processing bias across the arousal continuum. Arousal bias is well established to exist for a variety of stimuli (see Xu et al., 2021). Similar in concept to valence bias, arousal bias describes some processing advantage for stimuli at one end of the arousal continuum, high arousal, or low arousal. It has been suggested that some of the contradictory results found when investigating valence bias in FEs may be due to stimulus arousal that was not accounted for (Lundqvist et al., 2013). For this reason, this study will account for stimulus arousal, and so any identified valence bias can be interpreted within the context of arousal bias.

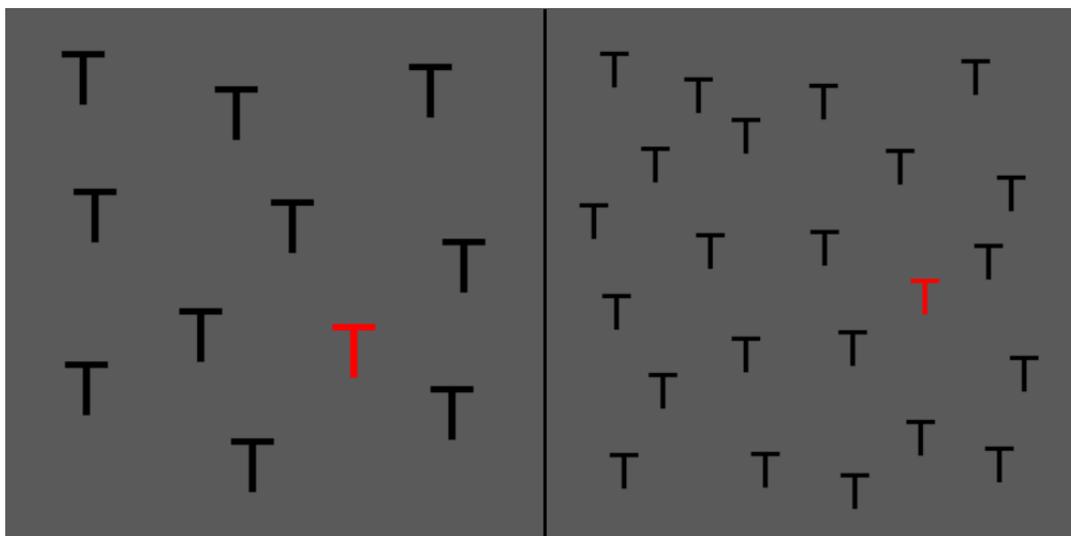
2.3 Visual Search and Foraging

At any point in time, our attention and eye gaze are focused on very specific objects or aspects within a visual scene. As you're reading this, your visual attention is focused on the words in this sentence. The other lines on the page likely look somewhat blurry, and without shifting your attention, you'd be unable to read them. The need to direct visual attention to process objects within a scene is apparent in all aspects of life, think of searching for your keys on a cluttered table, or looking for a specific house number while walking down the street.

The perceptual activity of directing attention across a visual scene to identify a specific target, like your keys, is known as visual search (see Wolfe & Horowitz, 2017).

Visual search behaviour has been a focus of research for over 50 years (Bella-Fernández et al., 2021), and the visual search paradigm has been applied to various areas of visual perception and attention research. Visual search tasks can give insight into both search strategy and the factors that impact search performance (Chan & Hayward, 2013). Such tasks typically require participants to search and identify a target stimulus from an array of distractor stimuli, target and distractor stimuli can differ on one or more visual features (see Wolfe & Horowitz, 2017). Visual search performance is typically measured using response time (RT) as a function of the number of distractors (the set size), with the slopes of RT x set size being the measure of efficiency for visual search (Wolfe & Horowitz, 2017). Note that the use of slopes as a measure for visual guidance is not necessarily straightforward (Kristjánsson, 2015; see Wolfe, 2016).

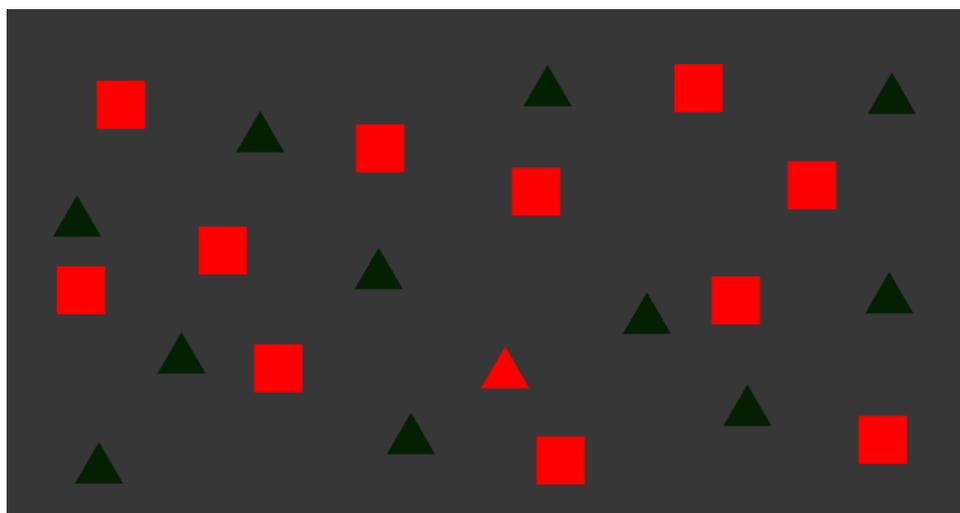
There are two main types of visual search tasks, feature and conjunction (see Treisman & Gelade, 1980; Kristjánsson & Egeth, 2019). Feature search tasks involve the search for a target that differs from distractors in one visual feature. An example of this would be searching for a red 'T' amongst an array of distractor black 'T's (see Figure 3). Performance on feature search tasks is mostly unaffected by increases in set size (McElree & Carrasco, 1999); finding a red 'T' in an array of 100 black 'T's is about as easy as finding it in an array of 10 black 'T's (see Figure 3). This is largely because targets in feature search tasks 'pop out', this is because target stimuli in feature search tasks differ from another by only a single feature (Wolfe & Horowitz, 2017). A feature describes a single visual property, for example colour, shape, or orientation. When a search array contains targets that differ from distractors by one visual feature, attention is drawn to the target, as opposed to having to effortfully orient attention identify it. This is known as bottom-up guidance, and it is driven by the salience of a target or stimulus (Wolfe & Horowitz, 2017).

Figure 3*Example of Feature Search*

Conjunction search on the other hand involves identifying a target that doesn't differ from distractors on just one feature (see Treisman & Gelade, 1980). This involves the presence of a variety of distractors that while different from another, that all have a common visual feature with the target, as opposed to having a single type of distractor as is commonly found in feature search tasks. A prime example of this is having to search for a red triangle in an array of red squares (same colour as target) and green triangles (same shape as target) (see Figure 4). Conjunction search requires the orienting of visual attention, which can be described as a systematic scan of each item in the array in order to identify the target (McElree & Carrasco, 1999). This form of visual search task requires more effort as set size increases, and so performance can be measured using the search slopes described above.

Figure 4

A Simple Example of Conjunction Search with a Single Target.



Foraging behaviour, while somewhat similar to visual search, involves the visual scanning of an area for multiple instances of a target among multiple distractors (Wolfe, 2013). A simple foraging example is berry picking, imagine having to pick the ripe berries off a bush, while leaving behind the unripe ones, that is foraging behaviour (Wolfe, 2013). Foraging behaviour has classically been studied in animals (Dawkins, 1971; see Scharf et al., 2010), and more recently it has been used to investigate human visual attention and processing (see Gilchrist et al., 2001; Hills et al., 2013; Kristjánsson et al., 2014; Kristjánsson & Kristjánsson, 2018; Kristjánsson et al., 2020; Wolfe, 2013). Foraging tasks involve presenting multiple targets among multiple distractors, for example 20 targets and another 20 distractors. Typically, each target disappears after being identified, similar to what would happen in a natural foraging behaviour like berry picking. This means that as the trial progresses, the distractor set size increases, along with the ratio of targets to distractors, resulting in the task becoming progressively harder as one progresses (Kristjánsson et al., 2020).

Kristjánsson et al. (2014) introduced an iPad based foraging task, designed to be easily administered in a lab environment, which provides an ideal example of a foraging task. As with typical foraging tasks, each trial required participants to find 40 targets among 40 distractors. They presented two variations of the foraging task, feature and conjunction. In both tasks,

there are two types of target stimuli. In feature foraging, target stimuli are defined by one specific feature, for example finding red and yellow targets among blue and green distractors. In conjunction foraging, targets are defined by more than one feature, for example searching for red circles and green triangles among red triangle and green circle distractors. As with classic visual search, conjunction foraging tasks require more effortful search, as targets do not pop out.

When attentional load increases, as it does in conjunction foraging tasks, both animals and humans tend to select the same target type consecutively at a rate above chance (continuing with the example above, one would identify multiple red circles in a row, rather than switching between identifying red circles and green triangles). This is known as run behaviour (Kristjánsson et al., 2020). When switching between one target type and another, more cognitive resources are needed, reducing efficiency, and increasing response time (Kristjánsson et al., 2020). Run behaviour is a key performance measure in foraging paradigms, as it illustrates what features of stimuli increase attentional load.

Another key performance measure in foraging tasks is inter target time (ITT) or serial response time (SRT). This is a measure of the time taken to select each target on a trial. Comparing SRT differences between different target stimuli can serve as an indicator that certain target features may be processed less or more efficiently. SRT also reflects different aspects of processing in foraging, for example the first target selection tends to be significantly slower than the subsequent selections on any given foraging trial, this could be reflective of forward planning, and response preparation (Basoudan et al., 2019).

2.3.1 Visual Search and Foraging for Complex Visual Stimuli

Classic visual search paradigms have been used to research more complex visual stimuli, like cars and words (for example Hemström et al., 2019). Visual search tasks, specifically single target visual search, has also been extensively used to investigate face perception and its underlying mechanisms (Calvo et al., 2008; Calvo & Nummenmaa, 2008; Frischen et al., 2008; Hemström et al., 2019; Keys et al., 2021; Tong & Nakayama, 1999).

However, this study is particularly interested in studies that have utilised multi target visual search or foraging tasks to investigate complex visual stimuli, like faces.

A few studies utilising multi target visual search or foraging of faces have been conducted. For example, Becker et al. (2011) conducted a series of experiments investigated FE recognition using both single target and multi target visual search. Another example is Hávarðardóttir and Þorlákssdóttir (2022), who used a foraging task as a tool to measure face recognition ability. However, investigating face perception using multi target visual search or foraging tasks is still relatively uncommon, and so this study aims to utilise a foraging paradigm to investigate specific aspects of face perception.

2.4 The Present Study

The aim of this current study is to further investigate some mechanisms relating to face perception using a foraging type task (based on the task used in Kristjánsson et al., 2014). More specifically we hope to provide further insight into the relationship between FE and FI processing and the FE valency bias, using an adapted foraging paradigm.

3.0 Experiment 1

This chapter provides the methodology, results, and a brief discussion for Experiment 1. This experiment was designed to explore two main questions. The first is whether variation in FI impacts the processing of FE, and the second is whether there is a processing bias for either positive or negative valence FEs. These questions were explored through a foraging task using AI generated face images of famous male celebrities exhibiting different expressions as stimuli. The task consisted of 20 trials, and on each trial, participants were required to search for faces fitting into a particular category of emotional valence.

3.1 Methodology

3.1.1 Aims and Rationale

The primary aim of this study is to further investigate the nature of the relationship between the processing of facial identity (FI) and facial expression (FE). This will contribute to the ongoing debate surrounding their relationship, and more generally add to our understanding of face perception. The main question being addressed is whether variation in identity influences the processing of facial expressions in a foraging task. This research will also shed light on the utility of foraging tasks for investigating the processing of complex visual stimuli, in this case faces.

3.1.2 Research Proposal and Ethical Approval

A research proposal for this study was submitted to the Department of Cognitive Science at the University of Malta. Once this was approved, a Research Ethics and Data Protection (REDP) form was submitted to the Faculty Research Ethics Committee (FREC) of the Faculty of Media and Knowledge Sciences via the University of Malta URECA platform (see Appendix A). A copy of the participant consent form was submitted along with the ethics form (see Appendix B). Given the non-sensitive nature of the participant population and the

data being collected, the REDP form met the criteria to only be submitted for records and did not need to undergo a review process by FREC (see Appendix A).

3.1.3 Recruitment

A convenience sampling technique was used to recruit participants. Participants were approached independently by the experimenter and given a brief explanation of what participation would entail before being asked to participate. The non-sensitive nature of the data being collected, and their rights pertaining to accessing their data were made clear to them before participation. Participants were also given an opportunity to ask any questions relating to the study before and after completing the experimental task, and were also given the contact information of the principal investigator and the experimenter in case they had any questions following their participation.

3.1.4 Risks and Benefits to Participants

The phenomena being investigated, and the data being collected, were not of a sensitive nature, and so there were no risks to participants throughout the entire duration of the study. There were also no direct benefits to participants. However, participants were financially compensated for their time and participation. Each participant was paid 5 Euros in cash for their participation, each session lasting approximately 25 minutes, this included the time taken for the recognition test, the collection of demographic data, an explanation of the task and study, and the completion of the experimental task.

3.1.5 Participants

A total of 12 participants were recruited to participate in experiment 1. This sample size was chosen based on other foraging experiments which utilised similar sample sizes (see Thornton et al., 2020; Kristjánsson et al., 2020; Prpic et al., 2019; Wolfe et al., 2016). An equal number of male and female participants took part, this was done to account for gender differences in facial recognition (Herlitz & Lovén, 2013), and expression perception

(Wingenbach et al., 2018). Anyone not between the ages of 18 and 40, and not Caucasian were excluded from the study. Non-Caucasian individuals were excluded due to the other race effect (McKone et al., 2021), as the stimuli used in the experiment were images of Caucasian celebrities (see Figure 4). All participants had normal or corrected to normal vision.

The mean age of participants in Experiment 1 was 25.1 years, and the overall age difference between female participants ($M = 25.2$ years) and male participants ($M = 24.8$ years) was negligible. Four participants were left-handed, the other eight being right-handed.

3.1.6 Stimuli Development

Typically, photographs of real faces are used as stimuli in face perception research. These images can be taken by researchers for use in a specific study or accessed through a face image database. There are several databases of face images that have been curated for research purposes. Often categorised by features that need to be controlled for in face perception research like race, gender, and expression, these databases are often made available on request for use in research (see <https://www.face-rec.org/databases/> and <https://libguides.princeton.edu/facedatabases> for examples).

Using a face image database provides various benefits. The most obvious benefit is that it is more time efficient to use images that are already available. Another factor to consider is that many face image databases are made up of images taken by researchers for that database, as opposed to being made up of already existing images. This means that the images in such databases are controlled for low level image features like luminance and shadow. Consistency in these low-level image features is important as it allows for more confidence that any effects found are related to features of interest, like expression for example. Finally, images in databases have likely been validated for use in research, and been used in other studies, so are a reliable source of data.

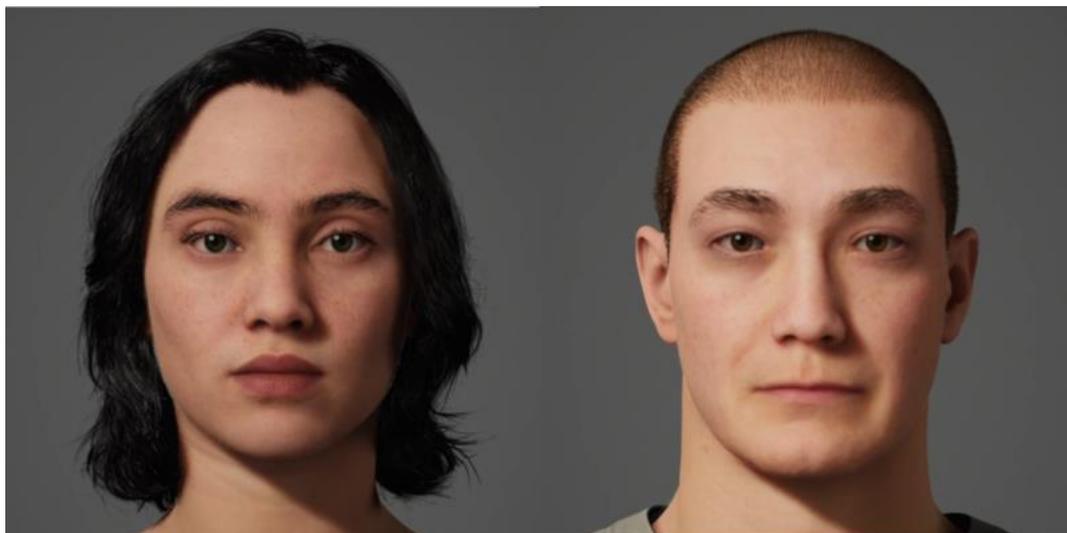
Despite the benefits of using a face image database, a decision was made in the early stages of planning this study to explore developing artificial images for use as stimuli. The primary motivating factor behind this choice was to explore the applicability of recent

technology to the study of face perception. Given the ever-changing nature of the technological landscape, it is vital to remain up to date on the various advancements that could be applied to research. Furthermore, there are also limitations to face databases, for example being unable to find a database that meets the requirements of a study. So, for this study, a few methods were explored for the development of artificial face stimuli.

MetaHuman is a plugin available on Unreal Engine, a game engine developed by Epic Games. The MetaHuman plugin allows for the creation of photorealistic digital humans (see Figure 5 for examples of MetaHuman avatars). The software also incorporates animation capabilities, allowing for the creation of various facial expressions for MetaHuman avatars. The software is available free of charge (and can be downloaded from <https://www.unrealengine.com/en-US/download>). Our initial idea was to use Metahuman to create several individually distinct faces (multiple identities), and then applying various animations to develop facial expressions. We were intrigued by this option as it would allow us to apply the exact same expression animations to different “identities”, potentially producing stimuli which varied in identity, but that remained relatively consistent in expression between said identities. Unfortunately, the software does require quite a powerful computer, specifically it requires a powerful graphics card to run efficiently, which we did not have access to. While we did try to use the software on a variety of different machines available to us, we ultimately decided to abandon the idea of using MetaHuman due to the time constraints of this project.

Figure 5

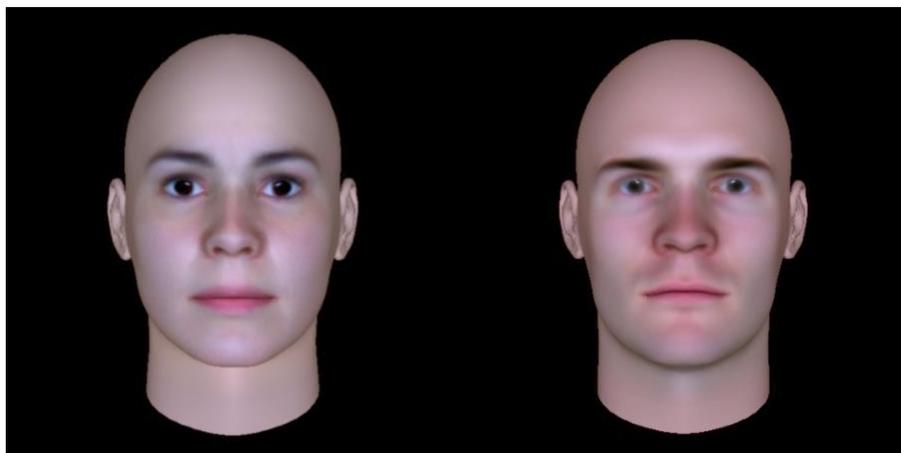
Examples of a female (left) and male (right) MetaHuman avatar.



Following this, we decided to attempt to use FaceGen. FaceGen is a software designed for automated human face generation. The software allows for the creation and customisation of different faces, which can vary in age, race, and gender. Some example stimuli are shown in Figure 6. The software also allows for very specific editing of facial expressions. It allows one to create facial expressions through the Facial Action Coding System (FACS). FACS is an anatomical based system that can be used to describe facial movement, within this system, any facial expression is made up of a number of distinct facial muscle movements known as action units (*Facial Action Coding System*, 2020). The modeller comes with all 44 distinct action units described in the FACS. While this software has been available for many years (*FaceGen About*, 2024), we thought it could allow us to follow through with our original idea of creating distinct identities with consistent expressions across those identities. Creating distinct identities using the software was entirely possible, however the limitations of the software became apparent when we attempted to apply the various expressions. Once we applied similar expressions (similar in terms of FACS action units) to the faces we had generated, we realised that it was no longer possible to differentiate between the different identities. This unfortunately, made the software unsuitable for our purposes.

Figure 6

Examples of female (left) and male (right) avatars generated using FaceGen.



Due to time constraints, we decided to explore other options that may not allow for such detailed customisation of the expressions but would still allow for the creation of unique expressions and distinct identities. So, we decided to move on to explore the use of artificial intelligence (AI) generated images as stimuli. With the introduction of text-to-image generative AI over the past few years, for example DALL-E by OpenAI (Ramesh et al., 2021), AI image generation has become a hot topic. While it was clear for the outset that this method would not allow us as much control over the stimuli as other methods explored, we felt it would be advantageous to explore the utility of such technology in face perception research. While there are many limitations to developing stimuli with generative AI, which will be discussed later in the limitations section of the discussion chapter, we ultimately went ahead with using this approach for this study, as discussed in the next section.

3.1.7 Stimuli

The experimental task made use of AI generated images of the faces of six Caucasian, male celebrities depicting different facial expressions. The use of famous faces is well established within the literature for investigating the processing of familiar faces (Yovel et al., 2014), this is because they are an easily accessible source of faces familiar to the general public. Picsart generative AI image generation tool was used to generate the stimuli. Picsart

suite is an online platform that provides a variety of photo and video editing tools against a monthly subscription fee. The AI powered image generation tool was introduced to the platform in November of 2022 (Moreno, 2022).

The AI image generation tool on Picsart is a text-to-image AI, meaning it requires a user text prompt for image generation. Multiple images are produced based on a single prompt, with the option to consistently request the generation of more images from the same prompt. Six Caucasian, male celebrities of varying ages were chosen to be used as stimuli, these were Chris Pratt, Chris Martin, Chris Hemsworth, Ed Sheeran, Mick Jagger, and Tom Cruise. These people were chosen based on their popularity, as it was likely participants would be familiar with the faces of most, if not all, of these people. Four facial expressions were needed for the study. Based on a circumplex model of face perception (Russell, 1980), the four expression categories were the following: high arousal negative valence, low arousal negative valence, high arousal positive valence, and low arousal positive valence.

