Face to Face: Flexibility in the Processing of Multiple Facial Cues

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Abstract

Early models of face processing proposed that facial cues indicating a person’s sex, race, and age, were processed separately from variant cues like emotional expression. Additionally, early theories of emotion perception suggested that processing of emotional expressions was unaffected by the situations in which the expressions were encountered. Subsequent research has demonstrated that this is not the case. The processing of emotional expressions is influenced by a range of contextual factors as well as by other social category cues present on the face. However, the manner in which the multiple sources of information on a face are integrated and how this integration is influenced by situational factors is not yet fully understood. Thus, the overall aim of this thesis was to extend our understanding of the influence of higher order cognitive states on the interaction of facial cues and social categories in the face, specifically in the processing of emotional expressions. This thesis describes a range of investigations, across a range of methods (including affective priming, visual search, and categorization) of how explicitly and implicitly activated higher order cognitive states influence the interaction of multiple facial cues and categories. Higher order cognitive states were manipulated explicitly by instructing participants to focus on different kinds of information available within the face. Higher order cognitive states were elicited implicitly by altering the other faces seen at the same time as the target face, altering the other faces seen on different trials within the same task, or altering the other faces seen in recently completed tasks.

Using the affective priming method, Chapter 2 demonstrated that implicit evaluations were more strongly influenced by the emotional expression displayed on the face primes than the social category, including race, sex, and age of the face. An influence of the social category was only observed when participants were instructed to focus on this dimension. This demonstrated that the nature of the task can influence the way in which cues like race, sex, age and emotion interact.

Using the visual search paradigm, Chapter 3 demonstrated that the nature of the background faces in a visual search task alters which expressions are more quickly detected. Happy faces were detected faster in backgrounds made up of a range of different emotional faces whereas angry faces tended to be detected faster in homogenous backgrounds made up of faces expressing the same emotion.

In Chapter 4.1, it was shown that the way facial cues of race influence the categorization of happy and angry emotional expressions depended on the presentation duration, stimulus type and importantly the number of different faces presented within a task. Chapter 4.2 investigated whether this finding could be accounted for with the perceptual load hypothesis and found it to be an unlikely explanation for the different patterns of results observed at small and large set.

Finally, Chapter 5 demonstrated that the way facial sex cues influence emotion categorization could be affected by other recently completed tasks. The typical finding of faster
categorization of happy than angry expressions displayed on female but not male faces was significantly altered when male and female faces were presented in separate tasks rather than together within the same task.

Together, these studies demonstrate that the way multiple facial cues indicating social category membership and emotion interact is flexible and sensitive to changes in task demands—both explicitly through instruction as well as implicitly through the composition of the task. On a practical level these studies highlight the need for considering how the composition of a task might be responsible for producing a particular pattern of results. On a theoretical level, these studies emphasize the necessity of better understanding the full range of situational influences on the interaction of multiple facial cues if we want to predict how a particular expression on a particular face will be processed within a given context.
**Declaration by author**

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature


Publications included in this thesis

Craig, B. M., Lipp, O. V., & Mallan, K. M., (2014). Emotional expression is preferentially processed in implicit evaluations of faces varying in race or age. *Emotion, 14*(5), 865-877. doi 10.1037/a0037270 – incorporated as Chapter 2 of the thesis with the inclusion of an additional experiment (Experiment 4) which did not appear in the original manuscript.

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Contributions by others to the thesis

The empirical chapters in this thesis were all prepared as manuscripts for publication. As such a number of anonymous reviewers have provided feedback which has contributed to the final version of these manuscripts. The thesis as a whole, including the introduction and general discussion chapters were also read by my supervisors Ottmar Lipp, Stefanie Becker and Eric Vanman who all provided critical edits and feedback on the work. Jan Craig and Daina Dickins also proofread parts of this thesis.

Statement of parts of the thesis submitted to qualify for the award of another degree

Experiments 1 and 3 of Chapter 2 were originally run and written up in partial fulfilment of the BPysc Honours, University of Queensland, 2010, degree awarded 14th December 2010. Subsequently, additional data was collected for Experiment 3, two additional studies were run (Experiments 2 and 4), and the manuscript was substantially rewritten in preparation for publication during candidature.
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<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>ASE</td>
<td>Anger Superiority Effect</td>
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<td>CRT</td>
<td>Cathode Ray Tube</td>
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<td>EEG</td>
<td>Electroencephalography</td>
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<td>ERP</td>
<td>Event Related Potential</td>
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<td>fMRI</td>
<td>functional Magnetic Resonance Imaging</td>
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<td>HSE</td>
<td>Happiness Superiority Effect</td>
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<td>M</td>
<td>Mean</td>
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<td>SD</td>
<td>Standard Deviation</td>
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<td>SEM</td>
<td>Standard Error of the Mean</td>
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<td>RT</td>
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Chapter 1
General Introduction
Being able to quickly and accurately interpret the emotional expressions of others allows us to behave appropriately in response. Avoiding someone who is expressing anger towards us may protect us from physical harm. Approaching those who appear friendly may allow us to forge social connections and build our social support networks. Research has demonstrated that we can recognize expressions quickly and accurately (Tracy & Robins, 2008) and that the expressions of others can indeed influence how we behave (Chartrand & Bargh, 1999).

The nature and origin of emotional expression has been the topic of long and continuing discussion. One of the most influential early works addressing the expression of emotion proposed that emotional expressions are evolutionarily evolved. Darwin (1872/2002) proposed that emotional expression are inherited in a number of different ways. Expressions originated as serviceable habits which were functional responses to the environment that are now preserved as signals. For example the baring of teeth as a sign of threat may have been a precursor to a biting attack. They could also be the antithesis of another signal in order to express the opposite emotion. For example, slinking and submissive behavior in dogs involves the opposite movements to aggressive behavior. Lastly, emotional expressions may be the release of nervous energy from the nervous system, such as shouting in pain. Although most emotional expressions do not retain their functional purpose (an anger expression is now rarely a precursor to a biting attack), Darwin argued that most expressions are innate and inherited from our ancestors rather than learned through social interaction. Darwin discussed similarities in the expressions of emotion in both animal and man and also provided anecdotal evidence that a range of emotions was expressed almost identically around the world including by members of geographically isolated tribes with little exposure to Europeans.

Interestingly, Darwin’s thoughts on the expression of emotion primarily dealt with the expression rather than the interpretation of others’ emotional expressions, but elements of his evolutionary approach were adopted into theories about how we recognize expressions in others. This Darwinian perspective, that emotional expressions were innate and universal, was adopted in later research such as in the theoretical work of Tomkins (1962). These ideas inspired more rigorous empirical investigation. Research on the development of emotional expression from infancy supported the idea that elements of emotional expression were innate (for reviews and examples of empirical work see Izard, 1994; Izard, Fantauzzo, Castle, Haynes, Rayias, & Putman, 1995; Izard, Huebner, Risser, McGinnes, & Dougherty, 1980). Additionally, investigations into the universality of emotion perception concluded that emotions were indeed perceived and expressed in comparable ways across a range of cultures, including those with limited contact to other ethnic groups (for reviews and examples of empirical work see Ekman, 1992; Ekman & Friesen, 1971; Ekman, Sorenson, & Friesen, 1969). This is known as the theory of basic emotions and strongly dictated the course of emotion perception research for the following decades. The basic emotion approach
assumed that there are a number of (somewhere between six, e.g. Ekman, 1992, and ten, e.g. Izard, 1977) distinct emotions that differ from each other in many ways including their physiological and probable behavioral responses and that the expression of these emotions was shaped by evolution. Each of these basic emotions has a characteristic expression composed of a combination of facial muscle movements which distinguish each emotion from the others (e.g. Ekman, 1992). Ekman and Friesen (1971) presented evidence demonstrating high agreement in the recognition of these characteristic emotional expressions in Papua New Guinean participants who had limited contact with Westerners. This finding was interpreted as proof that emotional expressions including happiness, sadness, anger, fear, surprise, and disgust were distinct, each communicated via a unique set of facial movements which could be easily interpreted by observers with high accuracy. These results were also taken as evidence that these basic emotional expressions were not culturally constructed or learned like a language, as they were shared around the world. The basic emotions identified by Ekman and Friesen (1971) are still those largely used in the emotion perception literature today as can be seen from the expressions represented in some of the most commonly used emotional face databases (e.g. the NimStim Database – Tottenham et al., 2009; the FACES database – Ebner, Riediger, & Lindenberger, 2010; the Montreal Set of Facial Displays of Emotion – Beaupre & Hess, 2005; the Karolinska Directed Emotional Faces – Lundqvist, Flykt, & Ohman, 1998). Although some databases include expressions of emotion not typically included in the six basic expressions and exclude some expressions that are typically included (e.g. the Montreal Set includes embarrassment but excludes surprise), the majority of emotional expression stimuli typically used in experiments represent these basic emotions. However, there are a number of observations reported in the literature that do not support a strong version of this basic emotion account.

In contrast to the basic emotion account, the relativist account of emotion expression and perception suggests that there are no distinct emotions with unique characteristic expressions (Russell, 1980), rather emotional expressions are learned like the languages we speak (e.g. Barrett, 2006). As such there are slight differences from culture to culture in the way emotions are expressed and perceived (Elfenbein & Ambady, 2002). There can also be variability in the expression of similar states and overlap in the expression of different states. They propose that universals shared across humankind are affect and arousal (Russell, 1995), but that the specific emotions we know of are not discreet and unique but rather constructs tied up in language. A range of evidence supports this position. The high accuracy in labeling of expressions observed in the original studies used to support the basic emotion account (e.g. Ekman & Friesen, 1971) decreases when the number of labelling options is increased or free labelling is used as the effectiveness of eliminating incorrect options is reduced or removed (e.g. Boucher & Carlson, 1980). Evidence from
patients with semantic memory loss suggests that those who do not have access to language categorize emotional faces by affect rather than into specific emotion categories when given a range of emotional faces to sort (Lindquist, Gendron, Barrett, & Dickerson, 2014). The labelling of the same expression can also be easily manipulated by providing additional context cues such as vignettes (Carroll & Russell, 1996), emotional backgrounds (Righart & de Gelder, 2008; Van den Stock, Vandenbulcke, Sinke, Goebel, & de Gelder, 2013) or expressive body language information (Aviezer et al., 2008) and the interpretation of the same expression can also vary depending on the other expressions that people have recently observed and labelled (Russell & Fehr, 1987; Yik, Widen & Russell, 2013). It is clear that the recognition of specific emotions is at least somewhat malleable and relative.

Contextual information displayed on the face itself also influences emotion perception. The face is a rich source of social information providing the observer not only with emotional expression information, but also, amongst others things, cues of a person’s racial group membership, gender, and age. Early models describing how the multiple sources of information on a face are perceived (e.g. Bruce & Young, 1986) were mainly focused on describing how identity is recognized from a face. Early models did not predict that identity cues or category information like race, sex, or age would interact with emotional expression perception, but rather suggested that facial cues of identity, sex, age, and emotional expression were processed independently via separate functional routes. This model formed the basis of much work seeking to better understand identity recognition and the processing of facial category and expression cues in isolation (see Quinn & Macrae, 2011 for a review). However, none of these cues is ever present in complete isolation but co-occurs with the other cues. Given this fact, so far, only a comparatively small body of work has focused on understanding if and how these multiple cues are processed in concert.

These studies have found that facial cues of group membership such as race, age, and sex can, in fact, influence the perception of emotional expressions. For example, the speed with which emotional expressions are categorized was found to depend on the sex of the face. Participants are faster to categorize happiness than anger on female faces but not on male faces (Bijlstra, Holland, & Wigboldus, 2010; Hugenberg & Sczensy, 2006). Similarly, rapidly presented neutral expressions were more likely to be labelled as angry when they were male than female, and faces manipulated to have lower brow lines and thus appear more masculine were also rated as angrier (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007). A similar influence of race has also been observed. Happiness was categorized faster than anger on White male faces, whereas anger was categorized faster than happiness on a structurally identical Black faces (Hugenberg, 2005). Similarly, participants high in implicit prejudice towards African Americans, also detected the onset of anger earlier on a face morphing from neutral to angry when the face was Black than when the face was
White (Hugenberg & Bodenhausen, 2003). The age of the face can also influence emotion perception. For example, cues of youth and old age (such as enlarged eyes or elongated faces) also make faces appear more fearful and angry respectively (Sacco & Hugenberg, 2009). Clearly, the way emotional expressions are perceived depends on other information present on the face.