Based on this information, a variety of prompts were drafted to be used in the AI image generation software. Examples of the prompts used can be found in Appendix C. Because of the sensitivity of the software, the prompts used for each identity varied between expressions. Of the generated images, the images judged to be most appropriate by the researcher were chosen. A single image of each expression class for each identity was generated, totalling 24 images. Figure 7 provides an example of a stimulus image before and after editing for a single identity, while Figure 8 shows the full set of stimuli used in this experiment.

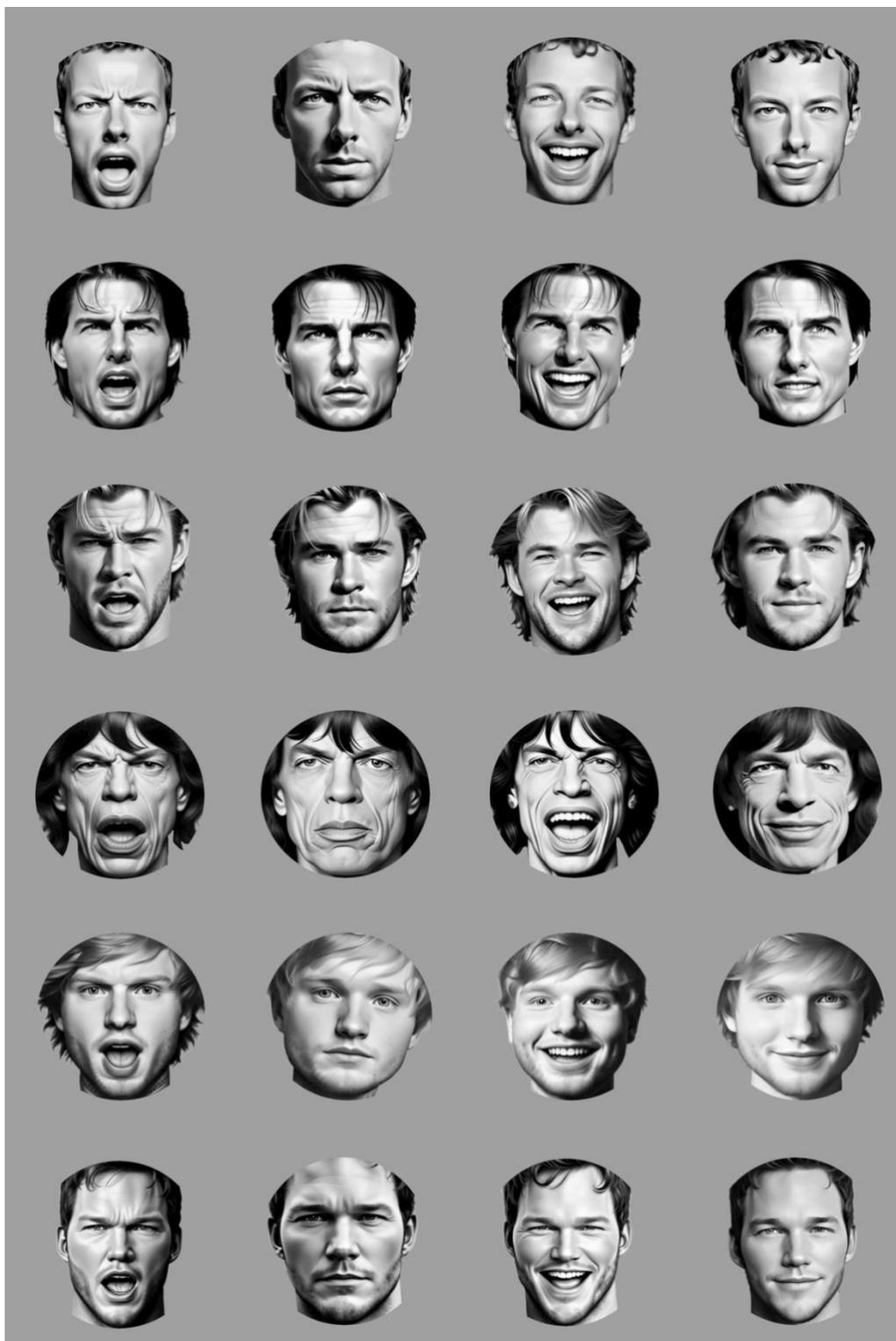
Figure 7

A figure showing a raw image generated on Picsart (left), and the same image after editing shown on a grey background (right).



Figure 8

All 24 stimuli used in experiment 1. Each row shows the four expression images for each identity used. From left to right, high intensity negative valence, low intensity negative valence, high intensity positive valence, low intensity positive valence.



Once generated, each of the 24 images was run through the Picsart AI image enhance tool, which among other things, increases the resolution and overall quality of the image (Pye, 2024), and replaces any background with transparency. The raw images were 1080 x 1080 px in size and were downloaded in PNG format. The images then needed to undergo further editing, and this was done using GIMP-2.10, a free image editing software. The images were cropped from below the hairline to the chin, ensuring the crop was an exact circle to maintain consistency across all images. Any parts of the neck or shoulders that were not removed with the initial cropping were erased using the eraser tool. Once cropped, the images were resized to 300x300 pixels, and made greyscale.

3.1.8 Experimental Task

The experimental task was adapted from the human foraging task developed by Kristjánsson et al. (2014). The task is an iPad based experimental task written using JavaScript. The code was adapted and edited to suit the requirements of this experiment.

The experimental task consisted of a single block of 20 trials. During each trial, 10 images of each of the 4 expression classes (as described above) were shown, totalling 40 face images (see Table 1 for a visual representation of this). This means that there was an equal division of high arousal and low arousal, and positive and negative faces. The images moved around the search area throughout the trial, the movement was random, and images could overlap. By having the stimuli moving, participants were unable to search the images in a systematic manner (for example row by row), forcing participants to search in a more dynamic manner. On half of the trials, all six face identities were included, while the other half of the trials presented images of only one identity (see Figure 9). This identity condition made it possible to investigate the effects of identity on expression processing.

Table 1

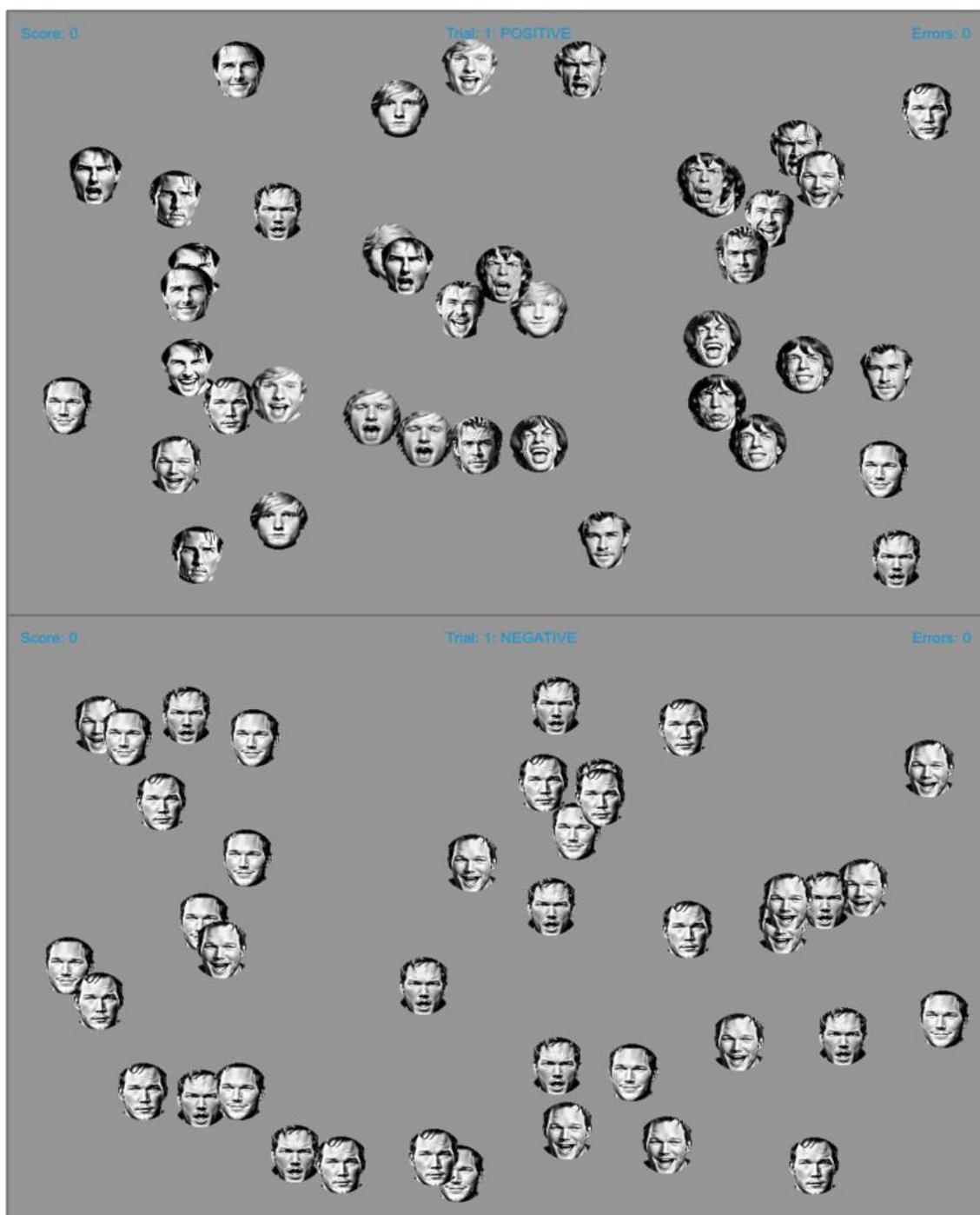
The number of images for each expression class shown on any given experimental trial.

	High Arousal	Low Arousal	Total
Positive Expression	10	10	20
Negative Expression	10	10	20
Total	20	20	

On a given trial, participants were required to select faces of a particular valence (positive or negative), which was indicated to them at the top of the screen. Half of the trials required them to select positive expressions, while the other half required them to select negative expressions. Each time a participant would successfully select and cancel a target, it would disappear. Thus, as the trial progressed, the target to distractor ratio would decrease and the task became progressively harder, as more search effort was required to locate target faces. Because of this, participants were only required to select 12 of the target images on any given trial. This was done primarily to prevent boredom and fatigue in participants. Once participants selected the 12 targets, the next trial automatically began. Any errors made were indicated to the participant through an error count shown on the top right of the screen. If, on any given trial, there were over 4 errors, the trial would be cancelled, and a new trial would automatically begin. The experiment would automatically end once 20 correct trials (trials with fewer than 4 errors) were completed.

Figure 9

Top panel shows a different identity trial, the bottom panel shows the single identity trial.



3.1.9 Data Collected

A range of measures were obtained on each experimental trial to be used for data analysis. This data was automatically recorded and was saved locally after each participant completed the experimental task. For each trial the type of Identity Condition (same identity or different identity), the target valence (positive or negative), and the number of errors made was recorded. For each target selection in each trial, the expression category of the selected target was recorded, making it possible to identify both the valence and arousal of the item. Response time (RT) data was also collected, this was measured as the time between the onset of the experimental trial, and the time of each of the 12 target selections, totalling 12 RT values per trial (RT1 through RT12). This raw RT data is cumulative, meaning it measures the time taken from the onset of the trial to each selection.

3.1.10 Procedure

Data collection took place in the Cognitive Science Lab at the University of Malta. Each participant met with the experimenter individually. Participants were first given a brief explanation of the study, and what would be required of them. They were given a hard copy of the consent form (see Appendix B) and were given the time to properly read it before signing. Once signed, participants were asked for some simple demographic data, this included their age, gender, and dominant hand. This data was recorded in a Microsoft Excel spreadsheet. Each participant was given a participant number, and this number was used to anonymously keep track of participants across the data.

Participants were then required to complete a recognition task. They were presented with a grid of images showing the uncropped versions of the stimuli used in the task. Each row showed four images of one of the six male celebrities included in the foraging task, each image showing a different expression (see Figure 10). Participants were asked to scan the sheet row by row, and indicate whether or not they could recognise the celebrity. They did not need to be able to name the celebrity necessarily, but just needed to be familiar with the face.

Their responses were recorded by the experimenter (see Appendix D). This was done to ensure no participant had any significant difficulty in recognizing faces.

Participants were then required to proceed with the experimental task. The task was presented on an iPad, with a 10.9 inch display (2360x1640 pixel resolution). The screen was set to full brightness (500 nits). Participants were required to use their fingers to select targets. Participants were seated in a soundproof, light-controlled booth to carry out the experiment. They were given another chance to ask any questions relating to the study before beginning the experimental task. The time to complete the task varied between participants due to individual differences in processing speed, but lasted approximately 10 minutes. Once the experimental task was completed, the experimenter was required to download the data, which was saved under their respective participant number.

Participants were asked for any feedback on the task, and if they had any other questions. Before leaving, they were paid for their participation in cash, and were required to sign a confirmation of receipt of payment (see Appendix E). The payment receipt sheet is a standard sheet issued by the Department of Cognitive Science, it purposefully does not disclose the nature of the study, to avoid having identifiable participant data connected to a particular study.

Figure 10

The recognition test sheet shows each of the 6 identities included in the experimental task.



3.1.11 Data Analysis

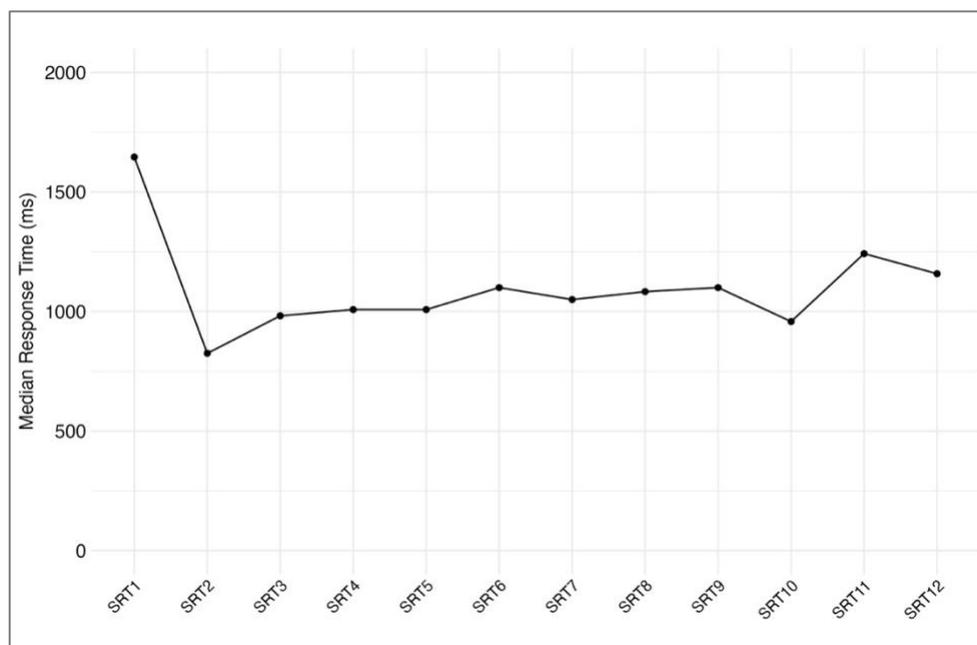
This section will describe the data analysis procedures conducted. Several statistical analyses were run on the collected data to investigate the relationship between FE and FI, expression valence bias, and arousal bias. All trials with more than four errors were excluded from data analysis. A total of 240 trials (20 correct trials per participant) were included in the final data analysis. This section is organised by dependant variable (DV).

RT1. Response time 1 (RT1), is the time taken for the first selection to be made on each trial. In multiple-target (e.g., Basoudan et al., 2018; Thornton & Horowitz, 2004; 2020) and foraging tasks (e.g., Kristjansson et al., 2020) RT1 has been shown to be subject to lag effects, that means that the first choice on any trial tends to have a significantly higher response time than the subsequent selections on the trial. Figure 11 clearly demonstrates this lag effect in the current data (note it shows serial RT values not cumulative RT), with a high initial response, followed by more consistent faster RT, known as the cruise phase. This lag is thought to be due to prospective planning and motor initiation delays, and for this reason, RT1 is typically analysed independently from other responses. Here, RT1 analysis allows us to investigate the effects of variation in identity and the effect of different expression targets during this initial response phase. The median RT1 was calculated as a function of Identity Condition and Target Valence for each participants using RStudio. The median data was then used to calculate a 2(Identity Condition) x 2(Expression Target) repeated measures ANOVA in JASP.

RTT. To summarise the overall time taken to complete the trial, excluding the first response, we analysed RT12-RT1 (RTT). By doing this we can get a more accurate analysis of the total time taken to complete a trial while factoring out the initial lag. The RTT value (RT12 – RT1) was calculated for each trial using RStudio. Analysis of RTT would allow for us gain insight into the effects of variation in identity and different expression targets during

Figure 11

Line graph showing median serial RT for each trial.



the main search phase of the trial, the cruise phase. The median of RTT was calculated as a function of identity condition and target expression for each participant, also using RStudio. The median data was then used to calculate a 2(Identity Condition) x 2(Expression Target) repeated measures ANOVA on JASP.

SRT. To analyse the time taken between selections the serial response time (SRT) values were calculated. While RT1 is the same as SRT1, the subsequent SRT values had to be calculated by subtracting the previous RT value from each RT value, so $RT2 - RT1$, $RT3 - RT2$, $RT4 - RT3$ and so on. This was done using RStudio and resulted in 12 SRT values for each trial. Due to the lag effect for the first selection, described above and illustrated in Figure 11, SRT1 was excluded from the analysis. The mean of SRT2 through SRT12 (meanSRT) for each trial was calculated, and the medians of meanSRT were calculated as a function of Identity Condition and Target Valence for each participant using RStudio. The median data was then used to calculate a 2(Identity Condition) x 2(Expression Target) repeated measures ANOVA on JASP. By analysing the SRT values in such a way, we could gain another insight

into how the overall performance on the task was influenced by variation in identity and expression target.

Arousal Proportion Analysis. The arousal class (high arousal or low arousal) was recorded for each target selection on every trial. This made it possible to assess if there was a bias for high or low arousal expressions when making selections. We coded low arousal selections as 0 and high arousal selections as 1, so that a value of 0.5 would indicate no bias. Mirroring the RT analysis, we performed separate analysis for the first response, and then looked at the overall selection bias during the remainder of the trial.

For both response-phase dependent measures, used one-sample t-tests to assess whether the observed bias differed from chance selection and a 2 (Identity Condition) x 2 (Expression Target) design to determine if variation in identity or expression valence produced any bias for either high or low arousal expressions.

Arousal Runs Analysis. The arousal choice data was used to calculate run counts for each trial. This is done by counting how many times participants switched between selecting high arousal and low arousal faces, this was done using RStudio. The mean run count was then calculated as a function of identity condition and expression condition for each participant. The mean data was then used to calculate a 2(Identity Condition) x 2(Expression Target) repeated measures ANOVA on JASP.

3.2 Results

This section presents the results for Experiment 1. Following the scheme outlined in the data analysis section of the methodology, results are organised by dependant variable, with the same 2 (Identity Condition) x 2 (Target Expression) repeated measures ANOVA used throughout unless otherwise specified.

3.2.1 RT1

Figures 12 & 13 summarise the pattern of results for median RT1 as a function of Identity Condition and Target Valence. Figure 12 provides an overview of response patterns using standard box plots, where the median is communicated as a line within the box, the interquartile range (IQR) as the box itself, the whiskers extending to the smallest and largest values within 1.5 times the IQR from the quartiles, and individual points beyond the whiskers representing outliers (this description applies to all boxplots in this paper). Figure 13 presents a more detailed view of the interaction between the two main independent variables.

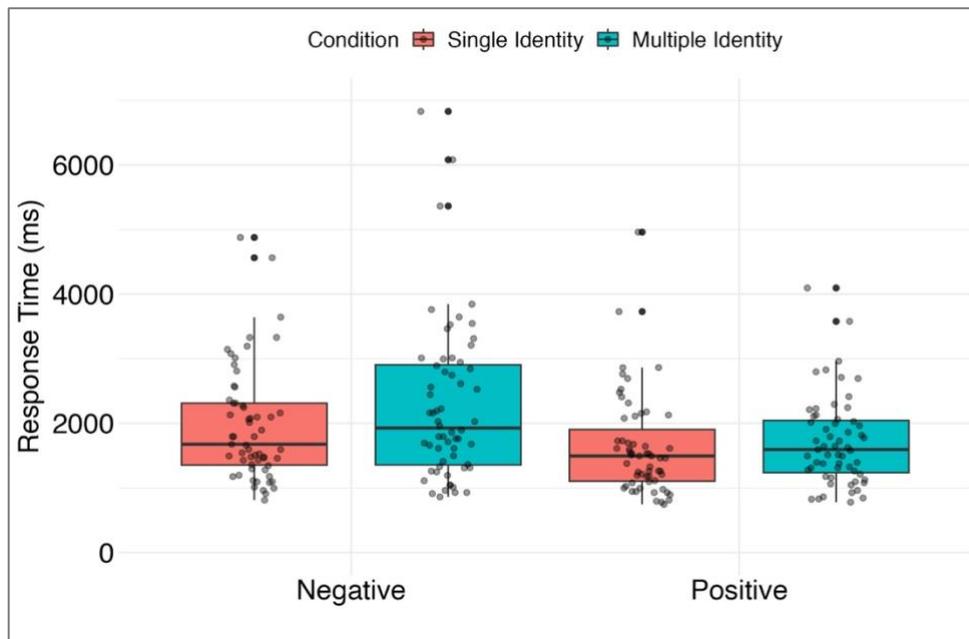
As can be seen in Figure 12, initial responses were quite slow, with the RT1 medians across all conditions at or just below 2 seconds. Response variability appears quite high, but is consistent across conditions, except for the negative Multiple Identity condition, which is somewhat elevated. This may be due to several outlier values. For multiple identity trials ($M=2240$ ms, $SEM=261$) responses were on average 347 ms slower than on single identity trials ($M=1894$, $SEM=104$), however, the main effect of Identity Condition was not significant, $F(1, 11)=2.556$, $p=0.138$, $\eta_p^2=0.189$.

There was, however, a significant main effect of Target Valence, with RT1 responses on positive target trials ($M=1971$ ms, $SEM=261$) being on average 191 ms faster than on negative target trials ($M=2163$ ms, $SEM=107$), $F(1, 11)=7.301$, $p=0.021$, $\eta_p^2=0.399$.

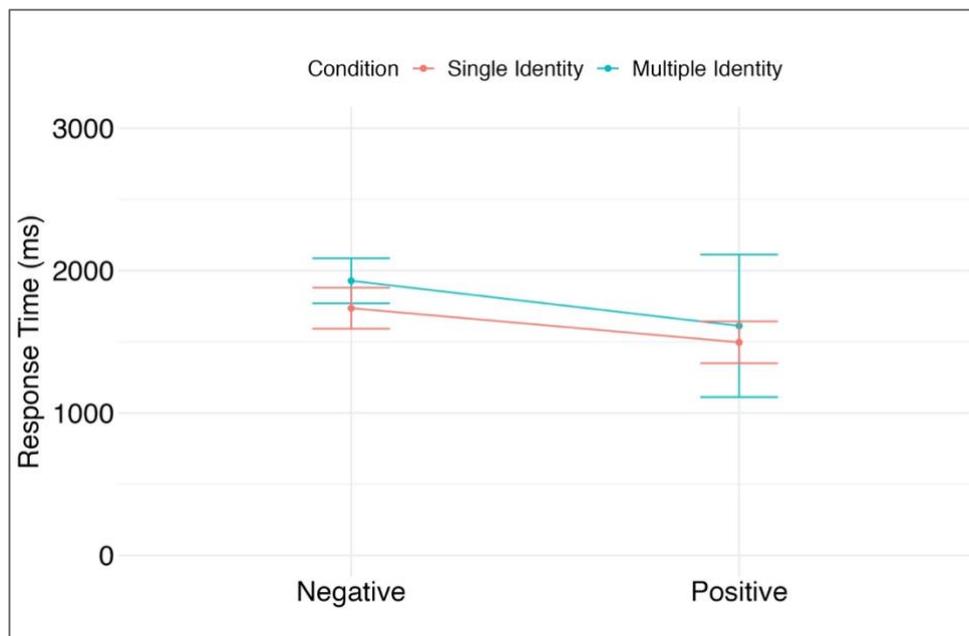
As can be seen in Figure 13, there was no interaction between Identity Condition and Target Valence, supporting this no significant effect was found for the interaction, $F(1, 11)=0.037$, $p=0.852$, $\eta_p^2=0.003$. For full results table see Appendix G.

Figure 12

Boxplot showing Experiment 1 RT1 as a function of Identity Condition and Target Valence.

**Figure 13**

Line graph showing Experiment 1 median RT1 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



3.2.2 RTT

Figures 14 & 15 summarise the pattern of results for median RTT as a function of Identity Condition and Target Valence. Figure 14 shows an overview of response patterns for RTT in a boxplot, while Figure 15 shows the interaction between Target Valence and Identity Condition.

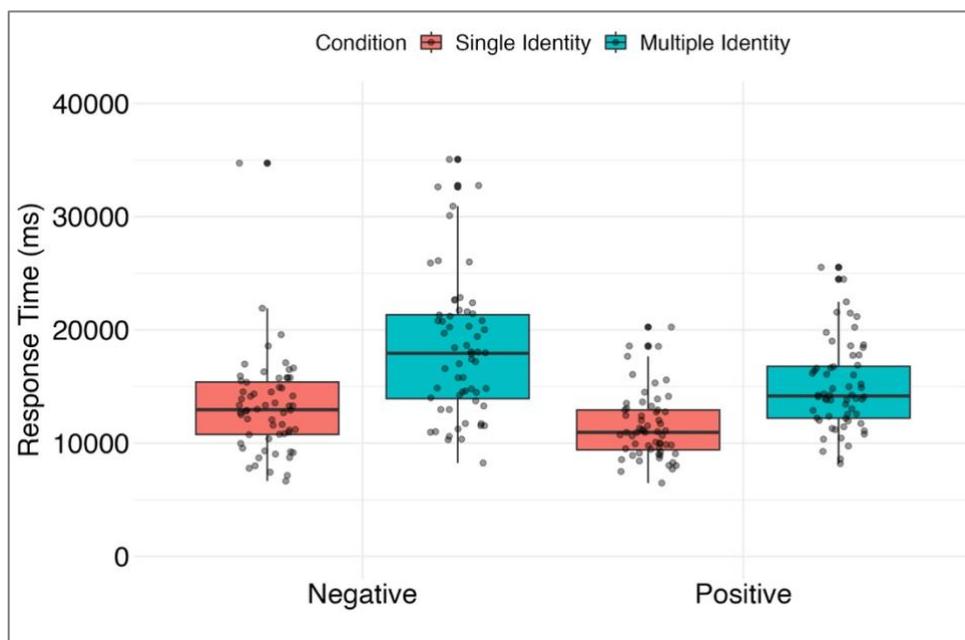
RTT was overall around 4 seconds shorter for the single Identity Condition trials ($M=12336$ ms, $SEM=342$) than it was for the multiple Identity Condition trials ($M=16610$ ms, $SEM=487$). This is clearly reflected in Figure 14, where the median lines for the multiple Identity Condition lie outside of the boxes of the single Identity Condition. This is corroborated by a significant effect for identity condition, $F(1, 11)=22.426$, $p<.001$, $\eta_p^2=0.671$). This indicates that variation in identity slows the search for FEs.

Looking to Figure 14, one can see that the medians for the positive Target Valence fall below the corresponding negative Target Valence boxes. RTT was around 2.5 seconds shorter for positive Target Valence trials ($M=13187$ ms, $SEM=348$) than for negative Target Valence trials ($M=15758$ ms, $SEM=531$). This is supported by a significant effect for expression target, $F(1, 11)=14.956$, $p=0.003$, $\eta_p^2=0.576$. Once again, this is indicative of a processing bias for positive valence expressions.

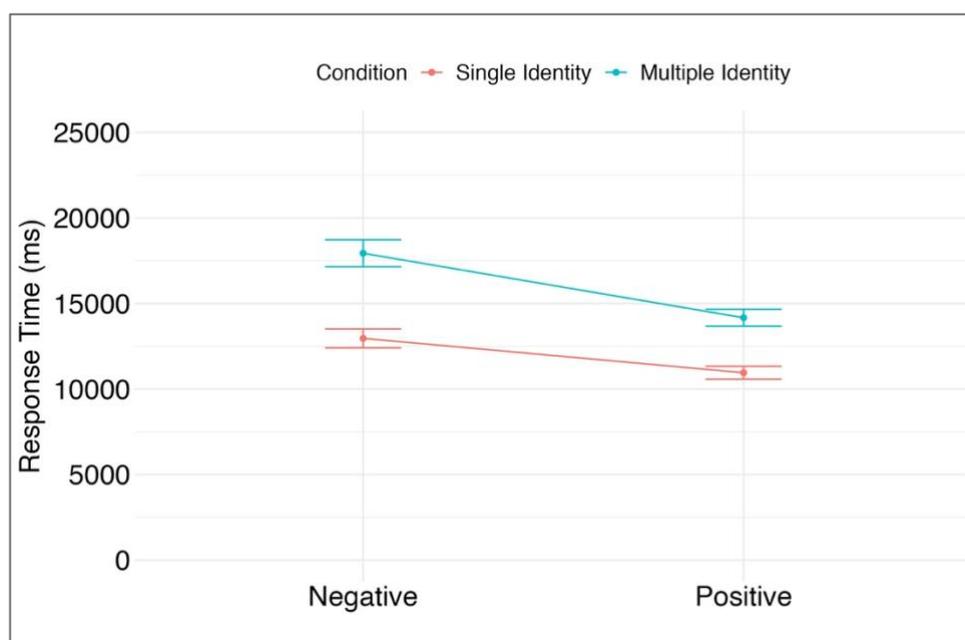
Figure 15 shows that the effect of identity condition is slightly smaller for positive target trials than it was for negative target trials. However, there was no significant interaction between Identity Condition and Target Valence for RTT, $F(1, 11)=3.83$, $p=0.076$, $\eta_p^2=0.258$. For full results table see Appendix H.

Figure 14

Boxplot showing Experiment 1 RTT as a function of Identity Condition and Target Valence.

**Figure 15**

A line graph showing Experiment 1 median RTT as a function of Target Valence and Identity Condition. Error bars show one standard error of the mean.



3.2.4 SRT

Figures 16 & 17 summarise the pattern of results for mean SRT as a function of Identity Condition and Target Valence. Figure 16 shows an overview of response patterns for mean SRT in a boxplot, while Figure 17 shows the interaction between Target Valence and Identity Condition for mean SRT.

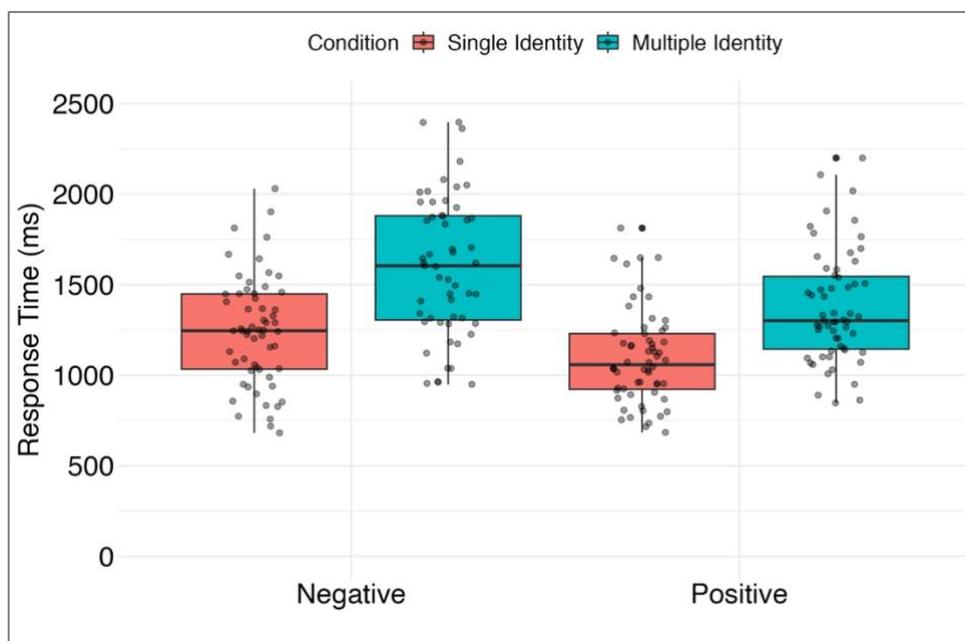
Figure 16 shows that the medians for the multiple Identity Condition are clearly higher than the medians for the single Identity Condition. SRT for multiple identity trials was around 300ms slower ($M= 1288$ ms, $SEM= 52$) than single identity trials ($M= 952$ ms, $SEM= 36$). Corroborating this, a significant effect was found for identity condition, $F(1, 11)= 30.33$, $p= <.001$, $\eta_p^2= 0.734$. Once again, this result supports the argument that variation in identity decreases the efficiency of search for facial expressions.

Looking at Figure 16, one can see that medians for the negative Target Valence boxes fall below the medians of the corresponding positive Target Valence boxes. Overall, mean SRT was around 180ms slower for negative Target Valence trials ($M= 1029$ ms, $SEM= 41$) than for the positive Target Valence trials ($M= 1211$ ms, $SEM= 64$). Supporting this observation, a significant effect was found for expression target, $F(1, 11)= 17.071$, $p= 0.002$, $\eta_p^2= 0.608$. This further support supports the notion that search for positive facial expressions is more efficient than for negative expressions.

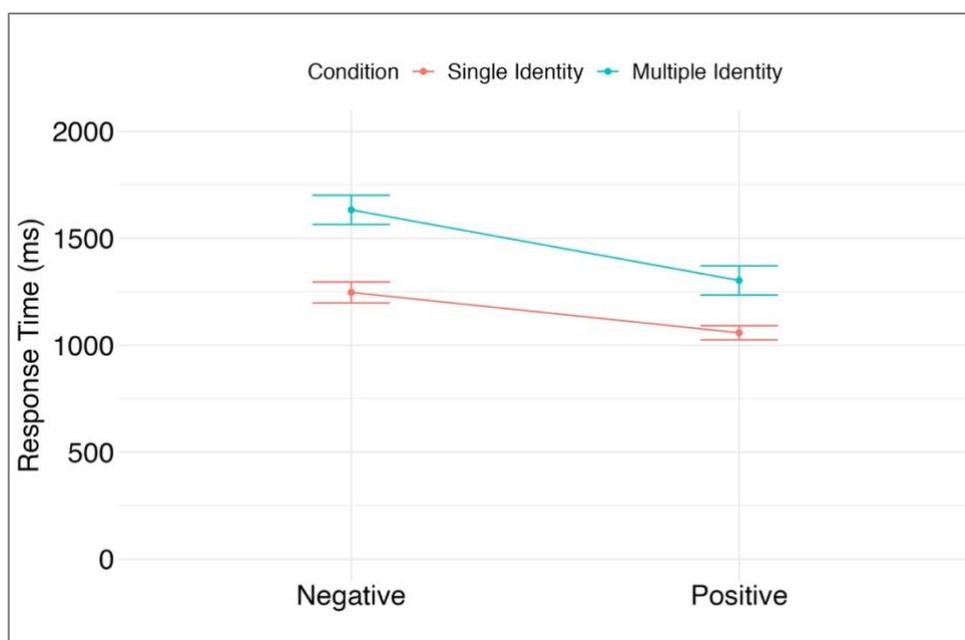
Looking at Figure 17, one can notice that the effect of Identity Condition is only marginally different in size for positive Target Valence as it is for negative Target Valence. Corroborating this, no significant effect was found for the interaction between Target Valence and Identity Condition, $F(1, 11)= 0.557$, $p=0.471$, $\eta_p^2= 0.048$. For full results table see Appendix I.

Figure 16

Boxplot showing Experiment 1 mean SRT as a function of Identity Condition and Target Valence.

**Figure 17**

Line graph showing Experiment 1 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



3.2.5 High Arousal Count Proportion

Figures 18 & 19 summarise the pattern of results for the proportion of high arousal selection as a function of Identity Condition and Target Valence. Figure 18 shows an overview of the proportions of high arousal selection in a boxplot, while Figure 19 shows the interaction between Target Valence and Identity Condition for high arousal selection proportion.

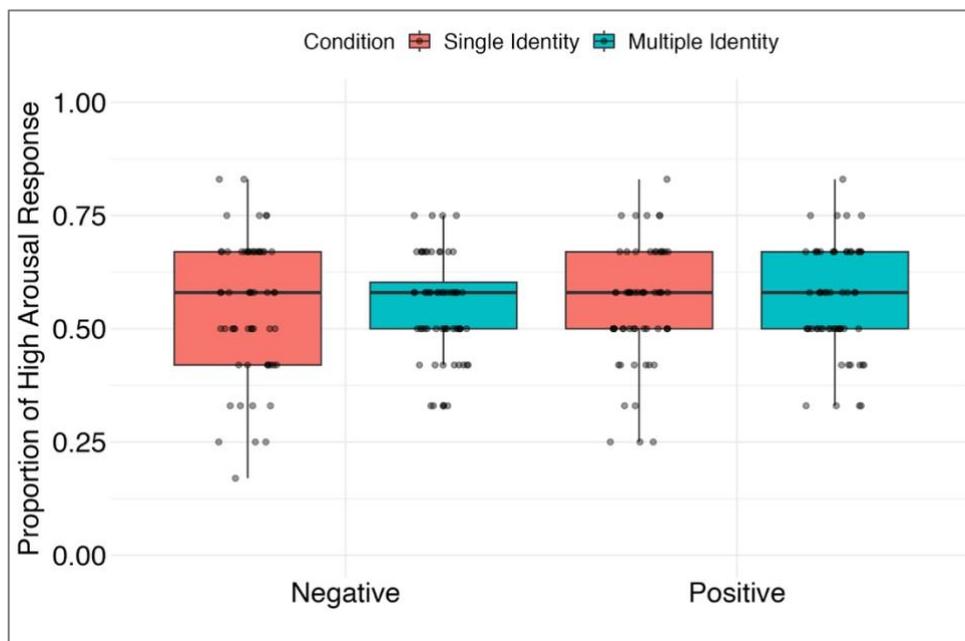
As can be seen in Figure 18, the proportion of high arousal choices was relatively consistent across both Identity Condition and Target Valence, with the medians for all four boxes being near identical. In fact, no significant result was found for Identity Condition, $F(1, 11) = 0.129$, $p = 0.727$, $\eta_p^2 = 0.012$, or Target Valence, $F(1, 11) = 0.179$, $p = 0.681$, $\eta_p^2 = 0.016$.

Figure 19 shows the interaction between Identity Condition and Target Valence, and it is clear that there is no interaction between either conditions and the proportion of high arousal expression selections, corroborating this no significant effect was found for the interaction, $F(1, 11) = 0.04$, $p = 0.845$, $\eta_p^2 = 0.004$. For full results table see Appendix J.

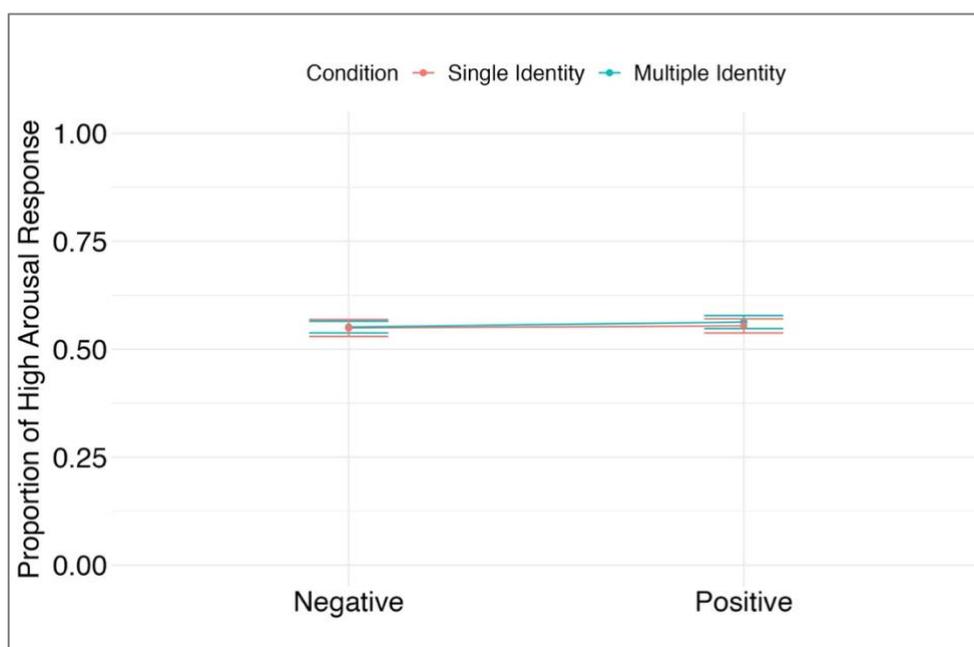
A one sample t-test was run on the overall proportion of High Arousal choices, collapsed by participant (see Appendix K). Looking at Figure 18, it is clear that proportion of high arousal selection is consistently above 0.5 ($M = 0.554$), $t(11) = 6.028$, $p = <0.001$. This indicates, that while small, there does seem to be a processing bias for high arousal FEs. Another one sample t-test was run on the proportion of high arousal responses for the first selection in each trial (see Appendix L). Participants tended to have a proportion higher than 0.5 for high arousal choices ($M = 0.558$), $t(11) = 1.984$, $p = 0.036$. This indicates that the bias for high arousal FEs was present even for the first selection on any given trial, indicating that the bias is not impacted by the processing responsible for the lag effect found in the first selection.

Figure 18

Boxplot showing Experiment 1 mean high arousal choice proportion as a function of Identity Condition and Target Valence.

**Figure 19**

Line graph showing Experiment 1 mean high arousal choice proportion as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



3.2.6 Arousal Runs

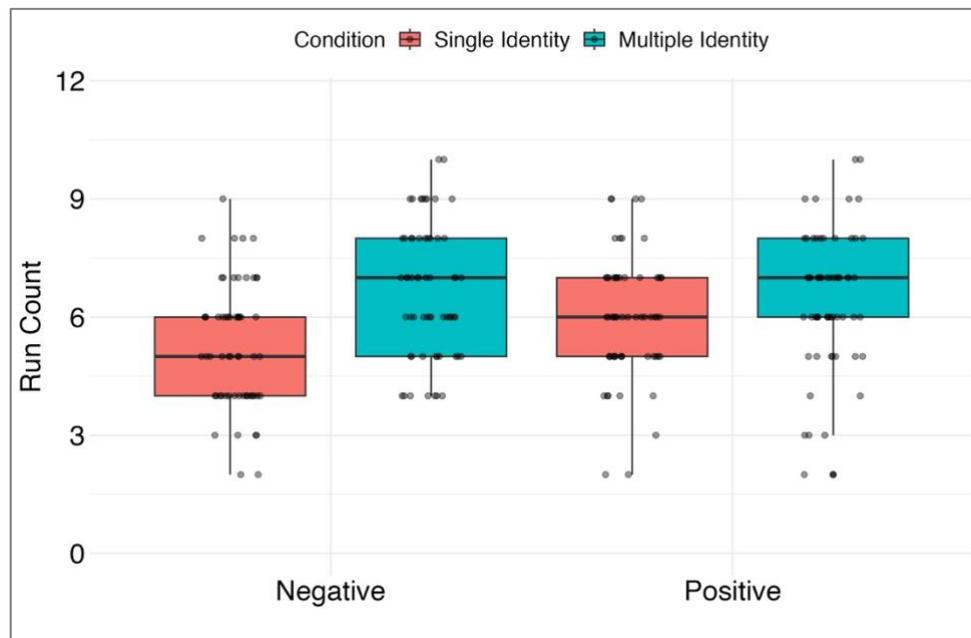
Figures 20 & 21 summarise the pattern of results for the number of runs per trial as a function of Identity Condition and Target Valence. Figure 20 shows an overview of the run count in a boxplot, while Figure 21 shows the interaction between Target Valence and Identity Condition for run count.

Looking at Figure 20, the medians for the multiple Identity Condition sit at or above the upper quartiles for single Identity Condition. The mean number of runs per trial was overall higher for multiple identity trials ($M= 6.6$, $SEM= 0.152$) than for single identity trials ($M= 5.63$, $SEM= 1.588$). This is supported by a significant effect for identity condition, $F(1, 11)= 24.12$, $p= <.001$, $\eta_p^2 = 0.687$. Figure 20 also shows that run counts were quite similar between positive and negative Target Valence trials, consistent with this no significant effect was found for Target Valence, $F(1, 11)= 1.926$, $p= 0.193$, $\eta_p^2= 0.149$.