In turn, emotional expressions can also influence the perception of other facial cues. For example, the typically observed *other race effect*, the observation of poorer recognition memory of other race identities than own race identities, was attenuated when the faces expressed anger (Ackermann et al., 2006). Racially ambiguous faces were more likely to be labelled as Black when expressing anger rather than happiness (Hugenberg & Bodenhausen, 2004; Hutching & Haddock, 2008). Similarly, angry androgynous faces were more likely to be labelled as male and happy androgynous faces are more likely to be labelled as female (Becker et al., 2007; Hess, Adams, Grammer, & Kleck, 2009).

It can be seen that race, sex, and age cues can influence the processing of emotional expressions under some circumstances and that emotional expressions influence the processing of race, sex, and age under others, however, the majority of these studies only looked at the interaction in one direction (i.e. by looking at only the influence of social category information on emotion perception, or only looking at the influence of emotional expression on the processing of social category information). A few studies have been conducted aiming to investigate the nature of the interaction between emotional expression and other social cues. In studies aiming to understand how multiple facial cues influence each other reciprocally, participants must complete two similar tasks using the same faces where the social category (i.e. race, sex, or age) is the focus of one task and emotional expression is the focus of the other. If there is no interaction of one cue with the other in either task, it can be said that the cues are processed independently. If, for example, race has an influence on emotional expression perception in one task but emotional expression does not influence race in the other, or vice versa it can be said that the two cues interact asymmetrically. Interactions of this nature have been used to argue that multiple facial cues are processed interdependently and have also been used to infer the relative ease, order or importance of processing these multiple cues (e.g. Atkinson, Tipples, Burt, & Young, 2005; Karnadewi & Lipp, 2011). A symmetrical interaction is observed when race influences emotional expression just as emotional expression influences race across both tasks and is also argued to reflect that multiple facial cues are processed via shared or interrelated neural mechanisms (e.g. Aguado, Garcia-Gutierrez, & Serrano-Pedraza, 2009).

Attempts to establish the nature of the interaction between facial cues of group membership and emotional expression have provided mixed results. Some studies have provided evidence for an asymmetrical interaction where group membership cues influence the processing of emotional
expression in the absence of a reciprocal effect of emotional expression on the processing of group membership cues. This has been demonstrated in the Garner paradigm for race, sex and age (Karnadewi & Lipp, 2011) and for sex (Atkinson et al., 2005). Further research now suggests that an asymmetrical interaction in the opposite direction may also be observed. For example, an influence of emotional expression was observed in visual search for race targets in the absence of an influence of race on visual search for emotion targets (Lipp, Craig, Frost, Terry, & Smith, 2014). Evidence for a symmetrical interaction of facial cues of sex and emotional expression has also been observed (Aguado et al., 2009). Conversely, some studies have found independence of processing, including studies that use stimuli and methods that are highly similar to those which have found interactions (e.g. Le Gal & Bruce, 2002; Kubota & Ito, 2007).

To describe the processes occurring when two cues interact, a number of explanations have been proposed and tested. These current proposals are focused on what happens on a single trial when a face is observed. Some explanations of the interaction of multiple cues suggest that particular structural features in a face contribute to the recognition of multiple categories. Interactions in the processing of multiple cues are observed to the degree that recognizing a person’s race, sex, or age and their emotional expression relies on the same facial cues. For example, a strong brow that is a cue of masculinity may also help the recognition of the expression of anger which involves the furrowing of the brow (Becker et al., 2007; Hess et al., 2009). Other explanations suggest that the recognition of category information (like a person’s race, sex, or age) in a face activates evaluations, associations, and stereotypes related to those categories. These associations then facilitate the categorization of congruent categories and inhibit the categorization of incongruent categories. For example, the observation that happy expressions are categorized faster than angry expressions on own race faces but not for other race faces is proposed to be due to own race members being evaluated as positive. This positive evaluation then facilitates the categorization of the congruent expression, happiness (Bijlstra, et al., 2010; Hugenberg, 2005; Hugenberg & Sczesny, 2006).

Although these explanations do not rule out the influence of situational factors, they are focused on what happens in response to the presentation of a single face and thus predict a consistent pattern of results regardless of the particular task or stimuli used. However, it is common to observe inconsistencies in the results produced even across similar studies. For example, Hugenberg (2005) and Kubota and Ito (2007) found conflicting results in the categorization of happy and angry expressions on African American and Caucasian faces. Using a small set of computer generated faces presented for short durations of 200ms, Hugenberg (2005) found an interaction of race and emotional expression (such that happy expressions were categorized faster than angry expressions on Caucasian faces but angry expressions were categorized faster than
happy expression on African American faces). On the other hand, using a large set of photographic faces presented until participants categorized the face, Kubota and Ito (2007) found that facial race cues had an additive rather than an interactive effect, as happy expressions were categorized faster than angry expressions on both Caucasian and African American faces, but response times were overall slower to categorize expressions on African American faces. Given that the majority of studies investigating the processing of multiple facial cues indicate that these cues are not processed independently, and that the same cues can interact differently depending on the particular experimental task and context, an updated model of face processing that incorporates these findings is necessary. The finding that multiple facial cues interact suggests that featural information present on the face such as the shape of eyes or the angle of the jaw lines may contribute to the recognition of multiple categories including, for example, both gender and emotional expression. The finding that the nature of the interaction between social category cues and emotion depends on the task and context suggests that trial or stimulus level explanations are not sufficient and that the way multiple categories are recognized may also be determined by top down influences like current expectation and task goals (e.g. Lipp, Craig, & Dat, 2015). Acknowledgement of both the bottom up influences of shared facial cues as well as the top-down influences of higher order states like task goals to the recognition of categories like race, sex and emotion is absent from traditional models of face processing (e.g. Bruce & Young, 1986; Burton, Bruce, & Hancock, 1999; Calder & Young, 2005; Haxby, Hoffman, & Gobbini, 2000) and similarly absent from models of person perception and stereotype activation which attempt to describe how we form stable impressions of others and how this leads to the activation of stereotypes (e.g. Bodenhausen & Macrae, 1998; Brewer, 1988; Fiske & Neuberg, 1990). Recently, a new model of person construal has been proposed (See Figure 1) which describes how both top-down and bottom-up factors can influence the processing of social categories like sex, race, age and emotional expression on the face. This model, the dynamic interactive theory of person construal (Freeman & Ambady, 2011), proposes that the recognition of categories like emotional expressions, race, age and sex from facial cues is the result of an interaction of low level visual and auditory information as well as the top down influence of a range of largely unspecified higher order cognitive states including contextual information, task goals, motivation, and stereotypes. When a face is observed, the visual information activates cue level nodes. These represent areas of the brain responsible for detecting particular facial shapes, structures, configurations and colors such as brow shape or skin tone. These cues are integrated by the observer to allow stable categorizations of race, sex, age, and emotional expression to form at the category level. Cue level information can contribute to multiple different category level construals driving interactions of multiple cues. For example, a particular feature may increase the activation of both a particular emotion and a particular sex category. A furrowed brow may
strengthen the likelihood of both an angry emotion construal and a male sex construal. This process of integrating facial cues into category construals of race, age, sex, and emotional expression is simultaneously shaped by the top down influence of higher cognitive states and stereotypes which influence which category level nodes are more likely to be activated. For example, asking participants to categorize the sex of a faces while emotional expression information is also present can strengthen the activation of sex relevant category and cue level nodes to prioritize the processing of sex and reduce the activation of task irrelevant emotion, race, and age category and cue level nodes. The system described is an iterative looping feed forward-feedback system. Each level can influence each other and the influences of both top-down and bottom-up factors can change over time meaning that each time a face is presented in a task with many trials, recent experiences including the associations activated by previous faces can influence performance via higher order top down influences.

Figure 1. Diagram of the dynamic interactive theory of person construal. Copyright © 2011 by the American Psychological Association. Reproduced with permission. The official citation that should be used in referencing this material is Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. Psychological Review. 118(2), 247-279. http://dx.doi.org/10.1037/a0022327. The use of APA information does not imply endorsement by APA.
This model can provide a way to explain why different studies purportedly looking at the same phenomena using slightly different methods draw different conclusions about the nature of face processing. This model suggests that the way multiple cues interact depends on the state of the observer. Different task demands have different top down influences by implicitly differentially weighing different category and cue level nodes. Although, this new model is exciting, to date, research which serves to elaborate on these top down influence of higher order cognitive states is very limited.

Each of the chapters in this thesis will describe research elaborating on the influence of higher order cognitive states on the interaction of multiple facial cues. Each of the studies describes how different elements of face processing tasks can explicitly or implicitly activate higher order cognitive states that influence the way multiple facial cue and categories interact within the very same faces. All of the studies described share in common the finding that emotional expressions on the very same faces are processed differently in very similar or even sometimes identical tasks based on either the participant’s explicit goals (Chapter 2), the context set by concurrently present faces (Chapter 3), the context set by the other faces recently observed within a task (Chapter 4) or faces observed in other recently completed tasks (Chapter 5).

Of the sparse literature describing the influence of higher order cognitive states on the interaction of multiple facial cues, the role of explicit task goals has been the most thoroughly addressed (e.g. Atkinson et al., 2005; Karnadewi & Lipp, 2011; Kubota & Ito, 2007). Studies described earlier that focus on the nature of the interaction between two categories utilize one method of addressing this. In these studies, a set of faces varying in multiple dimensions is presented. Participants have to complete two tasks of the same nature (e.g. two categorization tasks or two visual search tasks). In one task, one dimension of the face varies is explicitly task relevant while the other varies but is task irrelevant (e.g. categorizing emotional expression on face varying in race) and in the other, the second dimension is prioritized while the other varies but is task irrelevant (e.g. categorize race on faces also varying in emotional expression). As the same stimuli are used across the two tasks, different patterns of results across the two tasks reflect the contextual influence of explicit goals on the processing of multiple cues.

Studies addressing the nature of the interaction between cues such as sex or race and emotional expression have produced mixed results; however, the majority of them demonstrate an influence of the explicit goal on person construal, as the pattern of results observed when participants are focusing on one category like race or sex consistently differs from the pattern observed when focusing on emotional expression (e.g. Lipp et al., 2014; Karnadewi & Lipp; 2011, Kubota & Ito; 2007, Le Gal & Bruce, 2002). Although all of these studies aimed to describe the nature of the interaction between categories like sex, race and emotional expression, these studies
offer contradictory conclusions about the nature of the interaction. For example, a symmetrical interaction of sex and emotion was reported using sex and emotion categorization tasks (Aguado et al., 2009), whereas an asymmetrical interaction of sex and emotion was reported in studies using the Garner paradigm (e.g. Atkinson et al., 2005; Karnadewi & Lipp, 2010). Thus, it is likely that the nature of the task also influences the way in which multiple cues interact. Chapter 2 will describe how race, age, or sex, and emotion expression interact when implicit evaluations are being formed. Across four studies, implicit evaluations of faces varying in either race, age, or sex, and emotional expression were measured. The nature of the interaction between these cues was investigated by having participants focus on either the race, age or sex of the face in one affective priming task, and the emotional expression in the other. The resulting implicit evaluations observed differed when participants were focused on the race, age, or sex of the faces compared to when they focused on the emotional expression of the face or performed the task without an explicit goal related to the labelling of the prime face. We concluded that emotional expressions are prioritized in the formation of implicit evaluations of faces varying in both group membership cues like race, age, and sex and emotional expression.

This study contributes to the literature elaborating on the nature of the interaction between facial cues of group membership like race, age, and sex, and emotional expression demonstrating that such cues differ in their influence on the formation of implicit evaluations depending on their relevance to the task. This study also suggests that the nature of the interaction between multiple facial cues depends on the nature of the task itself. As the nature of the interactions observed differs from previous investigations, it is concluded that categories interact in different ways depending on whether the task requires categorization, detection or evaluations. These results speak to the important but often overlooked top down influence of explicit goals on the interaction of multiple facial cues; however, disparities in studies using more comparable methods suggest that implicit top down influences may also arise from the task itself.

One element of an experimental task that may implicitly impose a top down context on the interaction of facial cues is the presence of other faces. Prior research has described how previously observed faces can alter emotion perception. For example Russell and Fehr (1987) demonstrated that a neutral face was more likely to be labeled as sad after labeling an adjacent face as happy. Studies elaborating on the role that other faces play in tasks where the processing of multiple facial cues is required, are less common.