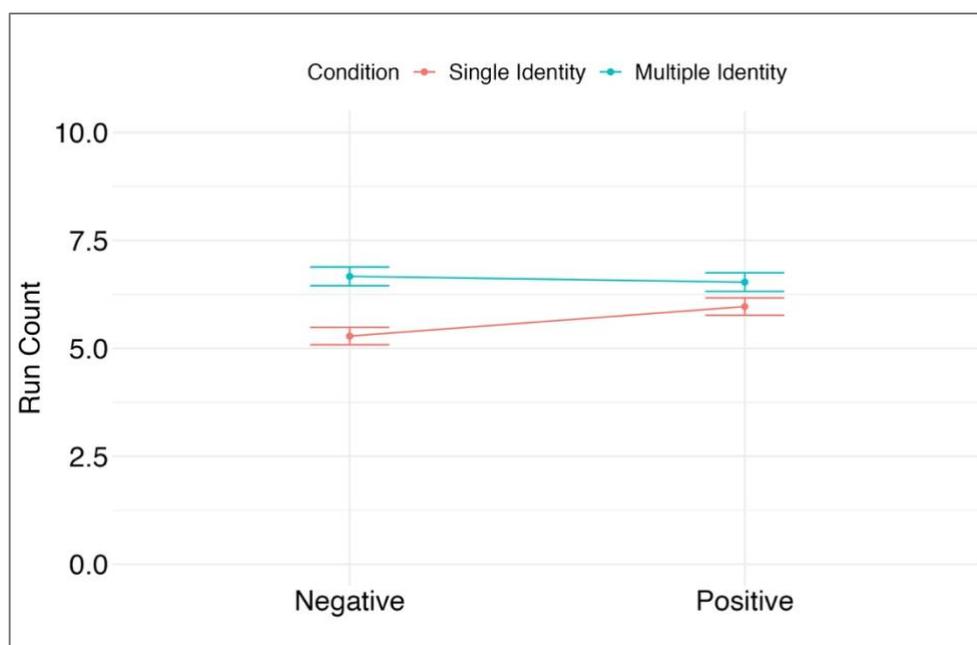
Looking at Figure 21, there does appear to be some interaction between Identity Condition and Target Valence for run count, with the difference in run count between single and multiple Identity Condition trials being smaller for positive Target Valence trials. Despite this, no significant effect was found for this interaction, $F(1, 11)= 3.477$, $p=0.089$, $\eta_p^2= 0.240$. For full results table see Appendix M.

Figure 20

Boxplot showing Experiment 1 mean run count as a function of Identity Condition and Target Valence.

**Figure 21**

Line graph showing Experiment 1 mean run count as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



3.3 Discussion

There were two main questions we set out to explore with Experiment 1, the first being whether variation in FI impacts the processing of FE, and the second was whether there is a positivity or negativity valence bias for FEs. We found clear evidence that variation in FI does impact the processing of FE. Specifically, we found that FEs on single Identity Condition trials were found faster than they were on multiple Identity Condition trials. This was supported by significant main effects for Identity Condition in the cruise phase response time measures, RTT and SRT.

Regarding the expression valence bias, based on trends in the existing literature, we expected to find a negativity bias. Typically tasks that present multiple faces at once result in a negativity bias (see Pinkham et al., 2010). However, there was a clear positivity bias throughout the entire experiment, with faster responses for positive Target Valence trials. This is supported by significant main effects for Target Valence in all response time measures analysed, RT1, RTT and SRT. No significant interactions were found between Identity Condition and Target Valence for any of the response time measures.

While the ANOVA for the high arousal count proportion yielded no significant effects, the t-tests run did indicate that the proportion was significantly higher than the expected 0.5 throughout the experiment, indicated a small bias for high arousal FEs.

This experimental task did include the repetition of stimuli. Since only one image per identity per expression class was generated, on single identity trials each image was repeated 10 times. Because of this, the shorter response times found for single Identity Condition trials could have been the result of participants searching for already identified and classified images, calling into question the validity of the results. In fact, the runs analysis did yield a significant effect for Identity Condition, with fewer runs for single identity trials. This result is likely due to participants simply selecting identical target images in a row. For these reasons, Experiment 2 was conducted. Experiment 2 is identical to Experiment 1, however 5 variations of each identity and expression class was generated, allowing us to investigate whether the effects found in Experiment 1 were due solely to image repetition.

4.0 Experiment 2

This experiment aimed to address some potential issues in Experiment 1, this was done by generated multiple images for the same stimulus category to avoid the image repetition found in Experiment 1. Experiment 2 is identical to Experiment 1 in every respect aside from the added stimuli. As with Experiment 1, this experiment aims to address two main questions, whether variation in FI (with less image repetition) impacts the processing of FE, and if there is a positivity or negativity valence bias in the processing of FEs.

4.1 Methodology

4.1.1 Aim and Rationale

The primary objective of this experiment was to address some limitations in Experiment 1. In the single identity trials in Experiment 1, there were 5 repetitions of each expression class, totalling the 40 images presented on each trial. The presence of repeated images could result in participants relying on low level image features for search, as opposed to relying on mechanisms of face perception. Because of this, we cannot be sure that the effects found for the identity condition in Experiment 1 are resultant of increased effort required due to mechanisms relating to FE and FI processing. Thus, this experiment aims to address this issue. By having multiple different stimuli for the same identity and expression class we can reduce the number of duplicate images in each trial, we can be more confident that any effects found are due to features related to FI and FE.

4.1.2 Research Proposal and Ethical Approval

The same ethics procedure described for Experiment 1 applies to this experimental task.

4.1.3 Recruitment

The same recruitment techniques and procedures were employed for this experiment as the ones described for Experiment 1. No one who participated in Experiment 1 was recruited for Experiment 2.

4.1.4 Risks and Benefits to Participants

As in Experiment 1, there were no risks or benefits to participants throughout the duration of this experiment. Each participant was paid 5 Euros in cash for their participation.

4.1.5 Participants

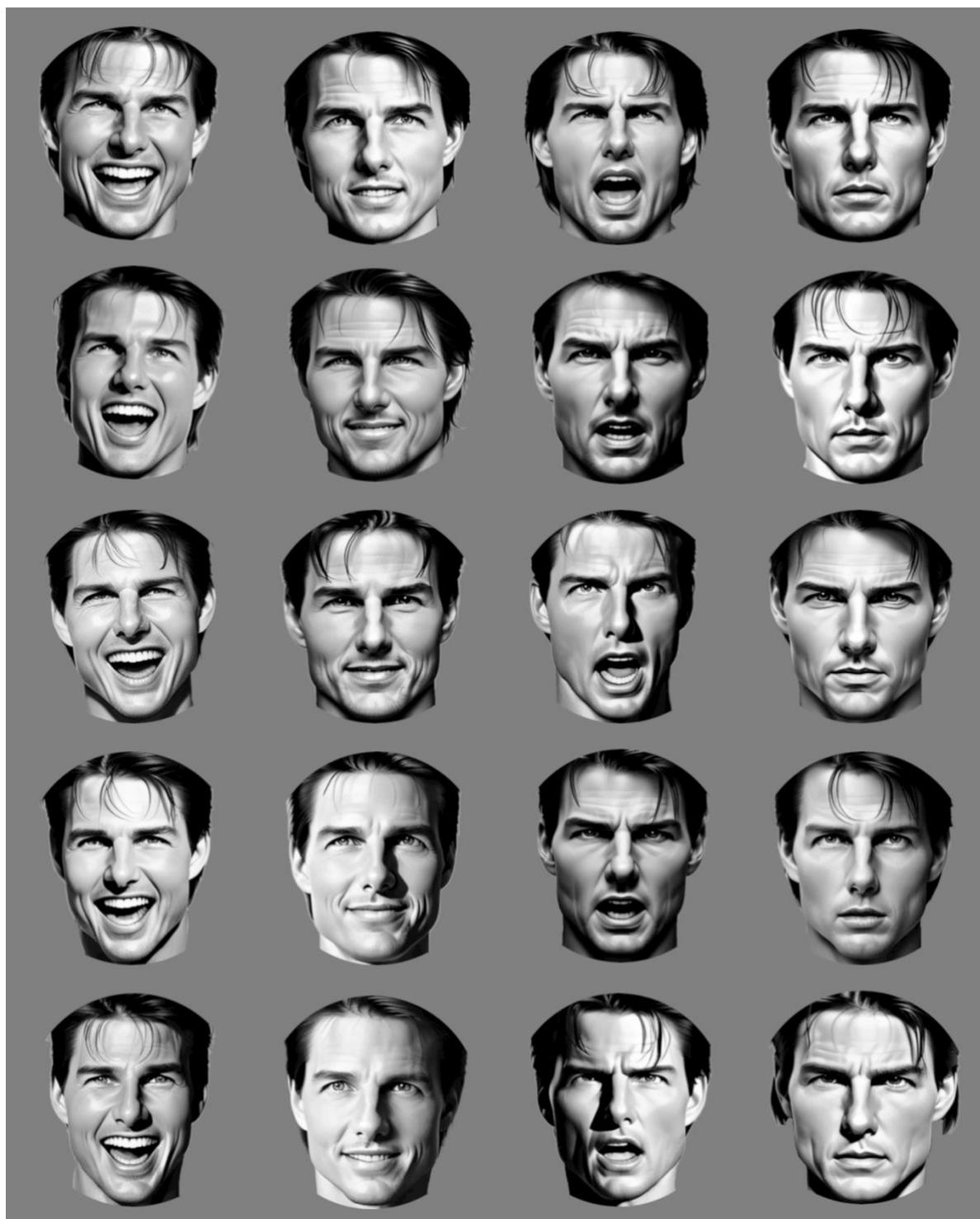
A total of 12 participants (6 female) were recruited for Experiment 2. The same exclusion criteria used in Experiment 1 were used in Experiment 2. Any participants who took part in Experiment 1 were also excluded, so as to ensure no practice effects that may skew results in this task. A practice effect describes the well-established phenomena where performance in visual search tasks tends to improve with practice and increased exposure (Clark et al., 2015). The mean age of participants in Experiment 2 was 23.9 years, and the overall age difference between female participants ($M = 24.7$ years) and male participants ($M = 23.2$ years) was negligible. All participants were right-handed.

4.1.6 Stimuli

Stimuli were generated in the same way as described for Experiment 1. The key difference for Experiment 2 is the quantity of stimuli generated. For each of the 6 male Caucasian celebrity identities, 5 distinct images were generated for each of the 4 expression classes (positive high arousal, negative high arousal, positive low arousal, negative low arousal), totalling 120 images. The images were edited in the same way as described in Experiment 1. See Figure 22 for an example of stimuli used, and see Appendix F for all stimuli used in Experiment 2.

Figure 22

Stimulus set for Tom Cruise used in Experiment 2, each column shows a different expression class.



4.1.7 Experimental Task

As with Experiment 1, the experimental task was based on the task and code used in Kristjánsson et al. (2014). The key difference between the task used in Experiment 1 is that on each trial, as opposed to having the same image repeated for each instance of a particular identity and expression class, multiple different images were used for each expression class (see Figure 22). By reducing the number of repeated stimuli on any given trial in Experiment 2, we can further investigate the effects found in Experiment 1. By doing this, we can have more confidence that effects found are the result of mechanisms relating to face perception, and not the result of limitations in the experimental design.

4.1.8 Data Collected

As was done for Experiment 1, for each trial the error count, the type of Identity Condition (same identity or different identity), the Target Valence (positive or negative), the expression category of the face selected for each of the 12 choices (valence and arousal), the number of errors made, and the RT for each of the 12 selections were recorded. In addition to this, the identity of each of the 12 choices for each trial was collected.

4.1.9 Procedure

The procedure for running Experiment 2 was identical to that for Experiment 1.

4.1.10 Data Analysis

Data analysis for this experiment was identical to that of Experiment 1.

Figure 23

A comparison of the single identity trial in Experiment 1 (top panel) and Experiment 2 (bottom panel).



4.2 Results

This section presents the results for Experiment 2. Following the scheme outlined in the data analysis section of the methodology (see Experiment 1), results are organised by dependent variable, with the same 2 (Identity Condition) x 2 (Target Expression) repeated measures ANOVA used throughout, unless otherwise specified.

4.2.1 RT1

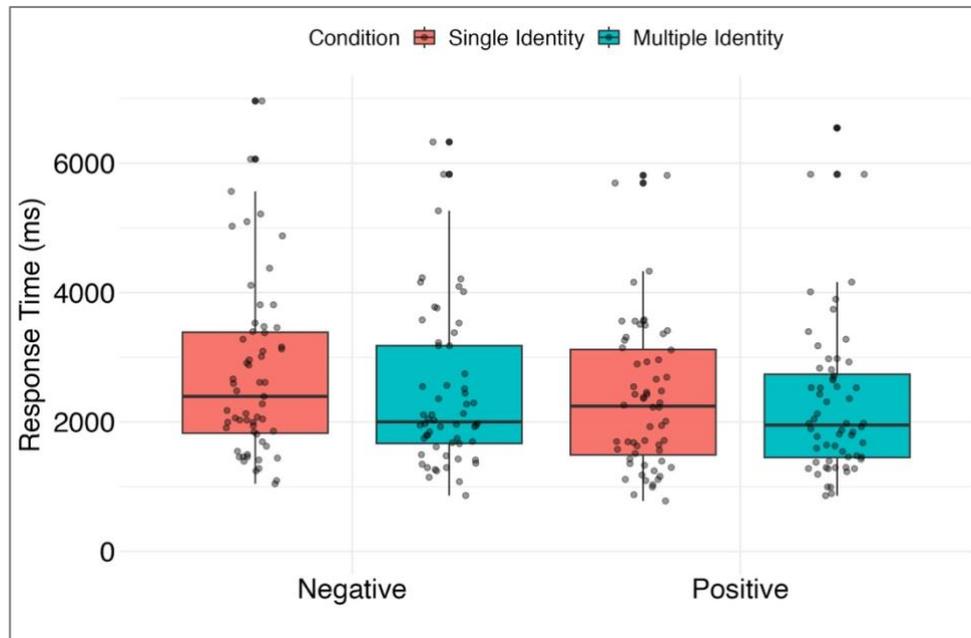
Figures 23 & 24 summarise the pattern of results for median RT1 as a function of Identity Condition and Target Valence. Figure 23 shows an overview of response patterns for RT1 in a boxplot, while Figure 24 shows the interaction between Target Valence and Identity Condition.

Figure 23 shows that initial response was quite slow, with the RT1 medians being around 2 seconds across all conditions. Response variability is quite high, but consistent across conditions. Multiple Identity Condition trials ($M= 2454$ ms, $SEM= 125$) were overall 175 ms faster than single Identity Condition trials ($M= 2629$ ms, $SEM= 141$), a much smaller difference between conditions than seen in Experiment 1. Consistent with this observation, no significant effect was found for Identity Condition, $F(1, 11)= 1.399$, $p= 0.262$, $\eta_p^2= 0.113$. Figure 23 also shows that median RT1 for positive valence expressions ($M= 2318$ ms, $SEM= 105$) was 446 ms faster than for negative expressions ($M= 2764$ ms, $SEM= 154$). Despite this difference, no significant effect for Target Valence was found, $F(1, 11)= 2.71$, $p= 0.128$, $\eta_p^2= 0.198$.

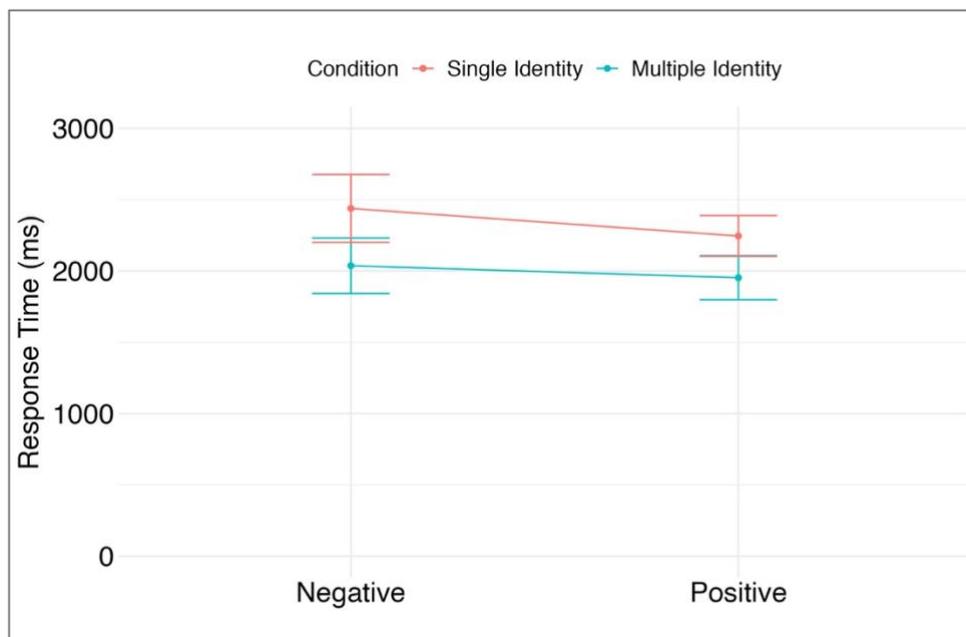
Looking at Figure 24, there does not appear to be an interaction between Identity Condition and Target Valence for RT1. Corroborating this observation, no significant result was found for the interaction, $F(1, 11)= 0.155$, $p= 0.702$, $\eta_p^2= 0.014$. For full results table see Appendix N.

Figure 24

Boxplot showing Experiment 2 RT1 as a function of Identity Condition and Target Valence.

**Figure 25**

Line graph showing Experiment 2 median of RT1 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



4.2.2 RTT

Figures 25 & 26 summarise the pattern of results for median RTT as a function of Identity Condition and Target Valence. Figure 25 shows an overview of response patterns for RTT in a boxplot, while Figure 26 shows the interaction between Target Valence and Identity Condition.

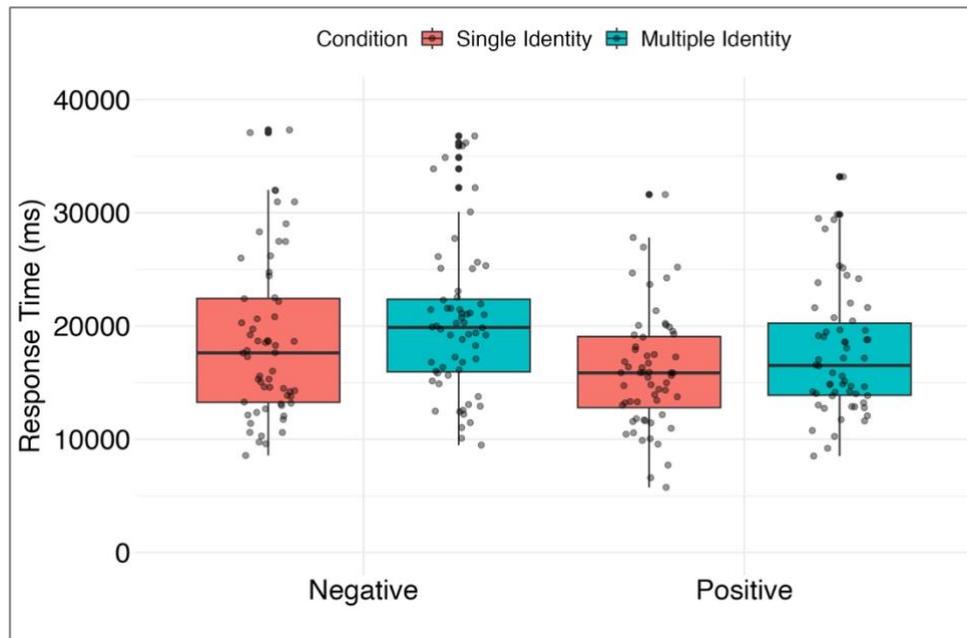
Figure 25 shows that the cruise phase of each trial lasted between 15 and 20 seconds, with response variability being quite high, particularly for the negative single Identity Condition. The median RTT for the single Identity Condition ($M= 17398$ ms, $SEM= 578$) was overall around 2 seconds shorter than the median RTT for multiple Identity Condition ($M= 19408$ ms, $SEM= 630$). However, this only yielded a marginally significant result, $F(1, 11)= 4.837$, $p= 0.05$, $\eta_p^2= 0.305$.

Looking at Figure 25, the medians for positive Target Valence both sit below the medians for negative Target Valence, with median RTT having been overall just above 2 seconds faster for positive expression targets ($M= 17269$ ms, $SEM= 574$) than it was for negative expression targets ($M= 19537$ ms, $SEM= 629$). Also of note is the larger number of extreme outliers for negative Target Valence trials. There was, however, a significant effect for Target Valence, $F(1, 11)= 7.674$, $p= 0.018$, $\eta_p^2= 0.411$.

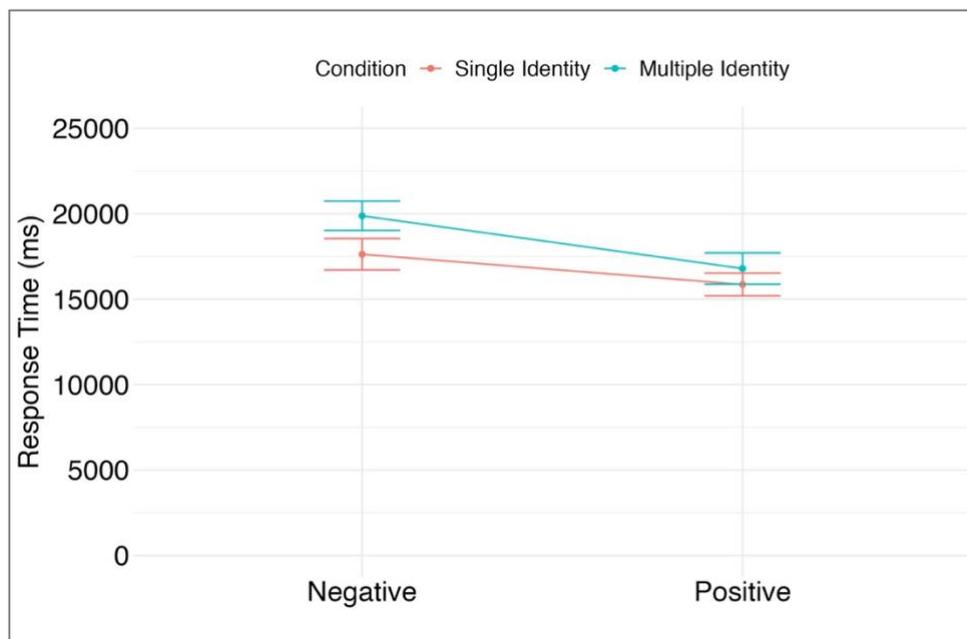
Figure 26 shows the interaction between identity condition and target condition for RTT, no significant effect was found for this interaction, $F(1, 11)= 0.265$, $p= 0.617$, $\eta_p^2= 0.024$. For full results table see Appendix O.

Figure 26

Boxplot showing Experiment 2 RTT as a function of Identity Condition and Target Valence

**Figure 27**

Line graph showing Experiment 2 median of RTT as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



4.2.3 SRT

Figures 27 & 28 summarise the pattern of results for mean SRT as a function of Identity Condition and Target Valence. Figure 27 shows an overview of response patterns for mean SRT in a boxplot, while Figure 28 shows the interaction between Target Valence and Identity Condition.

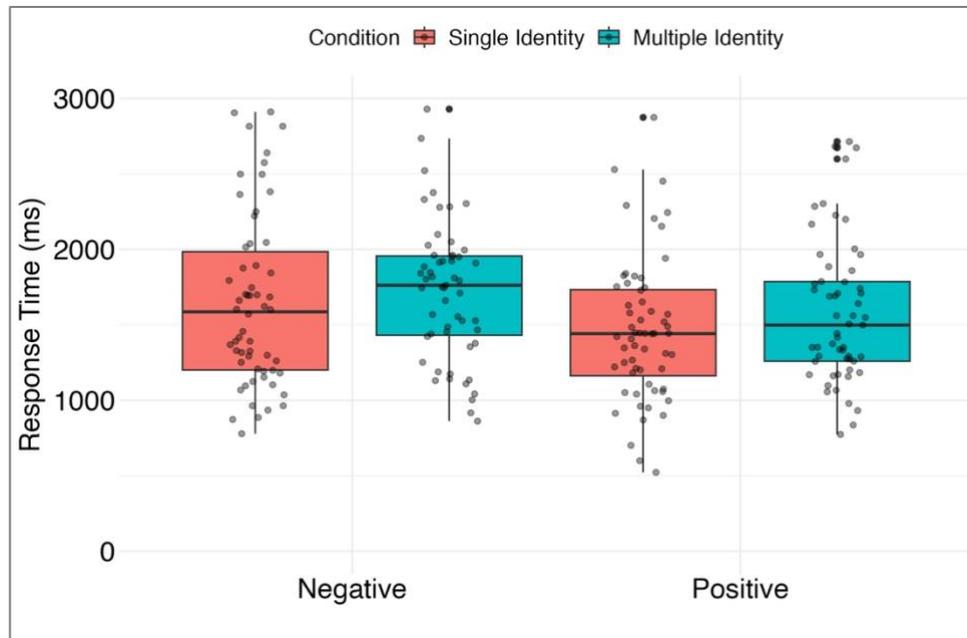
Looking at Figure 27 it is clear that there was quite high variability in mean SRT across all conditions, however, the medians for the single Identity Condition sit below the medians for the multiple Identity Condition. Overall, mean SRT was 136ms faster for the single Identity Condition ($M= 1291$ ms, $SEM= 52$) than for multiple Identity Condition ($M= 1427$ ms, $SEM= 58$). This is supported by a significant effect for Identity Condition, $F(1, 11)= 12.033$, $p= 0.005$, $\eta_p^2= 0.522$. Consistent with the marginally significant effect found for RTT, this further supports the argument that variation in identity interrupts expression processing. It also corroborates the results found in Experiment 1.

Figure 27 also shows that the medians for positive Target Valence trials fall below the medians for negative Target Valence trials, with mean SRT for positive targets ($M= 1268$ ms, $SEM= 50$) being over 182 ms faster than for negative targets ($M= 1450$ ms, $SEM= 57$), giving rise to a significant main effect for expression target, $F(1, 11)= 20.955$, $p= <.001$, $\eta_p^2= 0.656$. This is further evidence for a processing bias for positive valence expressions, which was also found for in Experiment 1.

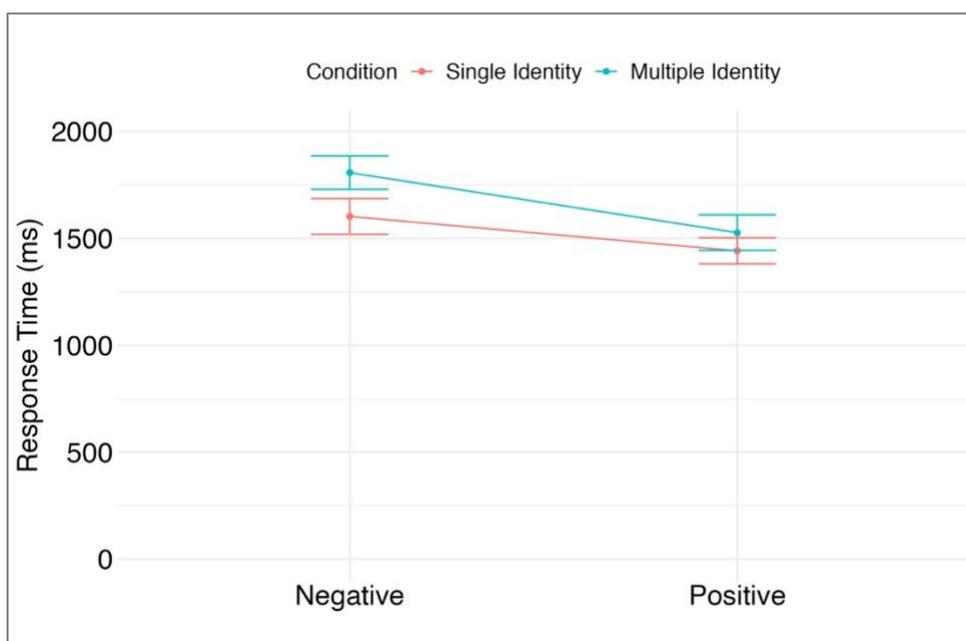
Figure 28 shows the interaction between Identity Condition and Target Valence for mean SRT. While there does appear to be a small interaction, with the difference between single and multiple target trials being smaller for positive target trials, no significant effect was found for this interaction, $F(1, 11)= 0.173$, $p= 0.686$, $\eta_p^2= 0.015$. For full results table see Appendix P.

Figure 28

Boxplot showing Experiment 2 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence.

**Figure 29**

Line graph showing Experiment 2 mean of SRT2 through SRT12 as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



4.2.4 High Arousal Count Proportion

Figures 29 & 30 summarise the pattern of results for mean high arousal choice proportion as a function of Identity Condition and Target Valence. Figure 29 shows an overview of response patterns for mean high arousal choice proportion in a boxplot, while Figure 30 shows the interaction between Target Valence and Identity Condition.

Figure 29 shows the medians for multiple Identity Condition trials are noticeably higher than the medians for single Identity Condition trials. Overall, selection on multiple identity trials was slightly more biased towards high arousal expressions ($M= 0.567$) than it was for single identity trials ($M= 0.531$). Corroborating this, a significant effect was found for identity condition, $F(1, 11)= 4.944$, $p= 0.048$, $\eta_p^2= 0.31$. This finding is unusual and differs from what was found in Experiment 1.

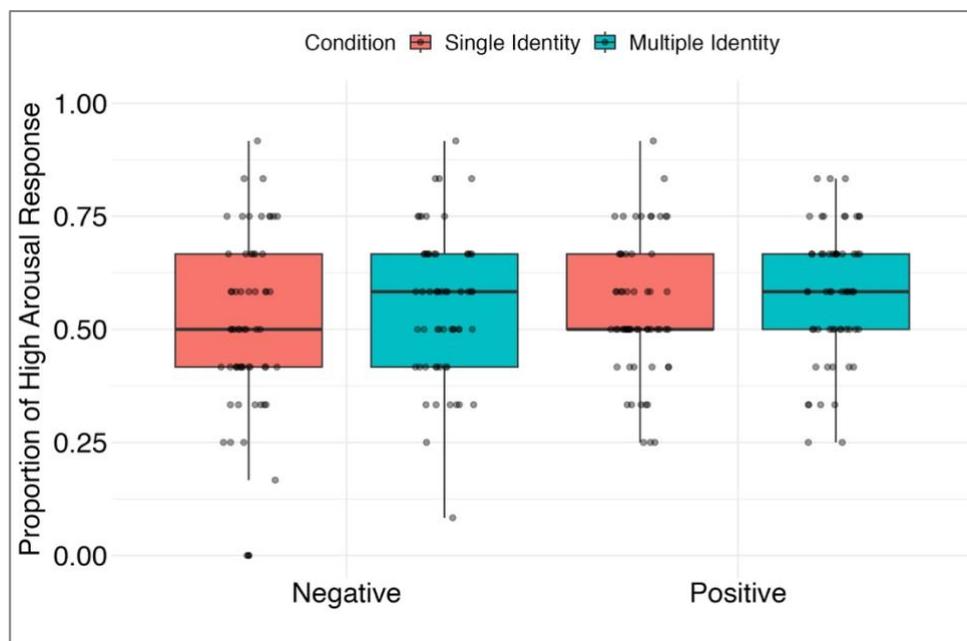
Figure 29 shows lower response variability for positive target trials compared to negative target trials; however, the medians still appear to be near identical. In fact, no significant effect was found for expression target, $F(1, 11)= 1.295$, $p= 0.279$, $\eta_p^2= 0.105$.

Looking at Figure 30, it is clear that there is no interaction between either conditions and the proportion of high arousal expression selections, in fact no significant effect was found for the interaction, $F(1, 11)= 8.996 \times 10^{-4}$, $p= 0.977$, $\eta_p^2= 8.178 \times 10^{-5}$. This is consistent with the results found in Experiment 1. For full results table see Appendix Q.

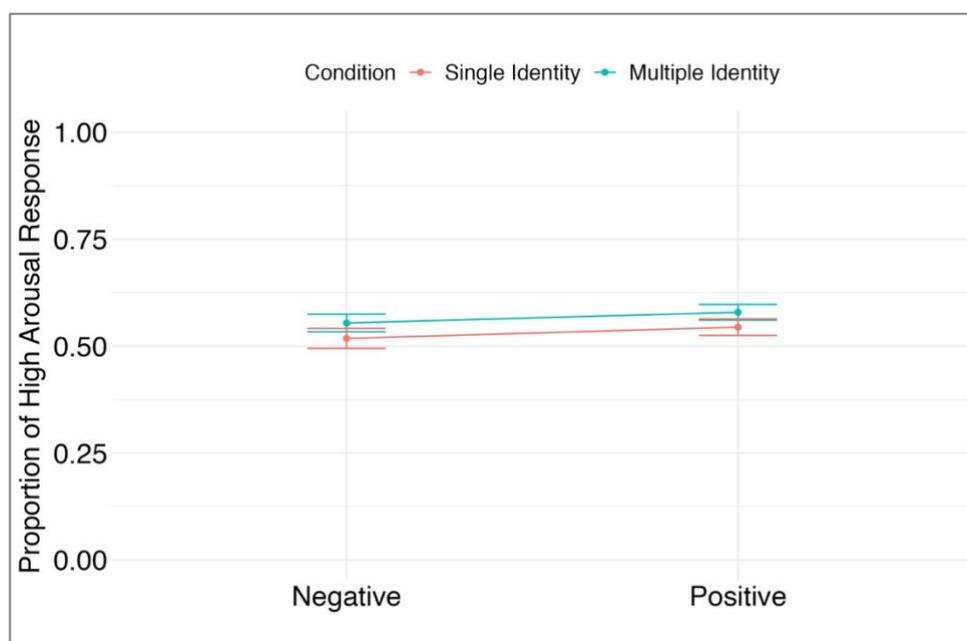
A one sample T-test was run on the overall high arousal choice proportion collapsed by participant (see Appendix R). Looking at Figure 29, it is clear that proportion of high arousal selection is consistently above 0.5 ($M= 0.549$), $t(11) = 3.2305$, $p= 0.004$. This indicates, that while small, there does seem to be a processing bias for high arousal FEs. Another one sample t-test was run on the proportion of high arousal responses for the first selection in each trial (see Appendix S). Participants tended to have a proportion higher than 0.5 for high arousal choices ($M= 0.658$), $t(11) = 4.1825$, $p= <0.001$. This indicates that the bias for high arousal FEs was present even for the first selection on any given trial, indicating that the bias is not impacted by the processing responsible for the lag effect found in the first selection. This is consistent with the bias found in Experiment 1.

Figure 30

Boxplot showing Experiment 2 high arousal choice proportion as a function of Identity Condition and Target Valence.

**Figure 31**

Line graph showing Experiment 2 high arousal choice proportion as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



4.2.5 Arousal Runs

Figures 31 & 32 summarise the pattern of results for mean run count as a function of Identity Condition and Target Valence. Figure 31 shows an overview of mean run count in a boxplot, while Figure 32 shows the interaction between Target Valence and Identity Condition.

Looking at Figure 31, medians across all four boxes sit at the same level, and variability is relatively consistent, except for negative single identity, where it appears to be higher. Supporting this observation, no significant effect was found for either Identity Condition, $F(1, 11) = 1.598$, $p = 0.232$, $\eta_p^2 = 0.127$. or Target Valence, $F(1, 11) = 0.55$, $p = 0.474$, $\eta_p^2 = 0.048$. This finding strengthens the argument that the significant effect found for identity condition in Experiment 1 was due to stimuli repetition in the single identity trials, with participants likely selecting identical images in a row, reducing the number of runs.

The interaction between Identity Condition and Target Valence is shown in Figure 232, and it is clear that there is no interaction between the two conditions. This is confirmed by the absence of a significant result for the interaction, $F(1, 11) = 0.399$, $p = 0.54$, $\eta_p^2 = 0.035$. For full results table see Appendix M.

Figure 32

Boxplot showing Experiment 2 mean run count as a function of Identity Condition and Target Valence.

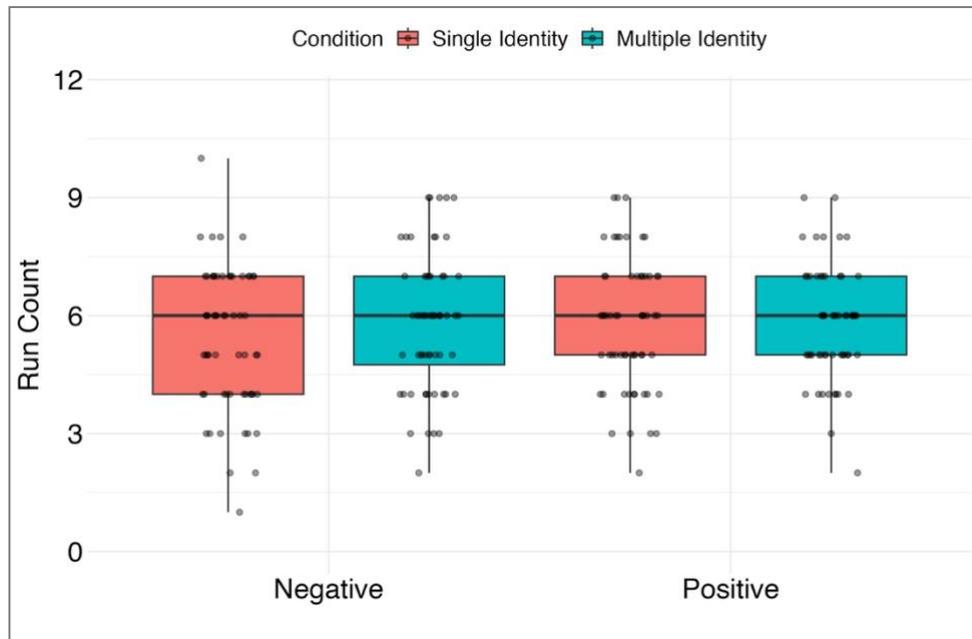
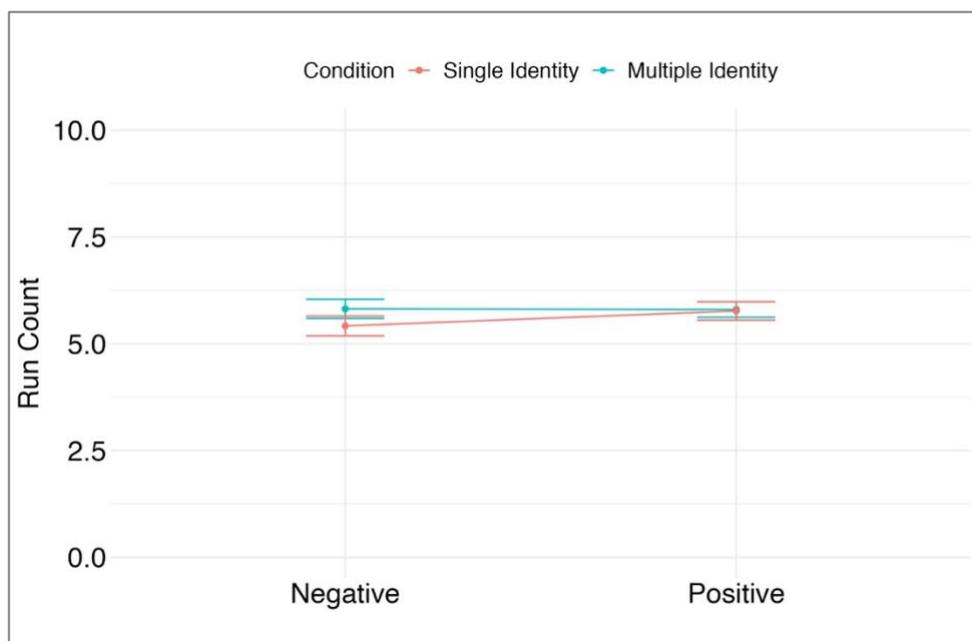


Figure 33

Line graph showing Experiment 2 mean run count as a function of Identity Condition and Target Valence. Error bars show one standard error of the mean.



4.3 Discussion

This experiment was conducted to further investigate whether the effects found in Experiment 1, specifically the significant effect for Identity Condition across the RT variables, were due to the repetition of stimuli. While results in this experiment did differ slightly from Experiment 1, particularly for RT1, they overall support the results and interpretations from Experiment 1.

A marginally significant effect and a significant effect were found for Identity Condition for RTT and SRT, respectively. With multiple Identity Condition trials having been overall slower than single Identity Condition trials; this finding further supports the argument that variation in FI impacts the processing of FE. SRT analysis yielded significant effects for Identity Condition in both experiments. In Experiment 1, the average SRT cost for multiple Identity Condition trials compared to single Identity Condition trials was 355 ms (SE= 61), this cost reduced to 158 ms (SE= 64) in Experiment 2 (see Table 2). This clearly indicates that some of the effect found in Experiment 1, was the result of easier search due to image repetition. Despite this, the results of Experiment 2 still indicate that variation in FI does impact the processing of FE.

Table 2

Table showing mean SRT difference between Identity Conditions (single and multiple) for Experiment 1 & 2, and effects of Identity Condition from ANOVA on SRT.

	Experiment 1	Experiment 2
Mean Difference (ms)	355	158
SE	61	64
<i>F</i>	30.33	12.033
Sig.	<.001	0.005
η_p^2	0.734	0.522

As with Experiment 1, an unusual positive valence bias was also found in this experiment, with significant effects for Target Valence found for RTT and SRT. No significant interactions were found for any of the response time variables.

Once again, as with Experiment 1, both t-tests run indicated a small bias for high arousal FEs overall. A significant finding differing from what was found in Experiment 1 is a significant effect for Identity Condition in the ANOVA run on the high arousal count proportion. Specifically, there was a significantly higher proportion of high arousal responses in multiple Identity Condition trials. This could be due to the increased difficulty in multiple Identity Condition trials, resulting in participants selecting more salient FEs of the particular Target Valence. Finally, no significant effects were found for the run count analysis.

Overall, this experiment produced a similar pattern of results to Experiment 1; specifically showing that variation in FI impacts the processing of FE, and the finding of a positive valence bias for FE processing.

5.0 General Discussion

This study set out to address two main issues. The first issue was to examine the relationship between FE and FI. More specifically, we set out to investigate whether variation in FI impacted the processing of FE. Secondly, we wanted to assess whether there was a processing bias for a particular FE valence. Both topics have been researched extensively, however we decided to adopt a foraging paradigm to address them. Foraging paradigms have, until now, been used to primarily investigate simple visual stimuli. This approach allowed us not only to address the abovementioned topics, but it also allowed for us to assess the applicability of foraging paradigms in researching the processing of complex visual stimuli. In addition to this, the study also allowed us to assess whether there was any processing bias for high arousal FEs.

Two experiments were conducted. In both experiments, participants were required to complete 20 foraging trials. On each trial, participants were required to identify 12 faces of a particular emotional valence (positive or negative) out of 40 faces. Half of the trials required participants to identify positive valence expressions, and the other half negative valence expressions. This would allow for the comparison in performance between expression valence targets, indicating whether a valence bias was present. The stimuli used were AI generated images of six male Caucasian celebrities. In each trial, there was an equal distribution of FEs, the expressions being high arousal negative, high arousal positive, low arousal negative, and low arousal positive. Half of the trials showed images of all six identities, while the other half showed only a single identity. This allowed for us to assess the impact of variation in identity on the recognition of expressions.

The key difference between the experiments was the stimuli used. In Experiment 1, only a single image was created for each of the four expression categories per identity. This meant that in the single identity trials, there were ten repetitions of the exact same image. For this reason, any results from Experiment 1 in relation to the identity condition could have been largely due to participants finding it easier to identify targets on the single identity trials due to the large number of image repetitions. To address this limitation, Experiment 2 was conducted.

For each identity, five different images of each expression were generated. This significantly reduced the number of image repetitions on single identity trials. By doing this, we could reduce the likelihood of participants relying on image repetitions for search and have more confidence that any significant result was truly related to mechanisms of face perception.

5.1 Overview of Results

The expectation was that Experiment 1 and 2 would have, overall, quite similar results, but the effects for Experiment 2 would be smaller, given the likely processing benefit provided by repeated images in Experiment 1. With regard to examining both the impact of variation in FI on FE processing, and processing bias for expression valence, the response time measures are the variables of interest, these being RT1, RTT, and SRT.

The analysis of RT1 yielded significant results for Identity Condition and Target Variance in Experiment 1. Specifically, that's median RT1 was lower for single Identity Condition trials and positive Target Valence trials. These results are indicated that variation in FI impacts the processing of FE, and are evidence for a positive valence processing bias. However, no significant effects were found for RT1 in Experiment 2. Since RT1 is the measure of the time taken to select the first target in a trial, it is subject to lag effect, which is thought to be due to response preparation and forward planning (see Basoudan et al., 2019). It could be, that the increased image variability in Experiment 2 increased cognitive load, resulting in more forward planning, reducing the effects of the independent variables on response.

RTT and SRT are both response measures that give insight into performance during the cruise phase of a trial. For the Identity Condition, RTT yielded a significant effect and a marginally significant effect in Experiment 1 and Experiment 2, respectively. Specifically, that response time for single identity trials were overall shorter than it was for multiple identity trials. It is possible that the image repetition in Experiment 1 was partially the cause for the significant Identity Condition effect in RTT, potentially explaining why only a marginally significant result was found for Experiment 2. Significant effects for Identity Condition were found in both

experiments for SRT; again, with single identity trials being overall shorter than multiple identity trials.

Looking at all the response time analyses, it is evident that variation in FI does reduce the efficiency of FE processing in some way. While results did vary between experiments, it is important to remember that the stimulus repetition in single identity trials in Experiment 1 likely modulated the significant effects found for Identity Condition.