Chapter 3 will consider how other concurrently present faces influence the interaction of multiple cues in visual search for emotional schematic faces. This investigation focuses on how top down influences affect the processing of visual information at the cue level producing construals of emotional expression, rather than investigating how multiple categories interact. Across a number
of experiments, participants were required to either search for, or search for and categorize schematic happy and angry expressions. In some of these experiments, the targets could only be differentiated from the background faces by integrating multiple sources of information in the face, whereas in others, a single feature could be relied upon to accurately identify the target. These cues were lines representing the eyebrows and mouths of the schematic faces. Additionally, the influence of the participants’ emotional states on the search for these emotional faces was investigated. This chapter demonstrates that the other background faces present on a trial in a visual search task determine which expressions (either happy or angry) are more quickly detected. It is proposed that the nature of these other faces elicits an implicit context that changes how participants perform the task and thus how they integrate the multiple sources of information. This study provides further evidence that other faces are an important and overlooked context that alters the way in which cue level information is processed.

It is not always the case in experiments or in natural interactions that faces are presented at the same time right next to each other. Often we might interact with one person and then subsequently interact with others. It may also be the case that other recently observed, but no longer present, faces can impose context on the interaction of multiple sources of facial information. There is some research to support this idea in studies investigating emotion perception. Yik et al. (2013) demonstrated that the same disgust expressions presented alone on the screen were labeled by the majority of participants as angry after they had previously labeled a sick looking face and as disgusted if they had recently observed an angry face. This study highlighted the importance of considering other recently observed faces as a context in which emotional expressions are processed. Recent investigations suggest that other faces observed within a task can also elicit an implicit context which influences the way multiple facial cues like gender and race interact. For example, Lipp and colleagues (2015), demonstrated that the happy categorization advantage for White males was modulated depending on whether these White male faces were presented along with Black male faces (in which case a happy categorization advantage was observed) or along with other White female faces (in which case no happy categorization advantage was observed).

Chapter 4 contains two subchapters which describe a further investigation into the influence of implicit contexts set by other faces, this time on the way race cues influence emotion categorization. Chapter 4.1 follows up on two studies, which investigated the influence of race cues on emotion categorization using similar methods but drew conflicting conclusions about the interaction of race and emotional expression (Hugenberg, 2005 and Kubota & Ito, 2007). Hugenberg (2005) provided evidence to suggest that race cues moderate the categorization of emotion – happy expressions were categorized faster than angry expression on White faces but angry expressions were categorized faster than happy expressions on Black faces. Kubota and Ito
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(2007) found that happy expressions were categorized faster on both White and Black faces. Chapter 4.1 presents a series of studies designed to isolate the methodological factor/s contributing to these differing outcomes. The stimulus type used (computer generated vs photographic), the presentation duration (200ms vs unlimited) and most importantly the number of stimuli used within the task influenced results. The observation of different patterns of results with similar stimuli within the same task, suggests yet another top-down influence implicitly elicited by the task – this time by other temporally proximal faces.

In the experiments in Chapter 4.1, stimulus set size was manipulated concurrently with the number of times each stimulus was presented. This made it impossible to determine whether the differing patterns of results at small and large set sizes was due to differences in the representativeness or heterogeneity of the set of faces or differences in familiarity with each of the stimuli. As such, a second subchapter (4.2) provides an extended investigation into the role of set size and describes attempts to pinpoint the mechanism underlying the influence of stimulus set size on the interaction of race and emotional expression in emotion categorization.

The results of this investigation rule out lower level explanations like the role of perceptual load and pin point the number of stimuli in the set rather than the number of times each face is presented as the key factor. It also provides further evidence that the other faces in a task can influence the interaction of race and emotion categories. Finally, the experiments in Chapter 4 highlight the importance of considering how the other faces presented within a task influence the interaction between multiple facial cues.

Finally, Chapter 5 investigates the influence of other faces observed in previous tasks on the interaction of sex and emotional expression. Typically, when both male and female happy and angry faces are categorized within the same emotion categorization task, happiness is categorized faster than anger on female faces, but not on male faces. In the current task, participants were presented with happy and angry faces across two separate tasks, in one task only male faces appeared and in the other only female faces were presented. Results demonstrated that the typical interaction is dependent on both the male and female faces being present within the task. When male and female faces were presented in separate tasks, the interaction changed. This was because when participants completed the female faces task first they categorized happiness faster than anger presented on both male and female faces. However, the typical interaction was not affected by categorizing happy and angry expressions in separate tasks. These results suggest that other recently completed tasks and recently observed faces elicit an implicit higher order cognitive state which can then influence the way multiple cues interact.

Each of the four empirical chapters demonstrates that the interaction of multiple facial cues is flexible and context dependent, a finding that is consistent with the dynamic interactive model of
person construal (Freeman & Ambady, 2011). This is an exciting new framework for conceptualizing how multiple facial cues interact and how we come to interpret the information carried on the face. However, when the model was originally described, what constituted a higher order cognitive state was left largely unspecified and which of these higher order cognitive states would influence person construal and which would not was unknown. Together the chapters in this thesis provide one of the first comprehensive attempts to elucidate these top down influences with a focus on the explicit influences as well implicit influences of other faces presented proximally in space and time.
References


Chapter 2

Emotional Expressions Preferentially Elicit Implicit Evaluations of Faces also varying in Race,
Age, or Sex
Abstract
Both facial social category cues (race, age, and sex) and emotional expressions can elicit implicit evaluations to guide subsequent social behavior. There is, however, little research addressing whether group membership cues or emotional expressions are more influential in the formation of implicit evaluations of faces when both cues are simultaneously present. The current study aimed to determine this. Emotional expressions but not race, age, or sex cues elicited implicit evaluations in a series of affective priming tasks with emotional Caucasian and African faces (Experiments 1 and 2) and young and old faces (Experiment 3) and male and female faces (Experiment 4). Spontaneous evaluations of group membership cues of race, sex, and age only occurred when those cues were task relevant suggesting the preferential influence of emotional expressions in the formation of implicit evaluations of others when cues of race, age, or sex are not salient. Implications for implicit prejudice, face perception, and person construal are discussed.
When we see a face, both variant cues like emotional expressions and invariant cues (e.g. sex, race, and age) are quickly extracted and automatically evaluated. These evaluations can influence how we feel (Adelmann & Zajonc, 1989; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Greenwald, McGhee, & Schwartz, 1998; Neumann & Strack, 2000) and how we behave (Chen & Bargh, 1999). But what information do we rely on most when multiple evaluative cues are available to us? Do we rely on cues that indicate group membership such as race, age, and sex, or on cues that indicate what a person is thinking and feeling, such as emotional expression?

Facial cues indicating group membership elicit implicit evaluations as evidenced by studies using a variety of ‘implicit’ measures including Affective Priming (Fazio et al., 1986), Implicit Association Tests (IAT; Greenwald et al., 1998), and Go/No-go Association Tasks (Nosek & Banaji, 2001). The term implicit evaluation refers to spontaneous affective responses to the net valence of a concept or stimulus (e.g. see Gawronski & Bodenhausen, 2014 for a discussion). In these tasks measuring implicit evaluations, stimuli indicating own and other group membership (e.g. faces) are paired with pleasant and unpleasant words or images. Implicit evaluations can be inferred from the speed and accuracy of response to these words or images. Faster and more accurate responding occurs when a pairing is affectively congruent and slower and less accurate when a pairing is affectively incongruent. Across a number of studies more positive evaluation of own versus other group faces has been well established. These include both other racial groups (Degner & Wentura, 2010; Greenwald et al., 1998; Ottaway, Hayden, & Oakes, 2001), and age groups (Dasgupta & Greenwald, 2001; Nosek, Greenwald, & Banaji, 2005; Perdue & Gurtman, 1990). Interestingly, females are also positively evaluated relative to males, but this tends not to be an ‘other group effect’ as it can be observed in both male and female participants (Eagly, Mladinic, & Otto 1994; Rudman & Goodwin, 2004).

Similar to group membership cues, facial expressions of emotion elicit implicit evaluations in the laboratory setting. For example, participants were faster to categorize pleasant words and slower to categorize unpleasant words overlaid onto a photograph of a happy face. Conversely, participants were faster to categorize negative words but slower to categorize positive words when overlaid onto an angry face (Stenberg, Wiking, & Dahl, 1998). This facilitation for congruent and inhibition for incongruent affective pairings demonstrates the quick and effortless elicitation of affect by emotional faces. Similar results have been found by Aguado, Garcia-Gutierrez, Castañeda, and Saugar (2007) and Haas, Omura, Constable, and Canli (2006).

The implicit evaluations of emotion and facial cues of group membership have generally been found in controlled experimental contexts where only the emotional expression or group membership cues were varied. When faces are encountered in natural settings, however, they vary on multiple dimensions, thus it is of interest to examine whether and how these cues influence each
other in the formation of implicit evaluations of a face. Studies investigating the implicit evaluation of faces with simultaneously varying group membership cues (such as race, sex, or age) and emotional expressions are sparse.

Weisbuch and Ambady (2008) conducted a study to look explicitly at the potential interaction between race and emotion on the implicit evaluation of faces. Participants were presented with face primes varying in race (Black and White) and emotional expression (fearful, neutral, and happy) in an affective priming task. Analysis of priming scores revealed an interaction of race and emotional expression. When expressing happiness, White faces were evaluated as more positive than Black faces. For fearful expressions, White faces were evaluated as more negative than Black faces. In these studies, however, only the question of whether race and emotion can influence implicit evaluations is answered. It could not be determined how these cues interact as it is unclear whether priming results were due to the influence of race on the evaluation of the emotional expression or emotional expression on the evaluation of race. Examination of the broader literature addressing the interaction of race and emotion suggests that either explanation is plausible.

Emotional expressions have been found to influence the processing of group membership cues across a number of tasks. Poorer recognition for other race than own race faces can be mitigated when the faces displayed anger (Ackermann et al., 2006). Similarly, participants high in implicit prejudice were faster to attribute ‘blackness’ to ambiguous race faces as they morphed between White and Black when the faces were angry, but not when they were happy (Hutchings & Haddock, 2009; Hugenberg & Bodenhausen, 2004). Further to this, cues of emotion have been found to influence search performance for targets defined by race in a visual search task (Lipp, Craig, Frost, Terry, & Smith, 2014). However, processing of group membership cues is not always influenced by emotional expression. In speeded race categorization, for example, other race faces were categorized faster than own race faces regardless of the emotional expression displayed (Kubota & Ito, 2007).

Group membership cues have also been found to influence the processing of emotional expressions. Participants high in implicit prejudice were faster to detect the onset of anger in faces morphing from happy to angry when the face was Black than when it was White (Hugenberg & Bodenhausen, 2003). Similarly, in speeded categorization, race and sex have been found to moderate the categorization of emotional expression. White happy faces were categorized faster than White angry faces. For Black faces, the opposite effect emerged: Black angry faces were categorized faster than Black happy faces (Hugenberg, 2005). Also, anger but not fear or happiness expressions were mimicked to a greater extent when displayed on an own race face than on an other race face (van der Schalk, et al., 2011). However, race does not always moderate the processing of
emotional expression (Kubota & Ito, 2007). The interaction between face race and emotional expression in categorization has been shown to vary as a function of, for instance, the type and number of face stimuli used (Craig, Mallan, & Lipp, 2012).

Most previous studies have approached the interaction of facial cues of group membership and emotional expression from one direction only; either investigating the influence of group membership cues on the processing of emotion or the influence of emotion on the processing of group membership cues. To investigate the nature of, for example, the race by emotion interaction, a study must employ the same faces varying in both cues across two tasks where race is task relevant in one, and emotion is task relevant in the other. These studies allow us to determine whether cues are processed independently (i.e. race and emotion cues do not influence each other) or whether the cues interact asymmetrically (i.e. race influences the processing of emotion in the absence of emotion influencing the processing of race or vice versa) or symmetrically (i.e. race influences emotion processing and emotion influences race processing).

Studies investigating the nature of the interaction using constant stimuli and methods are rare and offer mixed conclusions. One prior study of face categorization, for instance, supports a symmetrical interaction between group membership cues (sex) and emotional expression (Aguado, García-Gutierrez, & Serrano-Pedraza, 2009) whereas other evidence suggests an asymmetrical interaction with race, age, and sex cues influencing emotion categorization, but not vice versa in the Garner paradigm (Atkinson, Tipples, Burt, & Young, 2005; Karnadewi & Lipp, 2011). A further recent study using the visual search method found evidence for an influence of emotion cues on search for targets defined by race in the absence of evidence for an influence of cues of race on the search for targets defined by emotion (Lipp et al., 2014). This suggests that the relative importance of group membership and emotion cues may vary across the processes being examined in different paradigms.