Regarding the Target Valence effects, consistent significant results were found through both experiments (except for RT1 in Experiment 2). Overall, participants were faster at positive Target Valence trials than they were for negative Target Valence trials. This decrease in response time for positive targets is a clear indication of a processing bias for positive FEs.

Analysis was also done to evaluate whether there was any bias for high arousal FEs. The ANOVA test did not yield any significant results; however, this only indicates that the task conditions of FE valence and identity variation did not have an effect on whether high arousal expressions were selected more. The t-tests conducted on the high arousal count proportions for both the first selection and total selection all indicated a processing bias for high arousal FEs over low arousal FEs. While this bias is small for both Experiment 1 and Experiment 2, with the mean high arousal proportion being just over 0.5 for both, it is still evident throughout the experiments.

Finally, the run count analysis did yield a significant result in Experiment 1 for the identity condition, with a higher mean run count found for single Identity Condition trials. However, no significant effects were found in Experiment 2. Because of this it is most likely that in Experiment 1, participants tended to choose identical targets in sequence due to the high image repetition in single identity trials. So, the significant effect found in Experiment 1 is likely due to image repetition rather than processing mechanisms related to face perception.

5.2 Intersection Between Facial Expression and Facial Identity Processing

As mentioned earlier, this study aimed to assess the relationship between FE and FI processing, in particular the effect of variation in FI on the processing of FE. The results of both experiments supported the hypothesis that variation in FI does impact the processing of FE. This finding is not unsurprising, as most studies conducted over the past few decades have come to similar conclusions (see literature review). There is also evidence from neuroimaging studies indicating that there are common processing areas for both FE and FI (see Bernstein & Yovel, 2015 for a review). Our findings do however contradict the popular PRH, first presented by Bruce and Young (1986), which argues that the processing of FE and FI are entirely independent of one another.

However, an overlap in processing does not necessarily explain why processing would become less efficient. Visual search and foraging paradigms are useful as they allow us to determine what features of visual stimulus are more salient. The tasks used in this study required participants to search for specific FEs, but the results show that FI, a feature not necessarily relevant to the task, impacted performance. This is a clear indication that variation in FI increased cognitive load in some manner, making the search for FEs less efficient. A possible explanation for this lies in the nature of how faces are processed.

Automatic processing describes the involuntary, unintentional, and effortless processing of certain features of a stimulus without conscious awareness (Yan et al., 2017). This means that the processing of said stimulus can occur without the conscious allocation of visual attention, thus involving a form of bottom-up attentional guidance (Palermo & Rhodes, 2007). If FI is processed automatically, this may result in common cognitive resources being allocated to processing FI, despite a conscious effort to search for a specific FE.

There is extensive evidence for the automatic processing of specific features of the face, including FI and FE. There is evidence for unconscious FI perception in prosopagnosia patients, with multiple studies finding differences in physiological response measures for familiar faces when compared to unfamiliar faces, despite the inability to consciously recognise the presented face (Bauer, 1984; de Haan et al., 1987; Tranel & Damasio, 1985).

The inability to ignore irrelevant dimensions of the face, as was found in this study, has also been argued to be evidence of the automatic processing of faces (see Yan et al., 2017). Many studies have found that FI exerts influence over the efficiency of processing of FE (Ganel & Goshen-Gottstein, 2004; Schweinberger & Soukup, 1998; Schweinberger et al., 1999). The interference of FI in processing has also been found for non-face stimuli; in studies looking at face-name interference, results show that the congruence of a distractor face to the presented name impacts name categorisation performance (Jenkins et al., 2003; Lavie et al., 2003).

Moving on from the evidence for the automatic processing of FE, behavioural evidence suggests that the emotional valence of a face that is not consciously perceived can influence perception of follow up stimuli (Murphy & Zajonc, 1993; Rotteveel et al., 2001). Neuroimaging studies have also shown FE related activation for specific FEs when participants are not consciously aware of stimulus. For example, many studies have found amygdala activation for unperceived fearful face stimuli (Pasley et al., 2004; Whalen et al., 1998; Vuilleumier et al., 2002). Studies on blindsight patient GY also found evidence of an unconscious ability to perceive FE, GY was able to discriminate between FEs with an above chance success rate (de Gelder et al., 1999; Morris et al., 2001).

The increased cognitive load resulting from the automatic processing of FI could account for why the processing of FE is slowed when variation in FI is present. However, this does bring up an important question; if FE is also processed automatically to some extent, why does variation in FI still have such a significant impact on the recognition of FEs? An interesting factor to consider is the familiarity of the stimuli. This study utilised celebrity faces as stimuli, famous faces are, to some extent, familiar faces. A study by Yan et al. (2017) conducted a series of experiments to assess the automaticity of processing for different aspects of a face, including identity and expression, between familiar and unfamiliar faces. They found that while there was evidence for some automatic processing of both identity and expression in unfamiliar faces, there was also significant evidence of top-down attention. However, for familiar faces, they found evidence of complete automatic processing for identity, but not for expression. Complete automatic processing of identity but not expression for

familiar faces could account for the results in this study and could also provide insight into why there is far less evidence for FE interfering in the processing of FI.

5.3 Valence Bias: The Face in the Crowd Effect

Another factor investigated in this study was whether there is a processing bias towards either positive FEs or negative FEs. Based on the current literature, we expected to find a bias for negative FEs. As highlighted in the literature review, there are conflicting findings regarding valence bias in FE research, and these are dependent on the type of paradigm used. Typically, in studies where multiple face images are presented together, as was done in this study, a bias for negative FEs is found. This is known as the face in the crowd effect (Pinkham et al., 2010), as the presentation of multiple face images at once is likened to a crowd. The most common explanation for this phenomenon is that when encountering multiple faces in a visual scene, it is evolutionary and socially beneficial to be able to identify negative expressions faster, as these could a signal to potential danger.

However, in both Experiments 1 and 2, a significant processing bias for positive FEs was found. In fact, multiple participants noted that they found positive Target Valence trials easier than negative Target Valence trials after completing the task. While that doesn't serve as solid evidence, it was also reflected in the data analysis. Participants were overall faster at identifying positive targets than they were negative in both single and multiple identity trials, and in both Experiment 1 and 2. This finding contradicts what one would expect to find based on the available literature on the topic. But why might this be?

There are a few possibilities as to why this study has found different results to what would be expected. Multiple studies have found a positivity bias (Leppänen and Hietanen, 2003; Svärd et al., 2012; Walden and Field, 1982), and it has been argued that this is likely because the features of positive FEs (specifically the upturned corners of the mouth in a smile) are more visually distinct, making them easier to identify (Calvo et al., 2010; Calvo et al., 2012). These findings are, however, typically found in studies where faces are presented

individually. Another possibility is that the two categories of positive FEs used, while displaying different levels of arousal, can be considered to be displaying the same emotion, happiness. This consistency of conveyed emotion between the high and low arousal categories of positive FEs could have made processing easier. Furthermore, the negative FEs may have been harder to categorize as negative. For example, the low arousal negative FEs could be interpreted as neutral FEs, requiring more attention and time to process. This increased difficulty with categorizing negative FEs could explain the positivity bias found.

The possibility that this result could be due to the observably more noticeable teeth in the high arousal positive stimuli was also considered. The noticeable show of teeth in the high arousal positive stimuli could have served as a cue to positive FEs within this particular set of stimuli, making processing more efficient. While analysis did show a bias for high arousal FEs, with high arousal selection consistently being just above 50%, the size of this bias was quite small. Taking this into consideration, while it may have contributed slightly, it is unlikely to be the sole cause of the positivity bias found, as if it were, we would have expected to see a far larger bias.

Overall, a multitude of factors could have contributed to the positive bias found in this study. While the finding differs to what would be expected based on the available literature, this is the first time a foraging paradigm has been used to investigate face perception. There could be factors relating to the nature of the paradigm that may have caused a positivity bias, but more research is needed to ascertain exactly what these factors could be.

5.4 Limitations and Future Directions

While this study did yield novel findings, it is always important to address potential limitations in any research project. Acknowledging such limitations also helps to guide future work. A potential limitation in this study is the small number of trials per experiment, each experiment only contained 20 trials. The low number of trials was chosen to reduce the duration of the task as much as possible, as foraging tasks can become rather frustrating for

participants to complete. However, the 20 trials typically did not take participants more than 15 minutes to complete, so had more trials been included, the total task time would not have increased so much as to make the task too tedious for participants. Including more trials or participants could have decreased response variability and thus increased the sensitivity of the tests we employed.

A few potential limitations relate to the stimuli themselves. Firstly, given that we developed novel stimuli for this task, using a relatively new technology, it would have been beneficial to validate the stimuli in some way. As mentioned earlier, it could be that some of the low arousal FE stimuli may have had lower discriminability than the high arousal FE stimuli. While this may be, to some extent, related to the inherent nature of FEs, increasing stimuli discriminability should always be a priority when developing stimuli for FE research. In the future, when using novel stimuli for FE research, it would be beneficial to conduct a pilot study to validate the stimuli. By assessing where a particular stimulus is perceived to fall on the continuums of valence and arousal using a pilot study, it could prevent stimuli with more ambiguous FEs from being included.

Another factor relating to stimuli that could have potentially limited the study was the exclusion of female face stimuli. The initial plan for the study was to use both male and female faces as stimuli, however it soon became apparent that it would not be possible. When attempting to develop AI text-to-image generated stimuli of female celebrities, it immediately became clear that there was a severe limitation in the tools ability to generate emotional expressions for female faces. This was particularly an issue when prompts were given for negative valence FEs, as the results typically depicted either smiling or neutral faces, an issue not encountered with the male celebrity prompts. Gender bias in AI has been the centre of an ongoing debate, and it is well established that text-to-image generative AI tools, like DALL·E 2, for example, have gender and racial biases in image generation (Sun et al., 2023; OpenAI, 2022). Pertinent to the issues encountered when developing stimuli for this study, it has been argued that generative image AI is biased toward how women are presented, specifically that AI generated images of women tend to depict a more positive affect (Sun et al., 2023). While

the exclusion of female faces from this study was unlikely to be detrimental to the results, it does highlight a significant limitation of using AI generated images as stimuli for face perception research. While this issue will likely improve in the future, it is important that any use of AI generated stimuli in research is accompanied by an adequate understanding of the severity of bias within AI.

When discussing the current study within the context of other existing literature, a few potential areas for further research become apparent. Firstly, it would likely be beneficial to investigate the interaction between FE and FI in both directions in a single study. This study solely examined the impacts of variation of FI on FE processing but did not address whether variation in FE impacts the processing of FI. By addressing both directions of the relationship in a single study, as has been done in other studies, more information pertaining to the mechanisms of the relationship can be ascertained.

Furthermore, future studies should shift focus away from simply identifying overlap between FE and FI processing, and towards understanding the mechanisms behind why such a relationship exists. As discussed, a possible explanation for the relationship is that certain aspects of the face, like FI, are processed more automatically than aspects like FE. Gaining further understanding into the automaticity of face processing, the differences in automaticity between different features of the face, and how these may account for the relationship between FE and FI in processing would be highly beneficial to understanding of face processing.

6.0 Conclusion

Face perception has long been the focus of research due to our impressive abilities to process such a complex stimulus so efficiently. Understanding how the processing of different aspects of face perception interact with one another has been a main focus of the field. This study aimed to further investigate the relationship between facial expression and facial identity processing, and if facial expression processing is biased towards a certain end of the valence continuum. This was done using a foraging paradigm, which also allowed us to ascertain whether it is an appropriate paradigm to investigate the processing of a visual stimulus as complex as faces. In two separate foraging experiments, we used AI generated images of celebrity faces showing different facial expressions. Participants were required to search for a specific facial expression valence (positive or negative) on each trial, and some trials showed multiple different identities, while others showed only a single identity.

From the results of both experiments, it is clear that variation in facial identity reduced the efficiency with which facial expressions were processed, this was evident in a slower response time for selecting target stimuli in trials with multiple identities in comparison to single identity trials. This indicates that processing of facial expression overlaps with the processing of facial identity in some way. This is consistent with literature on the topic from the past few decades. Based on this study, and the very extensive literature available, it is clear that facial expression and facial identity processing interact in some way, and future research should focus on identifying the mechanisms behind the relationship, as opposed to identifying the relationship itself. A good direction for future research would be to focus on automatic processing of the face, to what extent different aspects of the face are processed automatically, and how differences in automatic processing between familiar and unfamiliar faces may impact how the aspects of the face interact in processing.

A processing bias for positive facial expressions, in the form of shorter response time for positive targets, was evident in both experiments. Previous studies investigating valence bias in facial expression processing have found differing results, and this is dependent on the paradigm used. In paradigms where face stimuli are presented alone, a positivity bias is

typically found, whereas when multiple face stimuli are presented together, a negativity bias is found. This is known as the face in the crowd effect and is what we expected to find in this study. However, our results were unexpected, as we found a strong processing bias for positive facial expressions throughout the entirety of both experiments. A number of possible factors that may have contributed to this finding were explored, but none were concrete enough for a concrete conclusion to be made. Further study is needed on foraging for facial expressions to attempt to understand why this occurred.

This study also successfully utilised a foraging paradigm to investigate mechanisms of face perception. Previous foraging studies have used simple visual stimuli, that differ from one another across low level features like colour and shape. The foraging paradigm allowed for clear patterns in processing to emerge, confirming its utility in investigating complex visual stimuli, specifically the human face.

Overall, this study has provided further evidence that facial identity and facial expression processing overlap in some way. It also shed light on the utility of foraging paradigms for face perception research, opening the door for future research using foraging to investigate the processing of the human face.

References

- Basoudan, N., Torrens-Burton, A., Jenkins, A., Thornton, I. M., Hanley, C., Tree, J. J., Thomas, S., & Tales, A. (2019). Sequential Information Processing: The “Elevated First Response Effect” Can Contribute to Exaggerated Intra-Individual Variability in Older Adults.. *Yale Journal of Biology and Medicine* , 92(1), 13–20.
- Bauer, R. M. (1984). Autonomic recognition of names and faces in prosopagnosia: A neuropsychological application of the guilty knowledge test. *Neuropsychologia*, 22(4), 457–469. [https://doi.org/10.1016/0028-3932\(84\)90040-x](https://doi.org/10.1016/0028-3932(84)90040-x)
- Becker, D. V., Anderson, U. S., Mortensen, C. R., Neufeld, S. L., & Neel, R. (2011). The face in the crowd effect unconfounded: Happy faces, not angry faces, are more efficiently detected in single- and multiple-target visual search tasks. *Journal of Experimental Psychology: General*, 140(4), 637–659. <https://doi.org/10.1037/a0024060>
- Bella-Fernández, M., Suero Suñé, M., & Gil-Gómez de Liaño, B. (2021). Foraging behavior in visual search: A review of theoretical and mathematical models in humans and animals. *Psychological Research*, 86, 331–349. <https://doi.org/10.1007/s00426-021-01499-1>
- Bernstein, M., & Yovel, G. (2015). Two neural pathways of face processing: A critical evaluation of current models. *Neuroscience & Biobehavioral Reviews*, 55, 536–546. <https://doi.org/10.1016/j.neubiorev.2015.06.010>
- Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology*, 77(3), 305–327. <https://doi.org/10.1111/j.2044-8295.1986.tb02199.x>
- Bruyer, R., Laterre, C., Seron, X., Feyereisen, P., Strypstein, E., Pierrard, E., & Rectem, D. (1983). A case of prosopagnosia with some preserved covert remembrance of familiar faces. *Brain and Cognition*, 2(3), 257–284. [https://doi.org/10.1016/0278-2626\(83\)90014-3](https://doi.org/10.1016/0278-2626(83)90014-3)
- Calder, A. J., & Young, A. W. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience*, 6(8), 641–651. <https://doi.org/10.1038/nrn1724>

- Calvo, M. G., Fernández-Martín, A., & Nummenmaa, L. (2012). Perceptual, categorical, and affective processing of ambiguous smiling facial expressions. *Cognition*, *125*(3), 373–393. <https://doi.org/10.1016/j.cognition.2012.07.021>
- Calvo, M. G., & Nummenmaa, L. (2008). Detection of emotional faces: Salient physical features guide effective visual search. *Journal of Experimental Psychology: General*, *137*(3). <https://doi.org/10.1037/a0012771>
- Calvo, M. G., Nummenmaa, L., & Avero, P. (2008). Visual Search of Emotional Faces. *Experimental Psychology*, *55*(6), 359–370. <https://doi.org/10.1027/1618-3169.55.6.359>
- Calvo, M. G., Nummenmaa, L., & Avero, P. (2010). Recognition advantage of happy faces in extrafoveal vision: Featural and affective processing. *Visual Cognition*, *18*(9), 1274–1297. <https://doi.org/10.1080/13506285.2010.481867>
- Campbell, J., & Burke, D. (2009). Evidence that identity-dependent and identity-independent neural populations are recruited in the perception of five basic emotional facial expressions. *Vision Research*, *49*(12), 1532–1540. <https://doi.org/10.1016/j.visres.2009.03.009>
- Chan, L. K. H., & Hayward, W. G. (2013). Visual search. *Wiley Interdisciplinary Reviews: Cognitive Science*, *4*(4), 415–429. <https://doi.org/10.1002/wcs.1235>
- Clark, K., Appelbaum, L. G., van den Berg, B., Mitroff, S. R., & Woldorff, M. G. (2015). Improvement in Visual Search with Practice: Mapping Learning-Related Changes in Neurocognitive Stages of Processing. *Journal of Neuroscience*, *35*(13), 5351–5359. <https://doi.org/10.1523/jneurosci.1152-14.2015>
- Claydon, L. S. (2015). Rigour in quantitative research. *Nursing Standard*, *29*(47), 43–48. <https://doi.org/10.7748/ns.29.47.43.e8820>
- Corrow, S. L., Dalrymple, K., & Barton, J. (2016). Prosopagnosia: current perspectives. *Eye and Brain*, *8*, 165–175. <https://doi.org/10.2147/eb.s92838>
- Dawkins, M. (1971). Shifts of “attention” in chicks during feeding. *Animal Behaviour*, *19*(3), 575–582. [https://doi.org/10.1016/s0003-3472\(71\)80114-8](https://doi.org/10.1016/s0003-3472(71)80114-8)

- de Gelder, B., Vroomen, J., Pourtois, G., & Weiskrantz, L. (1999). Non-conscious recognition of affect in the absence of striate cortex. *NeuroReport*, *10*(18), 3759–3763. <https://doi.org/10.1097/00001756-199912160-00007>
- de Haan, E. H. F., Young, A., & Newcombe, F. (1987). Face recognition without awareness. *Cognitive Neuropsychology*, *4*(4), 385–415. <https://doi.org/10.1080/02643298708252045>
- Ellamil, M., Susskind, J. M., & Anderson, A. K. (2008). Examinations of identity invariance in facial expression adaptation. *Cognitive, Affective, & Behavioral Neuroscience*, *8*(3), 273–281. <https://doi.org/10.3758/cabn.8.3.273>
- FaceGen About*. (2024). Facegen.com. <https://facegen.com/about.htm>
- Facial Action Coding System*. (2020, January 30). Paul Ekman Group. <https://www.paulekman.com/facial-action-coding-system/>
- Fox, C. J., & Barton, J. J. S. (2007). What is adapted in face adaptation? The neural representations of expression in the human visual system. *Brain Research*, *1127*, 80–89. <https://doi.org/10.1016/j.brainres.2006.09.104>
- Fox, C. J., Oruç, I., & Barton, J. J. S. (2008). It doesn't matter how you feel. The facial identity aftereffect is invariant to changes in facial expression. *Journal of Vision*, *8*(3), 11. <https://doi.org/10.1167/8.3.11>
- Fox, E., Lester, V., Russo, R., Bowles, R. J., Pichler, A., & Dutton, K. (2000). Facial Expressions of Emotion: Are Angry Faces Detected More Efficiently? *Cognition & Emotion*, *14*(1), 61–92. <https://doi.org/10.1080/026999300378996>
- Frischen, A., Eastwood, J. D., & Smilek, D. (2008). Visual search for faces with emotional expressions. *Psychological Bulletin*, *134*(5), 662–676. <https://doi.org/10.1037/0033-2909.134.5.662>
- Ganel, T., & Goshen-Gottstein, Y. (2004). Effects of Familiarity on the Perceptual Integrity of the Identity and Expression of Faces: The Parallel-Route Hypothesis Revisited. *Journal of Experimental Psychology: Human Perception and Performance*, *30*(3), 583–597. <https://doi.org/10.1037/0096-1523.30.3.583>

- Garner, W. R. (1976). Interaction of stimulus dimensions in concept and choice processes. *Cognitive Psychology*, *8*(1), 98–123. [https://doi.org/10.1016/0010-0285\(76\)90006-2](https://doi.org/10.1016/0010-0285(76)90006-2)
- Garner, W. R., & Felfoldy, G. L. (1970). Integrality of stimulus dimensions in various types of information processing. *Cognitive Psychology*, *1*(3), 225–241. [https://doi.org/10.1016/0010-0285\(70\)90016-2](https://doi.org/10.1016/0010-0285(70)90016-2)
- George, N., Dolan, R. J., Fink, G. R., Baylis, G. C., Russell, C., & Driver, J. (1999). Contrast polarity and face recognition in the human fusiform gyrus. *Nature Neuroscience*, *2*(6), 574–580. <https://doi.org/10.1038/9230>
- Gerlach, C., Kühn, C. D., Mathiassen, A. B., Kristensen, C. L., & Starrfelt, R. (2023). The face inversion effect or the face upright effect? *Cognition*, *232*, 105335. <https://doi.org/10.1016/j.cognition.2022.105335>
- Gilchrist, I. D., North, A., & Hood, B. (2001). Is Visual Search Really like Foraging? *Perception*, *30*(12), 1459–1464. <https://doi.org/10.1068/p3249>
- Godinho, R. M., Spikins, P., & O'Higgins, P. (2018). Supraorbital morphology and social dynamics in human evolution. *Nature Ecology & Evolution*, *2*(6), 956–961. <https://doi.org/10.1038/s41559-018-0528-0>
- Grüter, T., Grüter, M., & Carbon, C.-C. (2008). Neural and genetic foundations of face recognition and prosopagnosia. *Journal of Neuropsychology*, *2*(1), 79–97. <https://doi.org/10.1348/174866407x231001>
- Hasselmo, M. E., Rolls, E. T., & Baylis, G. C. (1989). The role of expression and identity in the face-selective responses of neurons in the temporal visual cortex of the monkey. *Behavioural Brain Research*, *32*(3), 203–218. [https://doi.org/10.1016/s0166-4328\(89\)80054-3](https://doi.org/10.1016/s0166-4328(89)80054-3)
- Hávarðardóttir, H. F., & Þorlákssdóttir, G. (2022). *Assessing Face Recognition Abilities: Exploring the link between PI20, CFMT and a foraging task.* <https://hdl.handle.net/1946/41566>

- Haxby, J. V., Grady, C. L., Horwitz, B., Ungerleider, L. G., Mishkin, M., Carson, R. E., Hirsch, P., Schapiro, M. B., & Rapoport, S. I. (1991). Dissociation of object and spatial visual processing pathways in human extrastriate cortex. *Proceedings of the National Academy of Sciences*, *88*(5), 1621–1625. <https://doi.org/10.1073/pnas.88.5.1621>
- Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences*, *4*(6), 223–233. [https://doi.org/10.1016/s1364-6613\(00\)01482-0](https://doi.org/10.1016/s1364-6613(00)01482-0)
- Hemström, J., Albonico, A., Djouab, S., & Barton, J. J. S. (2019). Visual search for complex objects: Set-size effects for faces, words and cars. *Vision Research*, *162*, 8–19. <https://doi.org/10.1016/j.visres.2019.06.007>
- Herlitz, A., & Lovén, J. (2013). Sex differences and the own-gender bias in face recognition: A meta-analytic review. *Visual Cognition*, *21*(9-10), 1306–1336. <https://doi.org/10.1080/13506285.2013.823140>
- Hills, T. T., Kalff, C., & Wiener, J. M. (2013). Adaptive Lévy Processes and Area-Restricted Search in Human Foraging. *PLoS ONE*, *8*(4), e60488. <https://doi.org/10.1371/journal.pone.0060488>
- Hoffman, E. A., & Haxby, J. V. (2000). Distinct representations of eye gaze and identity in the distributed human neural system for face perception. *Nature Neuroscience*, *3*(1), 80–84. <https://doi.org/10.1038/71152>
- Horstmann, G., & Bauland, A. (2006). Search asymmetries with real faces: Testing the anger-superiority effect. *Emotion*, *6*(2), 193–207. <https://doi.org/10.1037/1528-3542.6.2.193>
- Jenkins, R., Lavie, N., & Driver, J. (2003). Ignoring famous faces: Category-specific dilution of distractor interference. *Perception & Psychophysics*, *65*(2), 298–309. <https://doi.org/10.3758/bf03194801>
- Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The Fusiform Face Area: A Module in Human Extrastriate Cortex Specialized for Face Perception. *The Journal of Neuroscience*, *17*(11), 4302–4311. <https://doi.org/10.1523/jneurosci.17-11-04302.1997>

- Kaufmann, J. M., & Schweinberger, S. R. (2004). Expression Influences the Recognition of Familiar Faces. *Perception, 33*(4), 399–408. <https://doi.org/10.1068/p5083>
- Kauschke, C., Bahn, D., Vesker, M., & Schwarzer, G. (2019). The Role of Emotional Valence for the Processing of Facial and Verbal Stimuli—Positivity or Negativity Bias? *Frontiers in Psychology, 10*(1654). <https://doi.org/10.3389/fpsyg.2019.01654>
- Keys, R. T., Taubert, J., & Wardle, S. G. (2021). A visual search advantage for illusory faces in objects. *Attention, Perception, & Psychophysics, 83*(5), 1942–1953. <https://doi.org/10.3758/s13414-021-02267-4>
- Kristjánsson, Á. (2015). Reconsidering Visual Search. *I-Perception, 6*(6), 204166951561467. <https://doi.org/10.1177/2041669515614670>
- Kristjánsson, Á., & Egeth, H. (2019). How feature integration theory integrated cognitive psychology, neurophysiology, and psychophysics. *Attention, Perception, & Psychophysics, 82*. <https://doi.org/10.3758/s13414-019-01803-7>
- Kristjánsson, Á., Jóhannesson, Ó. I., & Thornton, I. M. (2014). Common Attentional Constraints in Visual Foraging. *PLoS ONE, 9*(6), e100752. <https://doi.org/10.1371/journal.pone.0100752>
- Kristjánsson, T., & Kristjánsson, Á. (2018). Foraging through multiple target categories reveals the flexibility of visual working memory. *Acta Psychologica, 183*, 108–115. <https://doi.org/10.1016/j.actpsy.2017.12.005>
- Kristjánsson, T., Thornton, I. M., Chetverikov, A., & Kristjánsson, Á. (2020). Dynamics of visual attention revealed in foraging tasks. *Cognition, 194*, 104032. <https://doi.org/10.1016/j.cognition.2019.104032>
- Kurucz, J., & Feldmar, G. (1979). Prosopo-Affective Agnosia as a Symptom of Cerebral Organic Disease. *Journal of the American Geriatrics Society, 27*(5), 225–230. <https://doi.org/10.1111/j.1532-5415.1979.tb06037.x>
- Lacruz, R. S., Stringer, C. B., Kimbel, W. H., Wood, B., Harvati, K., O'Higgins, P., Bromage, T. G., & Arsuaga, J.-L. (2019). The evolutionary history of the human face. *Nature Ecology & Evolution, 3*(5), 726–736. <https://doi.org/10.1038/s41559-019-0865-7>

- Lavie, N., Ro, T., & Russell, C. (2003). The Role of Perceptual Load in Processing Distractor Faces. *Psychological Science*, 14(5), 510–515. <https://doi.org/10.1111/1467-9280.03453>
- Leppänen, J. M., & Hietanen, J. K. (2003). Positive facial expressions are recognized faster than negative facial expressions, but why? *Psychological Research Psychologische Forschung*, 69(1-2), 22–29. <https://doi.org/10.1007/s00426-003-0157-2>
- Lundqvist, D., Juth, P., & Öhman, A. (2013). Using facial emotional stimuli in visual search experiments: The arousal factor explains contradictory results. *Cognition and Emotion*, 28(6), 1012–1029. <https://doi.org/10.1080/02699931.2013.867479>
- Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*, 47(4), 1122–1135. <https://doi.org/10.3758/s13428-014-0532-5>
- McElree, B., & Carrasco, M. (1999). The temporal dynamics of visual search: Evidence for parallel processing in feature and conjunction searches. *Journal of Experimental Psychology: Human Perception and Performance*, 25(6), 1517–1539. <https://doi.org/10.1037/0096-1523.25.6.1517>
- McKone, E., Dawel, A., Robbins, R. A., Shou, Y., Chen, N., & Crookes, K. (2021). Why the other-race effect matters: Poor recognition of other-race faces impacts everyday social interactions. *British Journal of Psychology*, 114(S1). <https://doi.org/10.1111/bjop.12508>
- Moreno, J. (2022, November 5). Picsart Adds AI-Powered Image Generation And Copywriting Tools. *Forbes*. <https://www.forbes.com/sites/johanmoreno/2022/11/02/picsart-adds-ai-powered-image-generation-and-copywriting-tools/?sh=14045e0418a2>

- Morris, J. S., de Gelder, B., Weiskrantz, L., & Dolan, R. J. (2001). Differential extrageniculostriate and amygdala responses to presentation of emotional faces in a cortically blind field. *Brain*, *124*(6), 1241–1252. <https://doi.org/10.1093/brain/124.6.1241>
- Murphy, J., Gray, K. L. H., & Cook, R. (2016). The composite face illusion. *Psychonomic Bulletin & Review*, *24*(2), 245–261. <https://doi.org/10.3758/s13423-016-1131-5>
- Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology*, *64*(5), 723–739. <https://doi.org/10.1037/0022-3514.64.5.723>
- Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology*, *80*(3), 381–396. <https://doi.org/10.1037//0022-3514.80.3.381>
- OpenAI. (2022). *DALL·E 2 pre-training mitigations*. OpenAI. <https://openai.com/index/dall-e-2-pre-training-mitigations/>
- Palermo, R., & Rhodes, G. (2007). Are you always on my mind? A review of how face perception and attention interact. *Neuropsychologia*, *45*(1), 75–92. <https://doi.org/10.1016/j.neuropsychologia.2006.04.025>
- Pasley, B. N., Mayes, L. C., & Schultz, R. T. (2004). Subcortical Discrimination of Unperceived Objects during Binocular Rivalry. *Neuron*, *42*(1), 163–172. [https://doi.org/10.1016/s0896-6273\(04\)00155-2](https://doi.org/10.1016/s0896-6273(04)00155-2)
- Pinkham, A. E., Griffin, M., Baron, R., Sasson, N. J., & Gur, R. C. (2010). The face in the crowd effect: Anger superiority when using real faces and multiple identities. *Emotion*, *10*(1), 141–146. <https://doi.org/10.1037/a0017387>
- Prpic, V., Kniestedt, I., Camilleri, E., Maureira, M. G., Kristjánsson, Á., & Thornton, I. M. (2019). A serious game to explore human foraging in a 3D environment. *PLOS ONE*, *14*(7), e0219827. <https://doi.org/10.1371/journal.pone.0219827>

- Puce, A., Allison, T., Asgari, M., Gore, J. C., & McCarthy, G. (1996). Differential Sensitivity of Human Visual Cortex to Faces, Letterstrings, and Textures: A Functional Magnetic Resonance Imaging Study. *The Journal of Neuroscience*, *16*(16), 5205–5215. <https://doi.org/10.1523/jneurosci.16-16-05205.1996>
- Puce, A., Allison, T., Bentin, S., Gore, J. C., & McCarthy, G. (1998). Temporal Cortex Activation in Humans Viewing Eye and Mouth Movements. *Journal of Neuroscience*, *18*(6), 2188–2199. <https://doi.org/10.1523/JNEUROSCI.18-06-02188.1998>
- Pye, L. (2024, January 16). How to Use AI Enhance to Improve Your Photos - Picsart Blog. *Picsart Blog*. https://picsart.com/blog/post/how-to-use-ai-enhance-to-improve-your-photos%20post#Understanding_AI_Enhance
- Ramesh, A., Pavlov, M., Goh, G., & Gray, S. (2021). *DALL·E: Creating images from text*. Openai.com. <https://openai.com/research/dall-e>
- Rhodes, G., Pond, S., Burton, N., Kloth, N., Jeffery, L., Bell, J., Ewing, L., Calder, A. J., & Palermo, R. (2015). How distinct is the coding of face identity and expression? Evidence for some common dimensions in face space. *Cognition*, *142*, 123–137. <https://doi.org/10.1016/j.cognition.2015.05.012>
- Rossion, B. (2014). Understanding face perception by means of human electrophysiology. *Trends in Cognitive Sciences*, *18*(6), 310–318. <https://doi.org/10.1016/j.tics.2014.02.013>
- Rotteveel, M., de Groot, P., Geutskens, A., & Phaf, R. H. (2001). Stronger suboptimal than optimal affective priming? *Emotion*, *1*(4), 348–364. <https://doi.org/10.1037//1528-3542.1.4.348>
- Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. <https://doi.org/10.1037/h0077714>
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, *110*(1), 145–172. <https://doi.org/10.1037/0033-295x.110.1.145>

- Scharf, I., Lubin, Y., & Ovadia, O. (2010). Foraging decisions and behavioural flexibility in trap-building predators: a review. *Biological Reviews*, *86*(3), 626–639. <https://doi.org/10.1111/j.1469-185x.2010.00163.x>
- Schweinberger, S. R., Burton, A. M., & Kelly, S. W. (1999). Asymmetric dependencies in perceiving identity and emotion: Experiments with morphed faces. *Perception & Psychophysics*, *61*(6), 1102–1115. <https://doi.org/10.3758/bf03207617>
- Schweinberger, S. R., & Soukup, G. R. (1998). Asymmetric relationships among perceptions of facial identity, emotion, and facial speech. *Journal of Experimental Psychology: Human Perception and Performance*. <https://doi.org/10.1037//0096-1523.24.6.1748>
- Sergent, J., Ohta, S., & MacDonald, B. (1992). Functional Neuroanatomy of Face and Object Processing. *Brain*, *115*(1), 15–36. <https://doi.org/10.1093/brain/115.1.15>
- Shen, J., Reingold, E. M., & Pomplun, M. (2003). Guidance of eye movements during conjunctive visual search: The distractor-ratio effect. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, *57*(2), 76–96. <https://doi.org/10.1037/h0087415>
- Shuttleworth, E. C., Syring, V., & Allen, N. (1982). Further observations on the nature of prosopagnosia. *Brain and Cognition*, *1*(3), 307–322. [https://doi.org/10.1016/0278-2626\(82\)90031-8](https://doi.org/10.1016/0278-2626(82)90031-8)
- Simion, F., Di Giorgio, E., Leo, I., & Bardi, L. (2011). The processing of social stimuli in early infancy. *Progress in Brain Research*, *189*, 173–193. <https://doi.org/10.1016/b978-0-444-53884-0.00024-5>
- Somerville, L. H., & Whalen, P. J. (2006). Prior experience as a stimulus category confound: an example using facial expressions of emotion. *Social Cognitive and Affective Neuroscience*, *1*(3), 271–274. <https://doi.org/10.1093/scan/nsl040>
- Sun, L., Wei, M., Sun, Y., Ji Suh, Y., Shen, L., & Yang, S. (2023). Smiling women pitching down: auditing representational and presentational gender biases in image-generative AI. *Journal of Computer-Mediated Communication*, *29*(1). <https://doi.org/10.1093/jcmc/zmad045>

- Svärd, J., Wiens, S., & Fischer, H. (2012). Superior Recognition Performance for Happy Masked and Unmasked Faces in Both Younger and Older Adults. *Frontiers in Psychology*, 3. <https://doi.org/10.3389/fpsyg.2012.00520>
- Tanaka, J. W., & Farah, M. J. (1993). Parts and Wholes in Face Recognition. *The Quarterly Journal of Experimental Psychology Section A*, 46(2), 225–245. <https://doi.org/10.1080/14640749308401045>
- Thornton, I. M., & Horowitz, T. S. (2004). The multi-item localization (MILO) task: Measuring the spatiotemporal context of vision for action. *Perception & Psychophysics*, 66(1), 38–50. <https://doi.org/10.3758/bf03194859>
- Thornton, I. M., & Horowitz, T. S. (2020). Searching Through Alternating Sequences: Working Memory and Inhibitory Tagging Mechanisms Revealed Using the MILO Task. *I-Perception*, 11(5), 204166952095801. <https://doi.org/10.1177/2041669520958018>
- Thornton, I. M., Nguyen, T. T. N., & Árne Kristjánsson. (2020). Foraging tempo: Human run patterns in multiple-target search are constrained by the rate of successive responses. *Quarterly Journal of Experimental Psychology*, 75(2), 297–312. <https://doi.org/10.1177/1747021820961640>
- Tong, F., & Nakayama, K. (1999). Robust representations for faces: Evidence from visual search. *Journal of Experimental Psychology: Human Perception and Performance*, 25(4), 1016–1035. <https://doi.org/10.1037/0096-1523.25.4.1016>
- Tranel, D., & Damasio, A. (1985). Knowledge without awareness: an autonomic index of facial recognition by prosopagnosics. *Science*, 228(4706), 1453–1454. <https://doi.org/10.1126/science.4012303>
- Tranel, D., Damasio, A. R., & Damasio, H. (1988). Intact recognition of facial expression, gender, and age in patients with impaired recognition of face identity. *Neurology*, 38(5), 690–690. <https://doi.org/10.1212/wnl.38.5.690>
- Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, 12(1), 97–136. [https://doi.org/10.1016/0010-0285\(80\)90005-5](https://doi.org/10.1016/0010-0285(80)90005-5)

- Tsao, D. Y., & Livingstone, M. S. (2008). Mechanisms of Face Perception. *Annual Review of Neuroscience*, 31(1), 411–437. <https://doi.org/10.1146/annurev.neuro.30.051606.094238>
- Vuilleumier, P., Armony, J. L., Clarke, K., Husain, M., Driver, J., & Dolan, R. J. (2002). Neural response to emotional faces with and without awareness: event-related fMRI in a parietal patient with visual extinction and spatial neglect. *Neuropsychologia*, 40(12), 2156–2166. [https://doi.org/10.1016/s0028-3932\(02\)00045-3](https://doi.org/10.1016/s0028-3932(02)00045-3)
- Walden, T. A., & Field, T. M. (1982). Discrimination of Facial Expressions by Preschool Children. *Child Development*, 53(5), 1312. <https://doi.org/10.2307/1129021>
- Wang, Y., Fu, X., Johnston, R. A., & Yan, Z. (2013). Discriminability effect on Garner interference: evidence from recognition of facial identity and expression. *Frontiers in Psychology*, 4. <https://doi.org/10.3389/fpsyg.2013.00943>
- Waterfield, J. (2018). Convenience Sampling. In B. B. Frey (Ed.), *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation* (Vol. 4, pp. 402–403). SAGE Publications, Inc. <https://doi.org/10.4135/9781506326139>
- Webster, M. A. (2015). Visual Adaptation. *Annual Review of Vision Science*, 1, 547–567. <https://doi.org/10.1146/annurev-vision-082114-035509>
- Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., & Jenike, M. A. (1998). Masked Presentations of Emotional Facial Expressions Modulate Amygdala Activity without Explicit Knowledge. *Journal of Neuroscience*, 18(1), 411–418. <https://doi.org/10.1523/JNEUROSCI.18-01-00411.1998>
- Wingenbach, T. S. H., Ashwin, C., & Brosnan, M. (2018). Sex differences in facial emotion recognition across varying expression intensity levels from videos. *PLOS ONE*, 13(1), e0190634. <https://doi.org/10.1371/journal.pone.0190634>
- Wolfe, J. M. (1998). What Can 1 Million Trials Tell Us About Visual Search? *Psychological Science*, 9(1), 33–39. <https://doi.org/10.1111/1467-9280.00006>
- Wolfe, J. M. (2013). When is it time to move to the next raspberry bush? Foraging rules in human visual search. *Journal of Vision*, 13(3), 10–10. <https://doi.org/10.1167/13.3.10>

- Wolfe, J. M. (2016). Visual Search Revived: The Slopes Are Not That Slippery: A Reply to Kristjansson (2015). *I-Perception*, 7(3), 204166951664324. <https://doi.org/10.1177/2041669516643244>
- Wolfe, J. M., Aizenman, A., Boettcher, S. E. P., & Cain, M. S. (2016). Hybrid foraging search: Searching for multiple instances of multiple types of target. *Vision Research*, 119, 50–59. <https://doi.org/10.1016/j.visres.2015.12.006>
- Wolfe, J. M., & Horowitz, T. S. (2017). Five factors that guide attention in visual search. *Nature Human Behaviour*, 1(3). <https://doi.org/10.1038/s41562-017-0058>
- Xu, Q., Ye, C., Gu, S., Hu, Z., Lei, Y., Li, X., Huang, L., & Liu, Q. (2021). Negative and Positive Bias for Emotional Faces: Evidence from the Attention and Working Memory Paradigms. *Neural Plasticity*, 2021, 1–13. <https://doi.org/10.1155/2021/8851066>
- Yan, X., Young, A. W., & Andrews, T. J. (2017). The automaticity of face perception is influenced by familiarity. *Attention, Perception, & Psychophysics*, 79(7), 2202–2211. <https://doi.org/10.3758/s13414-017-1362-1>
- Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology*, 81(1), 141–145. <https://doi.org/10.1037/h0027474>
- Young, A. W. (2018). Faces, people and the brain: The 45th Sir Frederic Bartlett Lecture. *Quarterly Journal of Experimental Psychology*, 71(3), 569–594. <https://doi.org/10.1177/1747021817740275>
- Young, A. W., & Bruce, V. (2011). Understanding person perception. *British Journal of Psychology*, 102(4), 959–974. <https://doi.org/10.1111/j.2044-8295.2011.02045.x>
- Young, A. W., Hellawell, D., & Hay, D. C. (1987). Configurational Information in Face Perception. *Perception*, 16(6), 747–759. <https://doi.org/10.1068/p160747>
- Yovel, G., Wilmer, J. B., & Duchaine, B. (2014). What can individual differences reveal about face processing? *Frontiers in Human Neuroscience*, 8. <https://doi.org/10.3389/fnhum.2014.00562>

Appendix A

Copy of Research Ethics and Data Protection Form



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Research Ethics and Data Protection Form

University of Malta staff, students, or anyone else planning to carry out research under the auspices of the University, must complete this form. The UM may also consider requests for ethics and data protection review by External Applicants.

Ahead of completing this online form, please read carefully the University of Malta [Research Code of Practice](#) and the University of Malta [Research Ethics Review Procedures](#). Any breach of the Research Code of Practice or untruthful replies in this form will be considered a serious disciplinary matter. It is advisable to download a full digital version of the form to familiarise yourself with its contents (<https://www.um.edu.mt/research/ethics/resources/umdocuments/>). You are also advised to refer to the FAQs (<https://www.um.edu.mt/research/ethics/faqs>).

Part 1: Applicant and Project Details

Applicant Details

Name: Nina

Surname: Attard Montalto

Email: nina.attard-montalto.19@um.edu.mt

Applicant Status: Student

Please indicate if you form part of a Faculty, Institute, School or Centre: Faculty of Media & Knowledge Sciences

Department: Cognitive Science

Principal Supervisor's Name: Prof. Ian M Thornton

Principal Supervisor's Email: ian.thornton@um.edu.mt

Co-Supervisor's Name:

Study Unit Code: CGS5990

Course Title: Masters of Science in Cognitive Science

Student Number: 159900L

Project Details

Title of Research Project: Exploring the Interplay of Facial Expression and Identity Processing: A Foraging Paradigm Investigation

Project description, including research question/statement and method, in brief:

This project aims to investigate the relationship between the processing of facial identity and facial expression using a foraging task. The current understanding of how facial identity processing and facial expression processing are linked is quite limited. We intend to utilise a foraging paradigm, which has yet to be used, to investigate this issue. More specifically, we hope to:

- Gain further understanding into the relationship between facial identity processing and facial expression processing, and the nature of that relationship.
- Identify if, and to what extent, variation in facial identity impacts the efficiency of processing of facial expression.
- Gain further understanding into the processing of emotional expressions when participants are required to identify multiple emotions of the same class (positive or negative), as opposed to specific expressions which have been the focus of research until now.
- Gain further understanding of foraging behaviour for complex visual stimuli.

The study will utilise a computer-based foraging task. The task will contain approximately 40 trials. In each trial, the participant will be presented with a set of 40 faces. Each face will have of four facial expressions:

- Negative valence, high arousal.
- Negative valence, low arousal.
- Positive valence, high arousal.
- Positive valence, low arousal.

There will be multiple data collection episodes, as we refine our research questions depending on initial outcomes. Some sessions may involve lab-based data collection, and others will be online data collection. In person data collection will be conducted in the Cognitive Science lab at the University of Malta, and the task will be presented to participants on an iPad. The task will automatically collect response time and run pattern data. Online participants will use their regular web browser and make responses via the mouse.

Will project involve collection of primary data from human participants? Yes / Unsure

Explain primary data collection from human participants:

a. Salient participant characteristics (e.g. min-max participants, age, sex, other):

Approximately 24 participants will be recruited for each experiment. Participants will be between the ages of 18-40. All participants must have normal or corrected to normal vision. There will be no other exclusion criteria.

b. How will they be recruited (e.g. sampled, selected, contacted, etc.):

Participants will be recruited using a convenience sampling technique. The researchers will recruit people they know, and also gather participants from the University of Malta student population. Additional online participants may be recruited from prolific.co.uk, a professional service that provides access to a world-wide pool of individuals.