The aim of the current study was to clarify the nature of the interaction between three facial cues of group membership, race, age, or sex, and emotional expression specifically in the formation of implicit evaluations. As in previous research, the affective priming method was used to investigate this (Weisbuch & Ambady, 2008). Primes varied in race (Black and White; Experiments 1 and 2) or age (old and young; Experiment 3) and sex (male and female; Experiment 4) and emotion (angry, neutral, and happy; Experiments 1 and 3; fearful, neutral, happy, Experiment 2; angry and happy, Experiment 4). To determine the relative importance of the multiple cues, participants completed standard and focused affective priming tasks. In the latter, participants verbally categorized the race, age, or sex or the emotional expression of the face primes after evaluating the target word on each trial of the affective priming task. The requirement to verbalize one facial cue was to direct attention towards it and away from other potential sources of
evaluation. This procedure has been found to strengthen prime evaluations when compared to standard affective priming (Andrews, Mallan, Lipp, & König, 2011).

For Experiment 1, in line with past findings it was predicted that the spontaneous evaluation of faces would be dependent on both the group membership cue (race) and the emotional expression of the face (Weisbuch & Ambady, 2008). For example, White happy faces would be evaluated as more positive than Black happy faces and Black angry faces would be evaluated as more negative than White angry faces, as anger has been found to be more readily associated with other race than own race faces (Hugenberg & Bodenhausen, 2003; Hugenberg, 2005).

In the focused priming tasks it was expected that priming effects would be strengthened for the attended facial cue (Andrews et al., 2011). As the nature of the interaction between race and emotion cues in evaluation type tasks was unknown, the manipulation of attention could have multiple outcomes depending on whether emotion or race cues were evaluated preferentially. If emotion cues were evaluated preferentially, it was expected that focusing attention on emotional expression would strengthen emotion priming effects and attenuate race priming effects, whereas focusing attention on race would strengthen race priming but would not impact on emotion priming. However, if race cues were evaluated preferentially, it was expected that focusing on emotional expression may strengthen emotion priming but that race priming would still be present and that focusing on race cues would strengthen race priming effects but attenuate emotion priming.

**Experiment 1**

**Methods**

**Participants.** Participants were 29 first year psychology students (12 males, $M = 18.24$, $SD = 1.46$) who received course credit for participation. All participants identified themselves as Caucasian.

**Stimuli.** Across all tasks in Experiment 1, 60 images of male faces were used (either of African or Caucasian ethnicity, displaying happy, neutral or angry expressions) sourced from the Productive Aging Database (Minear & Park, 2004), the Nimstim Set of Facial Expressions (Tottenham et al., 2009), the Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2005), the Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Ohman, 1998), and the Eberhardt Face Database (http://www.stanford.edu/~eberhard/faces.html). Images were edited in Photoshop so that only the head was shown: neck, clothing, and background were removed in an attempt to maintain consistency across photos from different databases. Images were resized so that the faces occupied the same area in the image. Images were grayscaled and dropped onto a gray background 520 x 390 pixels in size. These 60 faces were divided into five sets of 12 faces containing two each of happy White, neutral White, angry White, happy Black, neutral Black, and angry Black faces.
The target words, drawn from previous research (Fazio, Jackson, Dunton, & Williams, 1995), were presented in bold, uppercase, White font on a black background. The pleasant words were ‘APPEALING’, ‘CHARMING’, ‘DESIRABLE’, ‘FAVORABLE’, ‘NICE’, and ‘SUPERIOR’. The unpleasant words were ‘ANNOYING’, ‘DISTURBING’, ‘INFERIOR’, ‘NASTY’, ‘REPULSIVE’, and ‘TERRIFYING’.

Procedure.

Participants were tested individually. Experimental tasks were executed in DMDX (Forster & Forster, 2003) presented on a CRT monitor with a 75 Hz refresh rate and a screen resolution of 1280 × 1024 pixels. After providing informed consent, participants were instructed that they would complete three tasks. In all of these tasks they were required to categorize target words as pleasant or unpleasant. They were told that on each trial a briefly presented face would be followed by a word that they were to categorize as ‘pleasant’ or ‘unpleasant’ as quickly and accurately as possible. Participants made their responses by pressing two buttons on a four-button box with their left and right index fingers. Participants always responded ‘pleasant’ by pressing the right button and ‘unpleasant’ by pressing the left button as key comparisons are made within finger. Before beginning each task proper, participants completed 12 practice trials. The standard affective priming task was always completed first, and the order of the race and emotion focused tasks was counterbalanced across participants.

Across the three priming tasks participants were exposed to a different set of stimuli in each task meaning that participants saw three of the five sets of 12 faces across the three tasks (i.e. 36 of the 60 stimuli). The use of the stimulus sets was counterbalanced across participants. Within each priming task, each of the 12 primes in a set was paired with each target word once, resulting in 144 trials randomized in blocks of 12 to ensure that the same prime or target was not presented more than two times in a row. The procedures of the standard and focused tasks differed slightly and are described in more detail below.

Standard affective priming task. On each trial, participants were presented with a blank screen for 1000ms followed by a fixation cross for 500ms. The prime (one of the 12 face stimuli in the set) was presented for 187ms on a black background followed by a blank screen for 93ms. This was replaced with the target word which was presented until a response was made or for 2000ms. Participants were instructed to pay attention to the prime faces but were not asked to evaluate or categorize them in any way. Their only task was to make button press responses to evaluate the target words as pleasant or unpleasant. Evaluation times were measured from the onset of the target word until a response was made.

Affective priming – race and emotion focused tasks. These modified tasks followed the same procedure as the standard affective priming task with slight differences as participants had to
make two responses on each task, firstly a button press to indicate whether a target word was pleasant or unpleasant, and secondly a verbal response to categorize the prime face as Black/White in the race focused task or happy/angry/neutral in the emotion focused task. As in the standard priming task, participants were presented with a blank screen for 1000ms followed by a fixation cross for 500ms. The prime (one of the 12 face stimuli in the set) was then presented for 187ms on a black background followed by a blank screen for 93ms. This was replaced with the target word which was presented for 1000ms and then replaced by a prompt to verbally classify the race or emotional expression of the prime. Participants were prompted to make their verbal response to the statement “The person was BLACK or WHITE,” for the race focused priming task and, “The person was HAPPY, NEUTRAL or ANGRY,” for the emotion focused priming task. This instruction appeared on center of the screen and remained until a button press response to the target was made or for 2000ms. The role of this prompt was to ensure that the participant’s attention was focused on the dimension of interest as they viewed each face prime. Participants were still instructed to make their button press response as quickly and accurately as possible and to make this button press judgement to the target word before verbally categorizing the race or the emotional expression on the face. Although the target word was presented for a shorter duration in the focused priming tasks, there was no difference between the standard and focused priming tasks in prime presentation duration or the time between the onset of the prime and the target.

**Data reduction and analysis.** Before analysis, responses faster than 100ms or three standard deviations faster or slower than each participant’s mean were removed as within subject outliers. In total 6% of the responses for the standard priming experiment, 11% of responses for the race focused task, and 16% of responses for the emotion focused task were removed due to incorrect responses or invalid response times. Priming scores (Sinclair, Lowery, Hardin, & Colangelo, 2005; Weisbuch & Ambady, 2008) were calculated by subtracting average evaluation times of positive target words from evaluation times of negative target words for each face category. This resulted in a priming score for happy, angry, and neutral, Black and White faces. Positive scores indicate relatively positive evaluations and negative scores indicate relatively negative evaluations.

Priming scores were submitted to a 2 (Race: Black, White) × 3 (Emotion: angry, neutral, happy) repeated measures univariate ANOVA. A separate analysis was conducted for each of the three tasks. The results from one participant were not included in the analysis of the race and emotion focused priming tasks due to equipment failure. Data from one additional participant were
not included in the analysis of the emotion focused priming task due to an error rate approaching chance (>40%)\(^1\).

Effect sizes reported are generalized eta squared values (Olejnik & Algina, 2003) rather than the more commonly reported partial eta squared values. Generalized Eta squared ($\eta^2_\text{G}$) reflects the variance explained by each treatment effect as a proportion of the total variance in the model with the other treatment effects subtracted, rather than the variance explained by the treatment effect as a proportion of the sum of the treatment and error variance within that factor alone ($\eta^2_\text{p}$). Although this typically results in effect size values which are substantially smaller in repeated measures factorial designs, this measure is recommended when comparing effect sizes across studies with non-identical designs (Bakeman, 2005; Fritz, Morris, & Richler, 2012).

**Results**

**Standard priming task.** In the standard affective priming paradigm, only the emotional expression displayed on the face significantly influenced implicit evaluations (Figure 1a). This was supported by a significant main effect of emotion, $F(2, 56) = 5.96, p = .006, \eta^2_\text{G} = .04$. Follow up comparisons revealed that angry primes were evaluated as more negative than both neutral, $t'(56) = 3.02, p = .004$, and happy primes, $t'(56) = 2.67, p = .013$. Happy and neutral primes did not differ significantly in evaluation scores, $t'(56) = 0.35, p = .728$. No significant main effect of race, $F(1, 28) = 0.361, p = .361, \eta^2_\text{G} < .01$ or interaction of race and emotion was found, $F(2, 56) = 0.22, p = .789, \eta^2_\text{G} < .01$.

**Race focused priming task.** As shown in Figure 1b, when participants were instructed to focus on race, both the race and the emotional expression displayed on the face influenced implicit evaluations. White primes were evaluated as more pleasant than Black primes regardless of emotional expression as indicated by a significant main effect of prime race, $F(1, 27) = 16.46, p < .001, \eta^2_\text{G} = .17$. Emotional expression also influenced implicit evaluations, $F(2, 54) = 5.90, p = .005, \eta^2_\text{G} = .06$. Adjusting for multiple comparisons ($\alpha = .016$ adjusted for three comparisons), angry faces were evaluated as more negative than happy faces, $t'(54) = 3.23, p = .002$, and neutral faces as marginally more negative than happy faces, $t'(54) = 2.43, p = .019$. There was no significant difference between angry and neutral faces, $t'(54) = 0.82, p = .416$. There was no significant interaction of race and emotion, $F(2, 54) = 0.60, p = .542, \eta^2_\text{G} = .01$.

**Emotion focused priming task.** Emotional expression but not the race of the face influenced evaluations (Figure 1c). This was supported by a significant main effect of emotion, $F(2, 52) = 27.57, p < .001, \eta^2_\text{G} = .21$. Overall, angry primes were evaluated as more negative than neutral primes, $t'(52) = 4.82, p < .001$, and happy primes, $t'(52) = 7.12, p < .001$. Neutral primes were also

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\(^1\) Initial analyses including participant gender as a between subjects factor indicated no significant impact of participant gender in any of the results presented across the three experiments so results are reported averaging across this factor.
Figure 1. Priming scores for angry, neutral, and happy faces as a function of the race of the face from the Standard Priming Task (Figure 1a), the Race Focused Priming Task (Figure 1b), and the Emotion Focused Priming Task (Figure 1c) of Experiment 1. Error bars represent one SEM.
evaluated as marginally more negative than happy primes, *t*(52) = 2.30, *p* = .026 (α = .016 adjusted for three comparisons). The main effect of race, *F*(1, 26) = 2.55, *p* = .112, η*G*2 = .02 and the Race × Emotion interaction, *F*(2, 52) = .842, *p* = .431, η*G*2 = .01, did not reach significance.

**Discussion**

The results from Experiment 1 suggest that race and emotion interacted asymmetrically in these affective priming tasks and emotional expression information was more heavily weighted in the formation of implicit evaluations. Emotion priming emerged in the absence of race priming in the standard priming task as well as in the emotion focused task. Race priming only emerged when the race of the face was explicitly task relevant; however, even under these conditions, emotion priming was still evident. The prediction that priming would be strengthened for the attended dimension in the race and emotion focused tasks was supported. The prediction based on past research by Weisbuch and Ambady (2008) that implicit evaluations formed in the standard priming task would be dependent on both the race and emotion of the face was not supported. Taken together, the findings of Experiment 1 suggest that emotional expressions are preferentially evaluated in affective priming tasks. In drawing this conclusion there are a number of factors that need to be considered.

One consideration, although not a key focus of this paper, is the finding of higher error rates as well as slower overall response times in the focused priming tasks. This is consistent with the cognitive load literature where introducing a second task, like the verbal categorization task, is found to increase task difficulty reflected behaviorally in increased response times and error rates (e.g. see Pashler, 1994). Given the focus of the current study is on more automatic processes, it is important to consider whether the longer response times observed in the focused priming tasks could allow more time for controlled processes to be engaged and to influence the outcome of the focused priming tasks. There are two key reasons why this is unlikely.

Previous research has revealed that introducing a second task leaves fewer resources available to inhibit the influence of the prime on the responses to a target and can exacerbate automatic priming effects (Lavie, Hirst, de Fockert, & Viding, 2004). The introduction of a second task should, if anything, increase rather than decrease the automatic influence of the prime on target responding. Additionally, we observe race priming in the focused but not the standard priming task. In our lab when we measure explicit evaluations of own and other race faces using procedures that permit the engagement of controlled processes such as rating tasks, we fail to find more negative evaluation of other race faces (e.g. Bramwell, Mallan, & Lipp, 2014). This suggests that when controlled processes are activated, participants inhibit the influence of any automatic race associations. Given we observe more negative implicit evaluations of other race faces in the race focused task, it seems unlikely that this reflects the effects of more controlled processes.
A second key consideration is why we fail to replicate Weisbuch and Ambady (2008). There are a number of differences between the studies that may account for this. Firstly, the current task used slightly different methods than that of Weisbuch and Ambady (2008) such as using word rather than pictorial targets which may have influenced the results. Additionally, the experiments were conducted in different cultural contexts. Participants in the Weisbuch and Ambady (2008) study were predominantly White American and to them Black faces may be more salient as they represent a culturally relevant racial outgroup. Participants in the current study were predominantly from Australia where the same stereotypes and associations are known but may be less salient. In our lab we tend to find more positive associations with White faces and more negative associations with Black faces on implicit evaluation measures when using neutral faces. Having said that, Africans are a less culturally relevant group to Australians as less than 1% of the population identifies their ancestry as African (Australian Department of Immigration and Citizenship, 2008). The results of the race focused priming task indicate that participants in Experiment 1 still demonstrated relatively negative evaluations of other race faces when this dimension was made salient suggesting a lack of negative bias towards African faces in our participants cannot account for the differences in results.

Another difference between the current experiment and the method used by Weisbuch and Ambady (2008) is that angry rather than fearful faces were used. This may have changed the experimental context and may have led happy other race faces to be evaluated in a comparatively different light. For example, presenting own and other race happy and fearful rather than angry faces together may have elicited a competitive intergroup context. Happiness on the other race face may have been related to the fear present on the own race face and thus seen as malicious and negative when present on other race faces.

In Experiment 1 we chose to use angry expressions to be consistent with previous studies investigating the nature of the interaction between race and emotion. i.e. whether race and emotion interact symmetrically or asymmetrically, or are processed independently (Karnadewi & Lipp, 2011; Kubota & Ito, 2007; Lipp et al., 2014), and the majority of studies investigating the interaction of race and emotion (Craig et al., 2012; Hugenberg, 2005; Hugenberg & Bodenhausen, 2003, 2004; Hutchings & Haddock, 2009; van der Schalk, 2011). Weisbuch and Ambady (2008), however, chose to investigate evaluations of fear as it was a negative emotion not associated with stereotypes about African Americans.

Previous research investigating the influence of race on emotion categorization suggests that the particular negative emotions used may not matter when the target emotional expressions selected are both positive and negative in valence as under these conditions, the influence of race on the categorization of emotion is primarily driven by evaluations rather than stereotypes (Bijlstra,
Holland, & Wigboldus, 2010). For example, the finding of faster categorization of happy than angry White faces but faster categorization of angry than happy Black faces was replicated when sad rather than angry faces were used, even though expressions of sadness are not generally associated with African Americans (Hugenberg, 2005).

Nevertheless, we failed to find an influence of both emotion and race together in the standard priming task when angry faces were used. It may be the case as proposed above, that the use of fear rather than anger is a key factor in the failure to replicate the findings of Weisbuch and Ambady (2008). The aim of Experiment 2 was to address this possibility. We replicated Experiment 1 but used fearful instead of angry faces to determine whether the use of anger rather than fear expressions explains the difference between the current results and the findings of Weisbuch and Ambady (2008). If the use of fearful rather than angry faces is the key factor that leads to the different outcomes, we predict that Experiment 2 should replicate the findings of Weisbuch and Ambady (2008) in that both emotional expressions and race cues should influence priming scores in the standard task. For the focused priming tasks, in line with the results of Experiment 1, we predict that priming will be strengthened for the focused dimension, but that emotion will be preferentially evaluated. As such we expect to observe both race and emotion priming in the race focused task, but only emotion priming in the emotion focused task.

**Experiment 2**

**Method**

**Participants.** Participants were 32 first year psychology students and volunteers from the University of Queensland (10 Male, $M = 19.63$ years, $SD = 2.12$) who received either partial course credit or AU $10 for participation. All participants identified as Caucasian. Data from one additional participant were not included as they did not identify as Caucasian.

**Stimuli.** Stimuli used throughout Experiment 2 were the same neutral and happy Black and White faces used in Experiment 1. The 10 White and 10 Black angry faces were replaced by 10 White and 10 Black fearful faces drawn from the same databases used in Experiment 1. As in Experiment 1, these 60 faces were divided into five sets of 12 containing two of each type of face (i.e. two happy White, neutral White, fearful White, happy Black, neutral Black, and fearful Black faces).

** Measures.**

**Standard affective priming task.** The same measures as in Experiment 1 were utilized for Experiment 2. The angry Black and White stimuli were replaced with fearful Black and White stimuli.

**Affective priming – race and emotion focused tasks.** The measures for the focused priming tasks used in Experiment 1 were also used in Experiment 2. As in Experiment 1, Participants were
prompted to verbally indicate the race of the face stating “The person was BLACK or WHITE” for the race focused priming task and “The person was HAPPY, NEUTRAL or FEARFUL” for the emotion focused priming task.

**Procedure.** Experiment 2 was conducted in a small group computer lab in groups of no more than three. The experimental tasks were presented on monitors with an 85 Hz refresh rate and a screen resolution of 1024 × 768 pixels. As in Experiment 1, the standard priming task was always completed first followed by the race and emotion focused tasks counterbalanced. Within any one testing session the same task sequence was used so that all participants were completing both the race and emotion focused tasks at the same time as other participants. Apart from the changes specified above, the experiment was run in exactly the same manner as Experiment 1.

**Data reduction and analysis.** The data reduction procedure used in Experiment 1 was used in Experiment 2, resulting in 6% of responses for the standard priming tasks, 10% for the race focused priming task, and 14% of responses for the emotion focused priming task being excluded due to incorrect or invalid responses. Calculation of priming scores and analyses were carried out as described in Experiment 1. Again, priming scores were submitted to separate 2 (Race: Black, White) × 3 (Emotional expression: fearful, neutral, happy) repeated measures ANOVAs for each task.

**Results**

**Standard priming task.** As can be seen in Figure 2a positive expressions were evaluated more positively than negative expressions regardless of the race of the face. This was confirmed by a significant main effect of emotion, \( F(2, 62) = 5.60, p = .006, \eta_G^2 = .04 \). Follow up comparisons revealed that happy faces were evaluated as more pleasant than fearful faces, \( t'(62) = 3.30, p = .002 \). The difference between fearful and neutral, \( t'(62) = 1.86, p = .068 \), and between neutral and happy faces, \( t'(62) = 1.44, p = .159 \), was not significant when adjusting for multiple comparisons. There was no significant race priming observed, \( F(1, 31) = 28.99, p < .001, \eta_G^2 = .23 \), indicated that White faces were evaluated as more positive than Black faces. There was also a significant main effect of emotion, \( F(2, 62) = 4.87, p = .011, \eta_G^2 = .04 \). Fearful expressions were evaluated as less positive than happy expressions, \( t'(62) = 3.10, p = .003 \), but there was no significant difference in evaluations between fearful and neutral or neutral and happy faces, \( t's < 1.83, ps > .072 \). This effect of emotion was moderated by race, \( F(2, 62) = 3.86, p = .039, \eta_G^2 = .03 \). Participants evaluated White faces as more pleasant than Black faces regardless of emotional expression \( t's > 4.51, ps < .001 \), but this difference was significantly
Figure 2. Priming scores for fearful, neutral, and happy faces as a function of the race of the face from the Standard Priming Task (Figure 2a), the Race Focused Priming Task (Figure 2b), and the Emotion Focused Priming Task (Figure 2c) of Experiment 2. Error bars represent one SEM.
larger for neutral faces than for happy, $t'(62) = 4.38, p < .001$, or fearful expressions, $t'(62) = 3.96, p < .001$.

**Emotion focused priming.** When focusing on the emotional expression on the face, only emotion priming was evident (Figure 2c). This was confirmed by a significant main effect of emotion, $F(2, 62) = 29.168, p < .001, \eta^2_G = .22$. Follow up comparisons indicate that happy expressions were evaluated as more positive than neutral, $t'(62) = 5.41, p < .001$, and fearful faces, $t'(62) = 7.18, p < .001$, but there was no difference in the evaluation of neutral and fearful faces, $t'(62) = 1.77, p = .082$. There was no significant main effect of race, $F(1, 31) = 0.48, p = .493, \eta^2_G < .01$, and the Race × Emotion interaction did not reach significance, $F(2, 62) = 0.08, p = .906, \eta^2_G < .01$.

**Discussion**

The aim of Experiment 2 was to determine whether the difference in results of Weisbuch and Ambady (2008) and the findings of Experiment 1 were due to the use of fearful expressions in the former, and angry expressions in the latter. The pattern of results for Experiment 2 was similar to the results reported in Weisbuch and Ambady (2008). Priming scores were numerically more positive for happy White than happy Black faces and numerically more positive for fearful Black faces than fearful White faces, but these differences did not reach significance in the current sample. In the standard priming task, only significant emotion priming was evident. However, as predicted in the focused priming tasks, both race and emotion priming were evident in the race focused task, but only emotion priming was found in the emotion focused task. This set of results is consistent with the findings of Experiment 1 and again suggests an asymmetrical interaction of race and emotion with preferential evaluation of emotional expressions in affective priming tasks.

Although the pattern of results in the standard priming task was similar to that reported by Weisbuch and Ambady (2008), consideration must be given to why the effects did not reach significance in the current comparably sized sample. It is possible that the results reported by Weisbuch and Ambady reflect a chance finding; however, differing affective responses to emotional expressions as a function of group membership have been found under a variety of circumstances. Support for affective divergence has been found in a number of labs using different methods (e.g. van der Schalk et al., 2011). We also find some evidence of affective divergence in the race focused priming tasks in both Experiments 1 and 2 where implicit evaluations were based on both race and emotion. It is also possible that differences in methodology such as the use of pictorial rather than word targets, fewer trials or a smaller set of primes in the Weisbuch and Ambady (2008) task accounts for the difference in results. However, the finding of affective divergence in the race focused priming tasks in both Experiments 1 and 2, suggests that baseline differences in the importance or salience of race cues to Australian and the American participants
may best explain the difference between the findings of Weisbuch and Ambady (2008) and the results of the standard priming tasks.

Regardless of this, the findings from the focused priming tasks suggest that emotional expressions are preferentially evaluated. This finding holds with the use of a large set of stimulus faces across two experiments using different negative emotional expressions. However, it remains to be determined whether this finding holds for other cues present on the face or whether the preferential evaluation of emotion cues over group membership cues only occurs when race is the group membership cue of interest. As such, Experiment 3 aimed to investigate the interactive effects of emotional expression and another invariant facial cue, age, to establish whether the results from Experiment 1 could be generalized to another social category that can be identified from facial cues.

There are a number of reasons why facial cues of age are an interesting avenue for investigating the generalizability of the Experiment 1 and 2 findings. The age of a face is another cue which is encoded early during face processing (Johnston, Kanazawa, Kato, & Ota, 1997). The processing of age cues has been found to parallel the processing of race cues in a number of ways. Firstly, cognitive effects like the Other Race Effect, the observation that own race faces are recognized more accurately than other race faces (Meissner & Brigham, 2001; MacLin & Malpass, 2003) have also been observed with younger and older other age faces (Anastasi & Rhodes, 2005; Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008; Wiese, Schweinberger, & Hansen, 2008). Similarly, the finding that other race faces are categorized faster than own race faces (Levin, 1996, 2000) has also been observed with own and other age faces (Johnston et al., 1997). Further to this, just as other race faces tend to be negatively evaluated, young adults tend to evaluate the faces of older adults as negative in comparison to young adult faces (Dasgupta & Greenwald, 2001; Nosek et al., 2005). Age cues have also been found to influence the perception of emotional expressions (Sacco & Hugenberg, 2009). Due to the apparent similarities observed between the processing of race cues and age cues, using a stimulus set where faces vary in age will allow us to investigate whether emotion cues are evaluated preferentially in affective priming tasks beyond the dimension of race.