Both in the lab and online, participants will be provided with a detailed explanation of what they will be required to do and will give explicit consent, either with a physical signature or by using a dedicated "confirm" button.

c. What they will be required to do and for how long:

Participants will be required to complete a foraging task. In the lab, the task will be presented to them on an iPad. Online participants will use their usual web browser. The entire task will take approximately 30-40 minutes. The total task time can differ between individual participants depending on individual differences in response time and processing speed.

During each trial, participants will be told what expression they are required to find. This could either be positive expressions or negative expressions. For each trial, 20 out of the 40 faces presented will fit into the required category. Participants will be required to find a sub-set of those faces (12-20 faces) On some trials, there will be five different facial identities, and on others only a single identity will be shown.

d. If inducements/rewards/compensation are offered: *

Participants will be financially compensated for their time at a rate of 10 euros an hour

e. How participants/society may benefit: *

There are no risks or benefits to the participants.

This research will help add to our understanding of facial processing, the processing of facial expressions and identity, and our understanding of foraging behaviour.

f. Is the participant's identity recorded at any stage of the research (e.g. in consent forms, records, publications): *

The participants identities will only be recorded on consent forms.

g. The manner in which you will manage and store the data: *

Any information pertaining to identity will be stored securely. The data being collected is not of a sensitive nature, however we will ensure that the data gathered from the experiment and any information pertaining to identity will be stored separately.

Will project involve collection of primary data from animals? No

Part 2: Self Assessment and Relevant Details

Human Participants

1. Risk of harm to participants: No / N.A.
2. Physical intervention: No / N.A.
3. Vulnerable participants: No / N.A.
4. Identifiable participants: No / N.A.
5. Special Categories of Personal Data (SCPD): No / N.A.
6. Human tissue/samples: No / N.A.
7. Withheld info assent/consent: No / N.A.
8. 'opt-out' recruitment: No / N.A.
9. Deception in data generation: No / N.A.
10. Incidental findings: No / N.A.

Unpublished secondary data

11. Human: No / N.A.
12. Animal: No / N.A.
13. No written permission: No / N.A.

Animals

14. Live animals, lasting harm: No / N.A.
15. Live animals, harm: No / N.A.
16. Source of dead animals, illegal: No / N.A.

General Considerations

17. Cooperating institution: No / N.A.
18. Risk to researcher/s: No / N.A.
19. Risk to environment: No / N.A.
20. Commercial sensitivity: No / N.A.

Other Potential Risks

21. Other potential risks: No / N.A.
22. Official statement: Do you require an official statement from the F/REC that this submission has abided by the UM's REDP procedures?
No / N.A.

Part 3: Submission

Which F/REC are you submitting to? * Faculty of Media & Knowledge Sciences

- Attachments:**
- Information and/or recruitment letter*
 - Consent forms (adult participants)*
 - Consent forms for legally responsible parents/guardians, in case of minors and/or adults unable to give consent*
 - Assent forms in case of minors and/or adults unable to give consent*
 - Data collection tools (interview questions, questionnaire etc.)
 - Data Management Plan
 - Data controller permission in case of use of unpublished secondary data
 - Licence/permission to use research tools (e.g. constructs/tests)
 - Any permits required for import or export of materials or data
 - Letter granting institutional approval for access to participants
 - Institutional approval for access to data
 - Letter granting institutional approval from person directly responsible for participants
 - Other

Please feel free to add a cover note or any remarks to F/REC

Declarations: *

- I hereby confirm having read the University of Malta Research Code of Practice and the University of Malta Research Ethics Review Procedures.
- I hereby confirm that the answers to the questions above reflect the contents of the research proposal and that the information provided above is truthful.
- I hereby give consent to the University Research Ethics Committee to process my personal data for the purpose of evaluating my request, audit and other matters related to this application. I understand that I have a right of access to my personal data and to obtain the rectification, erasure or restriction of processing in accordance with data protection law and in particular the General Data Protection Regulation (EU 2016/679, repealing Directive 95/46/EC) and national legislation that implements and further specifies the relevant provisions of said Regulation.

Applicant Signature: * Nina Attard Montalto

Date of Submission: * 29/01/2024

If applicable: Date collection start date

Administration

REDP Application ID MAKS-2023-00153

Current Status Acknowledged

If a submitted application needs to be amended, it can be withdrawn, edited, and resubmitted, and it will retain the same reference number. There is no need to submit a new application.

Appendix B

Copy of Participant Consent Form

University of Malta
Faculty of Media and Knowledge Sciences
Department of Cognitive Science

Informed consent form for the research project: Foraging for Facial Expressions

Aims of the Research:

We are investigating how quickly you can find particular facial expressions.

If you choose to participate in the research, this is what will be required of you:

- You will be required to complete an experimental foraging task.
- On each trial you will see a display containing 40 facial images.
- Your task will be to find 12 faces showing a particular type of expression.
- On some trials your targets will be faces with **POSITIVE** expressions (smile or laugh).
- On other trials you will search for faces with **NEGATIVE** expressions (sad or angry).
- The level of arousal (how intensely the person is expressing) is not relevant.
- On some trials the identity of the faces will vary. In other trials all targets will be the same person.
- Try to ignore this manipulation and always search for the expressions as quickly as you can.
- The task will be on an iPad, and you will need to use your finger to select the targets.
- There is no time limit, but you must try to select the targets as quickly as possible.

The experiment contains many trials, and each trial can last anywhere between 10 and 30 seconds. The whole task will not take longer than 30 minutes to complete. You are free to ask any additional questions at any point.

Voluntary nature of the research:

Your participation in this research is completely voluntary. You are free to stop participating and leave at any time. Your data will not be retained. Under the General Data Protection Regulation (GDPR) and national legislation, you also have the right to access, rectify, and where applicable, ask for the data concerning you to be erased at any time in the future.

Confidentiality:

In case of additional research of a similar nature, we need to retain the information that you participated in this study. This is necessary to ascertain that no one participated in two studies of a similar nature, which is a requirement in cognitive-science research. However, all data gathered will be stored independently from the information that you participated in this study. That is, we strictly separate the information about the names of participants and the gathered data.

Risks and benefits for participants:

There are no risks but also no benefits involved for the participant.

Contact:

In case of additional questions, you can contact the principal investigator, Prof. Ian Thornton (ian.thornton@um.edu.mt) or the experimenter, Nina Attard Montalto (nina.attard-montalto.19@um.edu.mt).

Consent:

I hereby declare to have read the information above. I did have the opportunity to ask questions about the study and my questions have been satisfactorily answered. I agree to participate in the research. I confirm that I am at least 18 years of age.

Full Name _____ Date _____

Signature _____

Appendix C

Examples of Text Prompts Used for Image Generation

Chris Hemsworth

- Pen and ink style. Blank white background. Chris Hemsworth. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Very angry. Open Mouth. Screaming. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but angry. Yelling.
- Pen and ink style. Blank white background. Chris Hemsworth. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look very sad. Frowning. Closed Mouth. Not Speaking About to cry. Depressed. Lips tremble.
- Pen and ink style. Blank white background. Chris Hemsworth. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look of surprise. Open Mouth. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but happy. Laughing eyes. Saying "Wow"
- Pen and ink style. Black and white. No colour. Blank white background. Chris Hemsworth. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Happy. Very slight smile. Looks wistful. Closed Mouth. Lips sealed. No teeth showing. Not Speaking. Smiling eyes.

Mick Jagger

- Pen and ink style. Blank white background. Mick Jagger. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Very angry. Open Mouth. Screaming. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but angry. Yelling.
- Pen and ink style. Blank white background. Mick Jagger. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look very sad. Frowning. Closed Mouth. Not Speaking About to cry. Depressed. Lips tremble.
- Pen and ink style. Blank white background. Mick Jagger. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look of surprise. Open Mouth.

Wide Eyes. Speaking clearly. Mouth wide open. Surprised but happy. Laughing eyes.
Saying "Wow"

- Pen and ink style. Black and white. No color. Blank white background. Mick Jagger. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Closed mouth smile. Looks wistful. Closed Mouth. Lips sealed. No teeth showing. Not Speaking. Smiling eyes.

Ed Sheeran

- Pen and ink style. Blank white background. Ed Sheeran. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Very angry. Furious. Open Mouth. Screaming. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but angry. Yelling. Furrowed Brow.
- Pen and ink style. Blank white background. Ed Sheeran. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look very sad. Frowning. Closed Mouth. Not Speaking About to cry. Depressed. Lips tremble.
- Pen and ink style. Blank white background. Ed Sheeran. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look of surprise. Open Mouth. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but happy. Laughing eyes. Saying "Wow"
- Pen and ink style. Black and white. No color. Blank white background. Ed Sheeran. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Happy. Very slight smile. Looks wistful. Closed Mouth. Lips sealed. No teeth showing. Not Speaking. Smiling eyes.

Chris Pratt

- Pen and ink style. Blank white background. Chris Pratt. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Very angry. Open Mouth. Screaming. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but angry. Yelling.
- Pen and ink style. Blank white background. Chris Pratt. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look very sad. Frowning. Closed Mouth. Not Speaking About to cry. Depressed. Lips tremble.
- Pen and ink style. Blank white background. Chris Pratt. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look of surprise. Open Mouth. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but happy. Laughing eyes. Saying “Wow”
- Pen and ink style. Black and white. No colour. Blank white background. Chris Pratt. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Happy. Very slight smile. Looks wistful. Closed Mouth. Lips sealed. No teeth showing. Not Speaking. Smiling eyes.

Tom Cruise

- Pen and ink style. Blank white background. Tom Cruise. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Very angry. Open Mouth. Screaming. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but angry. Yelling.
- Pen and ink style. Blank white background. Tom Cruise. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look very sad. Frowning. Closed Mouth. Not Speaking About to cry. Depressed. Lips tremble.
- Pen and ink style. Blank white background. Tom Cruise. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Look of surprise. Open Mouth. Wide Eyes. Speaking clearly. Mouth wide open. Surprised but happy. Laughing eyes. Saying “Wow”

- Pen and ink style. Black and white. No colour. Blank white background. Tom Cruise. Photo realistic. Very high resolution. Face in high resolution. Looks directly at camera. Happy. Very slight smile. Looks wistful. Closed Mouth. Lips sealed. No teeth showing. Not Speaking. Smiling eyes.

Appendix D

Recognition Test Results

	Chris Hemsworth	Chris Martin	Chris Pratt	Ed Sheeran	Mick Jagger	Tom Cruise
PP01	X	X	X	X	X	X
PP02	X	X	X	X	X	X
PP03	X		X	X	X	X
PP04	X	X	X	X	X	X
PP05	X	X	X	X	X	X
PP06	X	X	X	X	X	X
PP07	X	X	X	X		X
PP08	X	X	X	X	X	X
PP09	X	X	X	X	X	X
PP10	X	X	X	X	X	X
PP11	X	X	X	X	X	X
PP12	X			X	X	X
PP13	X	X	X	X	X	X
PP14	X	X	X	X		X
PP15	X		X	X		X
PP16	X	X	X	X	X	X
PP17	X		X	X		X
PP18	X	X	X	X		X
PP19	X	X	X	X	X	X
PP20	X		X	X	X	X
PP21	X		X	X		X
PP22	X		X	X		X
PP23	X		X	X		X
PP24	X		X	X		X

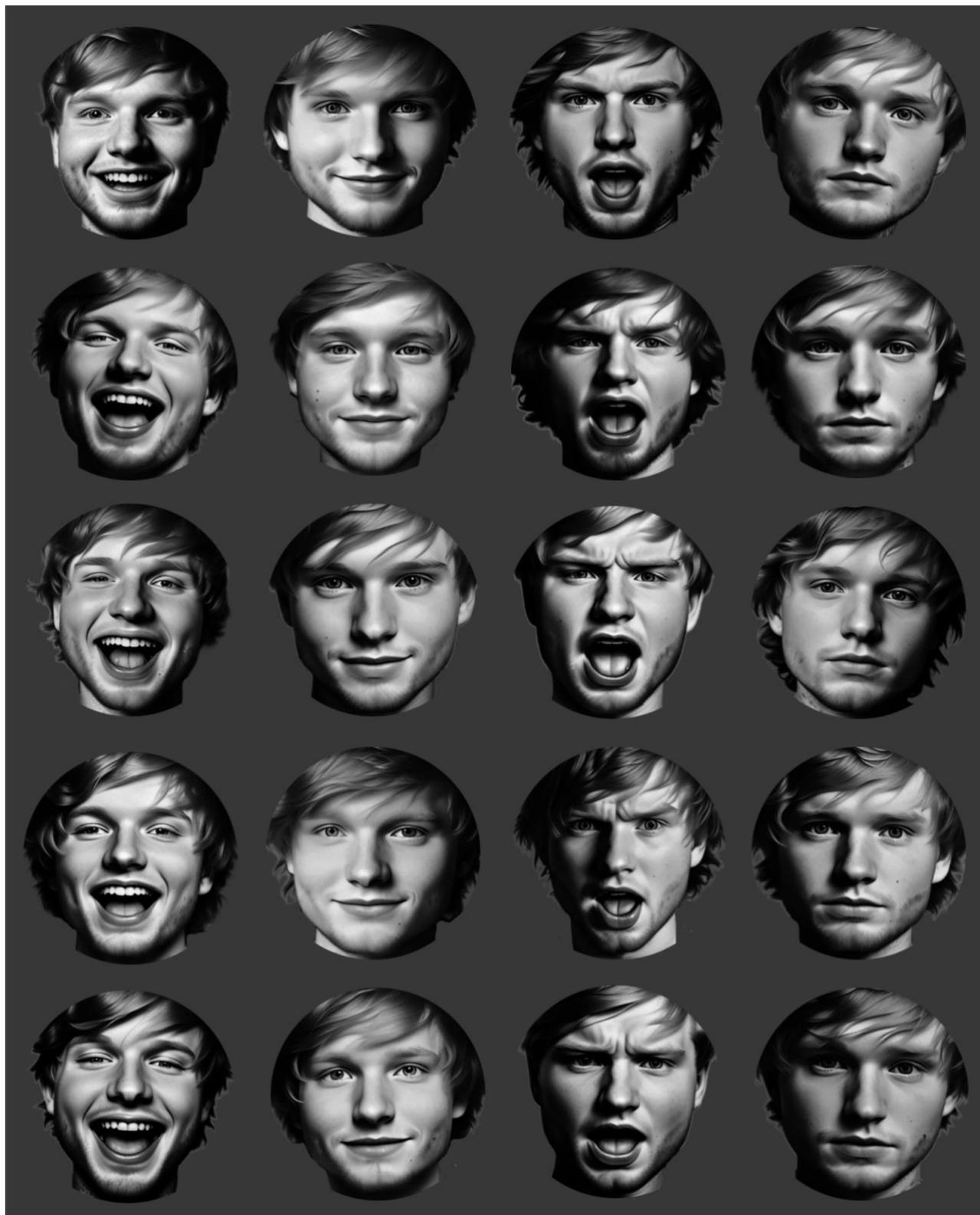
Appendix F

Experiment 2 Stimuli (in order Chris Hemsworth, Chris Martin, Chris Pratt, Ed Sheeran, Mick Jagger, Tom Cruise)

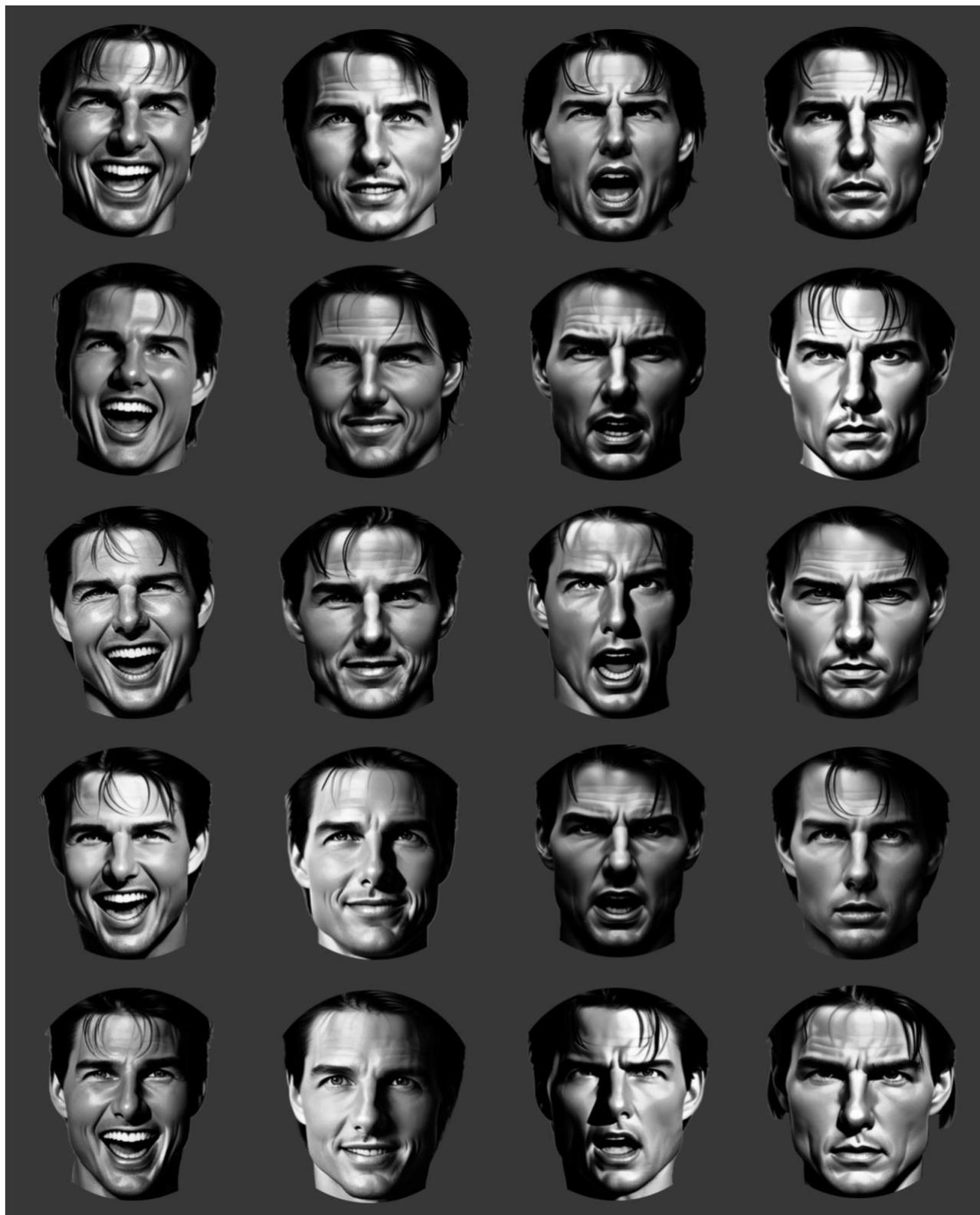












Appendix G

Results table for Experiment 1 Median RT1 2(Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	50370.492	2.556	0.138	0.189
Target	(1, 11)	194604.765	7.301	0.021	0.399
Condition*Target	(1, 11)	72907.856	0.037	0.852	0.003

Appendix H

Results table for Experiment 1 Median RTT 2(Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	7.729x10 ⁺⁶	22.426	<.001	0.671
Target	(1, 11)	4.345x10 ⁺⁶	14.956	0.003	0.576
Condition*Target	(1, 11)	3.382x10 ⁺⁷	3.83	0.076	0.258

Appendix I

Results table for Experiment 1 mean SRT 2(Identity Condition) x 2(Target Valence) ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	44644.311	30.330	<.001	0.734
Target	(1, 11)	23390.947	17.071	0.002	0.608
Condition*Target	(1, 11)	24296.311	0.557	0.471	0.048

Appendix J

Results table for Experiment 1 High Proportion Choice (Identity Condition) x 2(Target Valence) ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	0.003	0.114	0.742	0.010
Target	(1, 11)	0.005	0.017	0.898	0.002
Condition*Target	(1, 11)	0.004	0.208	0.657	0.019

Appendix KResults table for Experiment 1 Independent Sample *t*-test for Overall High Count Proportion

	<i>t</i>	df	<i>p</i>
Overall High Proportion	6.0276	11	<.001

Appendix LResults table for Experiment 1 Independent Sample *t*-test for First Choice High Count

Proportion

	<i>t</i>	df	<i>p</i>
First Choice High Proportion	1.9835	11	0.03642

Appendix M

Results table for Experiment 1 mean Run Count (Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	0.473	24.120	<.001	0.687
Target	(1, 11)	0.471	1.926	0.193	0.149
Condition*Target	(1, 11)	0.575	3.477	0.089	0.240

Appendix N

Results table for Experiment 2 Median RT1 2(Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	489335.915	1.399	0.262	0.113
Target	(1, 11)	668568.430	2.710	0.128	0.198
Condition*Target	(1, 11)	853367.642	0.155	0.702	0.014

Appendix O

Results table for Experiment 2 Median RTT 2(Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	4.947x10 ⁺⁶	4.837	0.050	0.305
Target	(1, 11)	1.180x10 ⁺⁷	7.674	0.018	0.411
Condition*Target	(1, 11)	8.969x10 ⁺⁶	0.265	0.617	0.024

Appendix P

Results table for Experiment 2 mean SRT 2(Identity Condition) x 2(Target Valence) ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	18445.182	12.033	0.005	0.522
Target	(1, 11)	18882.083	20.955	<.001	0.656
Condition*Target	(1, 11)	33149.606	0.173	0.686	0.015

Appendix Q

Results table for Experiment 2 High Proportion Choice (Identity Condition) x 2(Target Valence) ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	0.003	4.944	0.048	0.310
Target	(1, 11)	0.006	1.295	0.279	0.105
Condition*Target	(1, 11)	0.006	8.996×10^{-4}	0.977	8.178×10^{-5}

Appendix RResults table for Experiment 2 Independent Sample *t*-test for Overall High Count Proportion

	<i>t</i>	df	<i>p</i>
Overall High Proportion	3.2305	11	0.004004

Appendix SResults table for Experiment 2 Independent Sample *t*-test for First Choice High Count

Proportion

	<i>t</i>	df	<i>p</i>
First Choice High Proportion	4.1825	11	<.001

Appendix T

Results table for Experiment 2 mean Run Count (Identity Condition) x 2(Target Valence)

ANOVA

Variables	df	MSE	<i>F</i>	Sig.	η_p^2
Condition	(1, 11)	0.352	1.598	0.232	0.127
Target	(1, 11)	0.606	0.550	0.474	0.048
Condition*Target	(1, 11)	1.011	0.399	0.540	0.035