In Experiment 3 we again use angry, neutral, and happy expressions. Although there may be stereotypes about angry older adults, previous research demonstrates that fear is also associated with facial cues of age (Sacco & Hugenberg, 2009). Further, the results of Experiment 2 demonstrate that the results of Experiment 1 were not due to the use of emotional expressions stereotypically associated with the categories of interest but generalized to other non-stereotypic negative emotions. We therefore return to using angry expressions as was done in Experiment 1 to be consistent with the majority of the literature investigating the nature of the interaction between
emotion and group membership cues (Aguado et al., 2009; Karnadewi & Lipp, 2011; Kubota & Ito, 2007; Lipp et al., 2013). The aim of Experiment 3 was to assess whether and how cues of age and emotional expression interact in the evaluative context. The same methods implemented in Experiment 1 were utilized for Experiment 3; however, photographs of Black and White faces were replaced with images depicting younger and older adults expressing either angry, neutral or happy expressions. If the findings of Experiments 1 and 2 can be generalized to other cues of group membership, it is predicted that emotional expression but not age cues should influence priming scores in the standard priming task. In the focused priming tasks, priming should be strengthened in the task relevant domain and emotion cues should still influence priming scores in the age focused task but not vice versa.

**Experiment 3**

**Method**

**Participants.** Participants were 37 first year psychology students from the University of Queensland (11 Male, $M = 19.04$ years, $SD = 1.64$). Data from one additional participant were not included as they were aged over 30, outside of the age of the ‘young’ category defined by the age range portrayed in the stimulus set. All participants received course credit for their participation.

**Stimuli.** Stimuli used in Experiment 3 were 60 images of male faces (either young – younger than 30 or old – over 70 years, displaying happy, neutral or angry expressions) sourced from the productive aging database (Minear & Park, 2004) and the FACES database (Ebner, Riediger, & Lindenberger, 2010). Images were prepared to the same specifications as in Experiment 1. These 60 faces were divided into five sets of 12 containing two of each type of face (i.e. two happy young, neutral young, angry young, happy old, neutral old, and angry old faces).

**Measures**

**Standard affective priming task.** The same measures as in Experiment 1 were utilized for Experiment 3. The race related stimuli were replaced with age related stimuli.

**Affective priming – age and emotion focused tasks.** The measures for the focused priming tasks used in Experiment 1 were also used in Experiment 3. Participants were prompted to verbally indicate the age of the face stating “The person was YOUNG or OLD” for the age focused priming task and “The person was HAPPY, NEUTRAL or ANGRY” for the emotion focused priming task.

**Procedure.** Apart from the changes specified above, the experiment was run in exactly the same manner as Experiment 1.

**Data reduction and analysis.** The same method of data reduction used in Experiments 1 and 2 was used in Experiment 3, resulting in 8% of responses for the standard priming tasks, 14% for the age focused priming task and 15% of responses from the emotion focused priming task being excluded due to incorrect or invalid responses. Calculation of priming scores and analyses
were carried out as described in Experiment 1. Priming scores were submitted to separate 2 (Age: young, old) × 3 (Emotional expression: angry, neutral, happy) repeated measures ANOVAs for each task.

Results

Standard priming task. As can be seen in Figure 3a, only significant emotion priming was observed. This was supported by a significant main effect of emotion, $F(2, 72) = 3.63, p = .032, \eta_G^2 = .03$. Happy faces were evaluated as more positive than angry faces, $t(72) = 2.65, p = .010$. There was no difference between evaluations of happy and neutral or angry and neutral faces, $ts(72) < 1.67, ps > .099$. The age of the face had no overall significant influence on target word evaluations, $F(1, 36) = .94, p = .339, \eta_G^2 < .01$, and did not moderate the evaluation of emotion, $F(2, 72) = .40, p = .668, \eta_G^2 < .01$.

Age focused priming task. Inspection of Figure 3b suggests that young faces were evaluated as more positive than old faces as indicated by a significant main effect of age, $F(1, 36) = 31.62, p < .001, \eta_G^2 = .22$. There was no overall influence of emotional expression on evaluation scores, $F(2, 72) = .28, p = .741, \eta_G^2 < .01$, and no significant Age × Emotion interaction, $F(2, 72) = .33, p = .691, \eta_G^2 < .01$.

Emotion focused priming. As in the standard priming task, emotional expression but not age influenced the evaluation of target faces, $F(2, 72) = 20.98, p < .001, \eta_G^2 = .20$, (Figure 3c). Angry faces were evaluated as more negative than neutral faces, $t'(72) = 3.55, p < .001$, and neutral faces were evaluated as more negative than happy faces, $t'(72) = 2.52, p = .014$. There were no differences in priming scores as a function of the age of the faces, $F(1, 36) = 1.50, p = .229, \eta_G^2 < .01$, and age did not moderate the evaluations elicited based on emotional expression, $F(2, 72) = .98, p = .372, \eta_G^2 = .01$.

Discussion

The aim of Experiment 3 was to determine whether the results of Experiments 1 and 2 investigating the evaluation of faces varying in both race and emotion could be generalized to faces varying in age and emotion. For the standard priming task, it was predicted that happy faces would be evaluated as more pleasant than angry faces regardless of the age of the face and that there would be no difference in evaluations between old and young faces. Results from Experiment 3 supported this. Happy faces were indeed evaluated as more positive than angry faces regardless of the age of the face.

In line with the findings of Experiments 1 and 2, it was also predicted that emotion cues would be evaluated preferentially to age cues. As such, for the emotion priming task it was predicted that emotion priming, but not age priming would be evident. For the age focused priming task it was predicted that age priming would be evident but that cues of emotion may still influence
Figure 3. Priming scores for angry, neutral, and happy faces as a function of the age of the face from the Standard Priming Task (Figure 3a), the Age Focused Priming Task (Figure 3b), and the Emotion Focused Priming Task (Figure 3c) of Experiment 3. Error bars represent one SEM.
the resulting implicit evaluations. As predicted, in the emotion focused priming task, emotional expression information, but not the age, influenced implicit evaluations. As predicted, in the age focused priming task, age cues influenced implicit evaluations but unexpectedly emotion cues did not.

Taking a closer look at the results of the standard affective priming tasks may provide some insight as to why emotion priming was not evident in the age focused task. Priming scores provide information about relative positive and negative evaluations of stimuli. Comparing the percentage variance in priming scores explained by emotional expression in each the standard priming tasks across the three experiments (using $\eta^2$) reveals a numerically greater amount of variance explained by the emotional expressions on the face in Experiments 1 and 2 (percent variance = 3.60% and 3.82% respectively) than in Experiment 3 (percent variance = 2.57%). This suggests that the proportion of total variability accounted for by emotion was around one and a half times larger in Experiment 2 than in Experiment 3, although a small but significant emotion priming effect was evident in the absence of significant race or age priming in all tasks. Emotion priming being somewhat weaker in Experiment 3 may provide an explanation as to why emotional expressions did not significantly influence priming scores when cues of age were task relevant.

The finding that emotion priming was weaker in Experiment 3 is broadly consistent with the literature on the perception of emotional expressions displayed by older adults. A number of studies have demonstrated that young adults are less accurate in recognizing emotional expressions posed by older adults than expressions posed by young adults (Ebner, Johnson & Fischer, 2012; Richter, Dietzel, & Kunzmann, 2011). There are a number of reasons why this emotion recognition deficit for older adults’ expressions may occur (see Fölster, Hess, & Werheid, 2014 for a review). For example, young adults typically have less exposure to and thus less experience with perceiving emotional expressions on old than on young faces (Ebner & Johnson, 2009). Another possibility that has been proposed is that the changes in skin and muscle tone through the life span that lead to wrinkles and sagging skin increase visual noise which makes the emotion signal more difficult to interpret (Hess, Adams, Simard, Stevenson, & Kleck, 2012). As the emotional expression of the face was not focal to the task, the greater noise to emotion signal ratio may have reduced the extent to which emotional expressions influenced affective priming. Regardless of the mechanism underlying the poorer recognition of emotional expression on older adult faces, the fact that young adults are less accurate at recognizing emotional expressions on older adult faces provides a likely explanation for the smaller influence of emotional expression in the standard priming task of Experiment 3.

A person’s sex is the third main group membership category that can be quickly and accurately extracted from the face (e.g. Karnadewi & Lipp, 2011). Like race and age, sex cues have
been shown to interact with emotion cues in both emotion and sex perception. A number of studies have demonstrated an influence of sex cues on emotion categorization (e.g. Aguado et al., 2009; Becker et al., 2007; Hugenberg & Sczesny, 2006). For example, participants were faster to categorize happiness on female than male faces, and faster to categorize anger on male than female faces (Aguado et al., 2009; Becker et al., 2007). Emotional expressions have also been found to influence the perception of gender on androgynous faces (Becker et al., 2007), as well as influence sex categorization (Aguado et al., 2009).

The few studies that have investigated the nature of the interaction between emotional expression and cues of sex have produced mixed results. Using the Garner paradigm, Le Gal and Bruce (2002) presented evidence suggesting independent processing of sex and emotional expression. Alternatively, both Atkinson and colleagues (2005) and Karnadewi and Lipp (2011), have provided evidence for an asymmetrical interaction where cues of sex influence emotion processing in the absence of a reciprocal effect of emotional expression on sex categorization. On the other hand, across two categorization tasks, Aguado et al. (2009), provided support for a symmetrical interaction with sex and emotion influencing each other in both sex and emotion categorization. To this point, there is little evidence for the prioritization of emotion over sex cues in the paradigms that have currently been used to investigate the nature of the sex by emotion interaction.

**Experiment 4**

The aim of Experiment 4 is to determine how cues of sex and emotion interact in the evaluative context. Although, the current face processing literature supports a symmetrical interaction of sex and emotion or an asymmetrical interaction where sex cues are preferentially processed, the results from Experiments 1-3 provide evidence to suggest an asymmetrical interaction where preferential evaluation of emotional expression may be observed. If the finding of Experiments 1-3 do generalize to tasks where faces vary in sex, it is predicted that significant emotion priming will be observed in the absence of a significant influence of the sex cues in the standard and emotion focused priming task. Consistent with Experiments 1 and 2, it was predicted that both sex and emotion priming will be observed in the sex focused priming task.

**Methods**

**Participants.** Participants were 37 first year psychology students (9 males, $M = 23.78$, $SD = 9.41$) who received course credit for participation.

**Stimuli.** In Experiment 4, as the results of the previous three studies were not significantly influenced by the stimulus set, images of four male and four female models expressing happiness and anger were selected from the Nimstim Set of Facial Expressions (Tottenham et al., 2009). Images were edited as in the previous experiments but were presented on backgrounds $540 \times 650$
pixels in size. Three out of these four male and female identities were presented with in each task resulting is sets of 12 stimuli. As such, unlike in the previous experiments, participants saw a similar set of faces across the three tasks.

**Measures.**

**Standard affective priming task.** Experiment 4 proceeded in a similar manner to Experiments 1-3 with some slight differences. The primes were presented for 200ms rather than 187ms. Additionally, an alternative set of target words drawn from previous research were used (Andrews et al., 2011). The pleasant words were ‘CONFIDENT’, ‘EXCELLENT’, ‘PRAISE’, ‘PLEASURE’, ‘DELIGHT’, and ‘CHEERFUL’. The unpleasant words were ‘VIOLENCE’, ‘PAIN’, ‘INJURY’, ‘FATAL’, ‘KILLER’, and ‘LETHAL’. This allowed us to determine whether the effects observed in Experiments 1-3 were robust across slightly different methods. As in prior experiments, each prime was paired with each target word once, resulting in 144 trials.

**Affective priming – sex and emotion focused tasks.** These modified tasks followed the same procedure as the standard affective priming task. As in prior experiments, the target word was presented for 1000ms and then replaced by a prompt to verbally classify the sex or emotional expression of the prime. Participants were prompted with the statement “The person was MALE or FEMALE” for the sex priming task and, “The person was HAPPY or ANGRY” for the emotion priming task.

**Procedure.** Testing was conducted in line with the previous studies. Experiment 4 was conducted in small group testing lab. Participants were tested in groups of no more than six and the tasks were presented on a CRT monitor with a 85 Hz refresh rate and a screen resolution of 1024 × 768 pixels. Participants used the right and left shift keys on a standard key board, rather than a button box to make their responses.

**Data reduction and analysis.** The same method of data reduction used in Experiments 1-3 was used in Experiment 4, resulting in 8% of responses for the standard priming tasks, 9% for the sex focused priming task and 9% of responses from the emotion focused priming task being excluded due to incorrect or invalid responses. Calculation of priming scores and analyses were carried out as described in Experiment 1. Priming scores were submitted to separate 2 (Sex: male, female) × 2 (Emotional expression: angry, happy) repeated measures ANOVAs for each task. Data from one participant could not be included in analysis of the emotion focused task as they provided no correct responses in one condition.

**Results.**

**Standard priming task.** As can be seen in Figure 4a, happy primes were evaluated as significantly more positive than angry primes regardless of the sex of the face, $F(1, 36) = 13.59, p = .001, \eta^2_G = .08$. There was no significant influence of the sex of the face on priming scores and, $F(1,$
Sex focused priming task. When participants focused on the sex of the face, consistent with Experiments 1 and 2, both the emotional expression and sex of the face influenced priming scores. Happy expressions were evaluated as more positive than angry expressions, $F(1, 36) = 33.98, p < .001, \eta^2_G = .21$, and female faces were evaluated as more positive than male faces, $F(1, 36) = 16.44, p < .001, \eta^2_G = .09$. There was no significant interaction of sex and emotion, $F(1, 36) = 1.52, p = .225, \eta^2_G < .01$.

Emotion focused priming task. As can be seen in Figure 4c, when participants were focused on the emotional expression on the face, only emotional expression significantly influenced priming scores. Happy expressions were evaluated as more positive than angry expressions, $F(1, 35) = 32.56, p < .001, \eta^2_G = .38$. There was no significant difference in the evaluation of male and female faces, $F(1, 35) = 1.69, p = .203, \eta^2_G < .01$, and the interaction of sex and emotion did not reach significance, $F(1, 35) = 1.64, p = .210, \eta^2_G < .01$.

Discussion

The aim of Experiment 4 was to determine whether the finding from Experiments 1-3, that emotional expressions are evaluated preferentially over group membership cues like race and age, would generalize to the group membership cue of sex. As predicted, results were consistent with the previous experiments. In the standard priming task, and the emotion focused task, priming scores were influenced by emotional expressions in the absence of an influence of sex cues. In the sex focused task, both emotion and sex priming was observed.

These findings are, in some ways, consistent with the previous literature investigating the interaction of sex and emotion cues. Under some circumstances priming scores were influenced by both the emotional expression and the sex of the face. This is somewhat consistent with the previous categorization literature finding that emotion and sex categorization times can be jointly influenced by both sex and the emotional expression, even when one of the cues is task irrelevant (e.g., Aguado et al., 2009, Becker et al., 2007; Hugenberg & Sczesny, 2006). However, the current findings also differ in some ways from the previous literature as the current experiment suggests an asymmetrical interaction between sex and emotion cues where emotion is preferentially evaluated. Asymmetrical interactions previously reported were typically in the opposite direction.

Race, age, and sex priming only emerged when participants were also asked to categorize the race, age, or sex of the face whilst completing the affective priming task. Significant emotion
Figure 4. Priming scores for angry and happy faces as a function of the sex of the face from the Standard Priming Task (Figure 4a), the Sex Focused Priming Task (Figure 4b), and the Emotion Focused Priming Task (Figure 4c) of Experiment 4. Error bars represent one SEM.
PREFERENTIAL EVALUATION OF FACIAL CUES OF EMOTION

priming was evident in 11 of the 12 tasks. Together, these results suggest that emotional expressions appear to be preferentially evaluated over a range of group membership cues and that this effect is robust across different methods but suggest that there may be some differences in how race or sex and age interact with emotion cues in the formation of implicit evaluations.

**General Discussion**

The purpose of this study was to examine the nature of the interaction between facial cues of race, age, and sex, and emotional expression in the formation of implicit evaluations. The results of the four experiments were generally consistent. Emotion cues were evaluated preferentially in an affective priming task utilizing faces varying in both emotional expression and cues of race, age, or sex. This interpretation is supported by significant emotion priming in the absence of race, age, or sex priming in all standard priming tasks. Implicit evaluations of race, age, and sex cues were only evident when these cues were made task relevant via a concurrent race, age, or sex categorization task. The current results suggest that cues of race, age, or sex need to be salient to observe significant race, age, or sex priming when emotional expressions are varied within evaluations tasks. These findings can extend our understanding in both the areas of implicit prejudice and face processing.

The current results demonstrate that the commonly reported implicit race, age, and sex biases are not necessarily observed when emotional expressions are concurrently varied within the task, unless participants explicitly attend to race, age, or sex cues. This is not the first demonstration that implicit bias elicited in response to group membership cues is malleable. Implicit race biases have been reduced or eliminated in the laboratory by priming participants with positive exemplars of outgroup members such as sports people (Mitchell, Nosek, & Banaji, 2003) and even by the subtle presence of posters that prime outgroup heterogeneity (Brauer, Er-rafiy, Kawakami, & Phillips, 2012). The current findings demonstrate that implicit group membership biases may be attenuated in ways that do not rely on manipulating states of the observer, but rather manipulating a feature of the face. This is important as it suggests that members of groups who are typically negatively evaluated may effectively use emotional expressions to reduce the observer’s negative evaluations. This is not to suggest that the presence of emotional expression will always completely attenuate implicit evaluation based on race, sex, or age. As we see in the focused priming tasks, when cues of race, age or sex are made salient, we observe differences in the evaluation of White and Black faces, old and young faces, and male and female faces. It may be the case that when race, age, or sex is made salient by the broader context, such as the culture one lives in, that implicit evaluations may also be influenced by cues of race, age, or sex without the task drawing focus to them as observed by Weisbuch and Ambady (2008). These findings suggest that affective divergence, that is
emotional responding that depends on the group membership of the actor or poser, may be limited to situations where the group membership cue is contextually salient.

The current results also provide an important extension to the developing literature addressing the nature of the interaction between multiple facial cues. Past research demonstrated the interaction of race and emotion in the affective context but did not address the question of how these cues interact. It was unclear whether evaluations were primarily influenced by race but modulated by emotional expression or vice versa. We were able to address this by complementing a standard affective priming task with two focused priming tasks. Across three experiments, only significant emotion priming was observed unless participants were required to explicitly attend to the race, age, or sex of the face. Further to this, in the two race focused tasks and the sex focused task, emotion priming was also observed even though the task required participants to focus on the race of the face. We interpret this as a demonstration of the preferential evaluation of emotional expressions over cues of race, age, and sex in tasks that are evaluative in nature, like an affective priming task.

Although emotion has been found to influence the processing of race cues (e.g. Ackerman et al., 2006; Hugenberg & Bodenhausen, 2004), the few studies attempting to establish which cues are preferentially processed within the demands of a particular task have presented mixed results. In one study, a symmetrical interaction was observed such that emotion influenced the categorization of sex cues just as sex cues influenced performance on an emotion categorization task (Aguado et al., 2009). In others, evidence was provided for an asymmetrical interaction where race and age cues interfered with the categorization of emotional expression in the absence of a similar influence of emotion on the categorization of race and age cues (Karnadewi & Lipp, 2011). Further to this, a recent study by Lipp and colleagues (2014) provides evidence of an asymmetrical interaction in the opposite direction where emotion cues influence search for targets defined by race in the absence of a similar influence of race on emotion search. The current study provides a further demonstration of the preferential influence of emotional expression cues over cues of race, age, and sex. Considering the current study along with past research suggests that the way in which cues like race, age, and emotion interact depends on the nature of the task. It is thus important to consider how the context elicited by the task might influence results when drawing conclusions about the processing of multiple facial cues.

**Theoretical Implications**

Although the current study was not designed to explicitly test a particular theoretical model, the findings can be reconciled under the *dynamic interactive theory of person construal* (Freeman & Ambady, 2011). This model was favored over older models of face perception (e.g. Bruce & Young, 1986 or Haxby, Hoffman, & Gobbini, 2000) as it attempts to address how multiple facial...
cues interact, rather than just describing that distinct facial cues can be extracted from the structure and movement of a face. This connectionist model proposes that the representations we form of others are the product of an interactive system shaped by both bottom-up and top-down influences. Visual input activates cue level nodes sensitive to features like skin tone and face structure which are related to social categories such as race, age, sex, and emotion. Over time, cue level nodes excite relevant nodes at the category level resulting in stable person construals. This process occurs under the influence of top-down higher level cognitive states such as motivation, processing goals, and task demands. Although this model is focused on the person construal rather than evaluations, interpreting the visual information in a face is a necessary precursor to any evaluation that is elicited in response to that face. As such, implicit evaluations should be the result of an interaction of bottom-up and top-down influences.

A number of findings in the current study can be reconciled within this model. Firstly, the finding of preferential evaluation of emotional expressions over race and age cues within affective priming may be due to the affective priming task being evaluative in nature. As participants’ primary task was to make affective judgement, the task may have elicited a state that compelled the excitation of emotion relevant category and cue nodes. Although other relevant race, age, and sex nodes may still be activated in the system to some extent, emotion cues and categories were prioritized due to the evaluative nature of the task. On this note, it is important to consider how the nature of different tasks used to investigate the interaction of race/sex/age and emotional expression may differentially activate the various category and cue nodes and potentially explain why the nature of the interaction between race/sex/age and emotional expression differs substantially between tasks. For example, in an emotion categorization task, as affective judgements are being made, the evaluative properties of other dimensions of the face, such as positive or negative evaluations related to race, sex, or age may be more strongly activated and thus influence emotion perception. In a visual search task, however, when looking for a face that differs from the background in emotional expression or social category membership, the ‘same’ or ‘different’ judgements that are made are less likely to elicit a state that compels the excitation of emotion relevant category and cue nodes potentially increasing the chance of observing the influence of shared perceptual features on the interaction of multiple facial cues.

Beyond the use of affective priming tasks increasing the salience of evaluative information, and thus increasing the likelihood that emotional information influences implicit evaluations, the race, age, and sex and emotion focused tasks exert additional top down processing goals on the system prioritizing the excitation of the task relevant (race, age, sex or emotion) category and cue nodes. The additional processing goal weights the system in favor of evaluating the task relevant cues explaining why race, sex, and age priming is evident in the race, sex, and age focused tasks.
Despite this, the broader evaluative context weights the influence of emotion cues, potentially explaining why emotion priming was observed even in the race focused priming tasks.

This model can also provide an explanation for the disparity between the current findings and those of Weisbuch and Ambady (2008). Although our predominantly Australian sample tends to implicitly evaluate White faces as more positive than Black faces when only neutral expressions are present within the task, it may be the case that attitudes relating to race are not chronically activated or contextually relevant to the same extent as they are in an American sample. Cues of race may not be particularly salient to a predominantly White Australian sample when emotional expression information is also available, but may still be informative to a predominantly White American sample. This is another example of how the top-down influence of higher order cognitive states may modulate the evaluation of faces varying in cues of race and emotional expression.

Additionally, in Experiments 1, 2, and 4, emotion priming was also observed in the race and sex focused tasks, but this was not observed in the age focused task in Experiment 3. This inconsistency can also be reconciled within the model. As discussed previously, a tendency towards stronger emotion priming was observed in the standard priming task in Experiments 1, 2, and 4 (race) than Experiment 3 (age). As the tasks were equivalent, this suggests that the faces in Experiment 3 may have less powerfully activated emotion relevant cue and category nodes. When the concurrent age categorization task was added, the stronger excitation of age cue nodes elicited by the task may have outweighed the influence of emotion nodes on the resulting evaluation.

Slight differences in the findings of Experiments 1, 2, and 4 investigating race or sex by emotion interactions, and Experiment 3 investigating age by emotion interactions highlight the need for future research in this area. For example, evaluations of faces varying in race, age, or sex and emotion might also be modulated by varying other group membership cues within the task. These findings highlight the importance of beginning to investigate more thoroughly how multiple cues like race, age, sex, identity, and facial expression interact when more than two cues are present to better understand how these cues are evaluated in more naturalistic settings in which any or all of these cues may vary.

**Conclusion**

These studies contribute to the theoretical understanding of how faces varying in emotional expression and race, age, or sex cues are evaluated and to the area of face processing as a whole. Of particular novelty is determining the relative importance of different facial cues in implicit evaluation tasks. Emotional expressions are more influential than group membership cues of race, age or sex in the formation of implicit evaluations of faces varying on these dimensions; however, the way in which emotion interacts with race, sex and age may differ slightly. Overall, this series of studies has implications for interpersonal interactions with members of other groups. Results from
the current study indicate that when emotion information is available from a face, other facial cues of group membership such as age and race may not play a significant role in the formation of spontaneous evaluations unless the race, age, or sex cue is made salient in some way. Displaying positive emotional expressions when interacting with members of other groups may serve to overshadow negative evaluations formed on the basis of group membership cues alone. This may have flow on effects such as facilitating the effectiveness of interpersonal interactions with members of other groups.
References


Chapter 3
Different Faces in the Crowd: A Happiness Superiority Effect for Schematic Faces in Heterogeneous Backgrounds
Abstract

Recently, D.V. Becker, Anderson, Mortensen, Neufeld, and Neel (2011) proposed recommendations to avoid methodological confounds in visual search studies using emotional photographic faces. These confounds were argued to cause the frequently observed Anger Superiority Effect (ASE), the faster detection of angry than happy expressions, and conceal a true Happiness Superiority Effect (HSE). In Experiment 1, we applied these recommendations for the first time to visual search among schematic faces which previously had consistently yielded a robust ASE. Contrary to the prevailing literature, but consistent with D.V. Becker et al. (2011), we observed a HSE with schematic faces. The HSE with schematic faces was replicated in Experiments 2 and 3 using a similar method in discrimination tasks rather than fixed target searches. Experiment 4 demonstrated that background heterogeneity within task elicited a HSE, even when backgrounds were homogenous within each trial. Experiment 5 isolated background heterogeneity as the key determinant leading to the HSE. Finally, in Experiment 6, participants were induced to feel happy or sad to investigate the potential mediating role of the positive expectancy bias in visual search for emotional faces.
Emotionally salient stimuli can alter the allocation of attention (Fenske & Raymond, 2006). Hansen and Hansen (1988) provided an early demonstration of this, asking participants to search through arrays of photographic faces to detect emotional targets. Participants were faster to detect angry faces in happy and neutral crowds than happy faces in neutral and angry crowds. Moreover, one experiment demonstrated no significant time increment for detecting angry faces as the number of distractors increased, indicating that angry faces are processed preattentively and ‘pop-out’ of crowds. It was suggested that this Anger Superiority Effect (ASE) was the result of a cognitive mechanism evolved to quickly detect and attend to external sources of threat.

Subsequent research has produced inconsistent results with some studies utilizing photographic faces reporting an ASE (Horstmann & Bauland, 2006; Pinkham, Griffin, Baron, Sasson, & Gur, 2010), some studies finding no difference in detecting happy and angry expressions and others reporting a Happiness Superiority Effect (HSE; D.V. Becker, Anderson, Mortensen, Neufeld, & Neel 2011; Juth, Lundqvist, Karlsson, & Öhman, 2005; Savage, Lipp, Craig, S.I. Becker, & Horstmann, 2013). A number of researchers have implicated low-level perceptual features of the emotional faces as the cause of these inconsistent effects (Horstmann, Lipp, & S.I. Becker, 2012; Purcell, Stewart, & Skov, 1996; Savage et al., 2013). To eliminate the confounding influence of non-emotion relevant perceptual features on visual search for photographic emotional faces, some researchers have utilized schematic faces which are simple line drawings of emotional faces. Although schematic faces are not exactly the same as real faces, arguments have been made that schematic faces are processed in a face like way. For example, the happy categorization advantage, the faster categorization of happy than other neutral and negative expressions, has been found with schematic faces (Kirita & Endo, 1995). Further to this, the N170 ERP component, which is enhanced in response to faces, has also been found to be elicited by schematic emotional faces (Krombholz, Shaefer, & Boucsein, 2007). With few exceptions (e.g. S.I. Becker, Horstmann, & Remington, 2011), the results of studies using schematic faces consistently show faster detection of angry than happy expressions (ASE; for reviews see D.V. Becker et al., 2011; Frischen, Eastwood, & Smilek, 2008; Horstmann, 2009).

In light of the inconsistencies, D.V. Becker and colleagues (2011) reviewed the literature and concluded that methodological problems present in prior studies limit our ability to determine whether angry or happy faces are detected faster in crowds. D.V. Becker and colleagues presented five recommendations for future studies investigating visual search for emotional face. It was argued that implementing these recommendations would ‘unconfound’ the Face-in-the-Crowd Effect. They then demonstrated a HSE when implementing these recommendations in studies using photographic stimuli. They argued that these findings reflect a positivity bias which manifests in a slightly positive mood and an expectancy of positive over negative interactions. This leads to happy
expressions being detected and processed efficiently and allows for the affiliative intent expressed to be detected effectively and over distance. This finding of a HSE was also consistent with the finding of faster categorization of happy than of neutral or negative expressions (Leppänen & Hietanen, 2003) and provided converging evidence for the prioritization of positive affect in emotional expression processing.

Firstly, D.V. Becker et al. (2011) recommended varying the number of distractors (set size) within participants to detect potential differences in search efficiency. Secondly, the content of the distractor crowds should be held constant across the conditions of interest. This is to eliminate background properties as the source of any detection time differences. Additionally, fixed-target search designs should be used and low level visual features should be controlled for. Finally, heterogeneous backgrounds should be used to prevent participants from searching for non-emotion related idiosyncratic featural differences between stimuli. Although previous studies utilizing schematic faces have implemented at least some of these recommendations (e.g. Fox et al., 2000, Horstmann, 2007, 2009, Öhman, Lundqvist, & Esteves, 2001), to our knowledge, heterogeneous backgrounds within a trial have never been used in previously published studies.

The key consequence of using homogenous backgrounds in visual search experiments with schematic faces is that targets can be accurately detected by adopting a feature search strategy. Feature search describes a situation where the target is defined by a single feature like a color or shape. In the context of detecting a target emotional expression, participants could find the target by focusing on just one feature such as a particular eye brow line or a mouth curve, depending on the requirements of the task and the stimuli. Under these conditions, the target could be found without processing all the information necessary for identification of the emotion, and hence, search differences may not be driven by the emotional expression displayed, but by some visual feature confounded with it. By using heterogeneous backgrounds we can create a condition where targets can only be accurately detected by adopting a conjunction search strategy. Conjunction search describes a situation where the target is defined by a combination of features (e.g. shape and color; Treisman & Gelade, 1980; Wolfe, 1994). In the context of searching for emotional targets, such a target could only be identified by combining information from both the eye brows and the mouth line. Using heterogeneous backgrounds can thus unconfound search for happy versus angry targets, because neither of them can be found by attending to a single feature, and hence, differences in search performance cannot be attributed to a feature search strategy.

**Current Study**

We aimed to determine whether the HSE that has already been found using photographic face stimuli when adhering to the recommendations proposed by D.V. Becker et al. (2011), will be observed when schematic faces are used instead. This is important as the results of all previous
studies investigating visual search for emotional schematic faces could be due to one or more of the methodological confounds described by D.V. Becker et al. (2011). Determining whether happy or angry faces are detected faster when implementing these recommendations is all the more important as D.V. Becker et al. (2011), predict a HSE rather than an ASE although the majority of prior studies of visual search for emotional schematic faces had yielded an ASE.

To test this, participants completed fixed-target searches for happy and angry expressions amongst heterogeneous backgrounds that consisted of 1, 2, 4, or 6 search stimuli. Heterogeneous backgrounds were created using random combinations of distractor faces that were neither happy nor angry. These distractor faces were created by combining the eye brow and mouth features of the happy and angry targets. One type of distractor face had happy eyebrows but an angry mouth (sad) and the other had angry eyebrows but a happy mouth (scheming). The stimuli were controlled for on non-emotion relevant differences in low-level perceptual features. Using these faces in heterogeneous backgrounds meant that a target happy or angry face could only be detected by searching for a conjunction of features and not by just searching for a single feature. Backgrounds were controlled by creating two versions of the task with either happy or angry targets. As we adhered to D.V. Becker et al.’s (2011) recommendations, a HSE was predicted.

Experiment 1

Method

Participants. Participants were 38 undergraduate students (27 Females, M = 19.04, SD = 2.61) who participated for course credit. Data from an additional three participants who only completed one of the two tasks were excluded from analysis.

Apparatus and materials. The experimental task was displayed on 17” monitors with a refresh rate of 85Hz and a screen resolution of 1024 × 768 pixels in a laboratory seating up to six participants and executed in DMDX (Forster & Forster, 2003). Responses were made with the left and right shift keys on a standard keyboard with response mapping counterbalanced across participants.

The stimuli (see Figure 1, upper row) were four emotional schematic faces adapted from Lipp, Price, and Tellegen (2009). All faces shared the common features of two gray circles representing eyes, a triangle representing the nose, a curved line representing the mouth and two lines above the eyes representing eye brows. Four different emotional expressions (Happy, Angry, Sad, and Scheming) were created by swapping the eye brow lines and inverting the curve of the mouth. The face circumferences present in the Lipp et al. (2009), faces were removed. This was to eliminate the possibility that differences in detection time reflect the interaction between angry and happy features with the face circumference (Horstmann, S.I. Becker, Bergmann, & Burghaus, 2010;
S.I. Becker, Horstmann, & Remington, 2011; Purcell & Stewart, 2010). Each image was 85 × 115 pixels in size. The stimuli were matched in brightness and contrast.

**Procedure.** Participants were seated approximately 50 cm away from the monitor. They were instructed that they would complete two tasks. In each task, they indicated whether a target face was present on the display or not by pressing the right or left shift key. In one task, the target they searched for was always a happy face and in the other the target was always an angry face. The order of the happy and angry tasks was counterbalanced. They were informed that distracting non-target faces may be present and were provided examples of all stimuli before commencing the tasks. Participants completed 12 practice trials before each main task with task order counterbalanced.

On each trial a centered black fixation cross was presented on a white background for 500ms followed by the search array which was displayed until the participant made a response or for 5000ms. The search array was circular around fixation and consisted of six potential stimulus locations. Stimuli were presented at set sizes of 1, 2, 4, or 6. At set size two, stimuli always occupied opposing locations so stimuli could appear at positions 1 and 4, 2 and 5, or 3 and 6. At set size four stimuli appear at positions 1, 2, 4 and 5, 2, 3, 5, and 6, or 3, 4, 6, and 1. At set size six all positions were occupied. Backgrounds consisted of random combinations of sad and scheming faces. These faces differed from the target faces in either the mouth or eyebrows. Across both tasks, the background configurations were held constant and only the expression of the target face was altered. This was done so that potential differences in detection time between happy and angry targets could not be attributed to the backgrounds alone.

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*Figure 1.* Schematic stimuli used in Experiments 1, 2, and 4, 5 and 6 (upper row) and Experiment 3 (lower row). Emotions depicted from left to right are happy, angry, sad, scheming, and neutral.
Participants received feedback of an incorrect response with the word ‘WRONG’ presented at the bottom of the screen for 500ms. Half of the trials were target trials and half were non-target trials showing random combinations of sad and scheming faces. For each task, the target appeared in each target location at each set size three times resulting in 72 target trials and 72 non target trials matched in set size, totaling 144 trials for each task.

**Data preparation and analysis.** Incorrect responses were coded as missing and responses faster than 100ms and those more than three standard deviations from a participant’s mean were classified as within subject outliers and removed. This constituted 7% of responses. Response time and error rate data were analyzed with separate 2 (Trial type: target, non-target) × 2 (Target emotion: happy, angry) × 4 (Set size: 1, 2, 4, 6) repeated measures ANOVAs.

**Results**

**Response times.** Consistent with the key prediction of a HSE when the recommendations of D.V. Becker et al. (2011), were followed, participants were faster to indicate the presence and absence of happy faces than angry faces at each set size (see Figure 2). This was confirmed by a significant main effect of emotion, $F(1, 37) = 22.14, p < .001, \eta^2_p = .37$. Participants were also significantly slower to respond as the number of distractors increased, $F(3, 111) = 800.20, p < .001, \eta^2_p = .96$. Participants were slower to respond at each increase in set size, all $t$s $> 7.13, ps < .001$. They were also slower to respond on non-target than on target trials, $F(1, 37) = 389.76, p < .001, \eta^2_p = .91$. A Trial type × Set size interaction emerged, $F(3, 111) = 186.61, p < .001, \eta^2_p = .84$. Although participants were faster to respond on target than non-target trials at all set sizes $t$s(111) $> 5.35, p < .001$, the magnitude of this difference did not increase from set sizes 1 to 2, $t(111) = .02, p = .984$, but did increase from set sizes 2 to 4 and 4 to 6 $t$s $> 13.65, ps < .001$. No other effects were significant $Fs < 1.70, ps > .189$.

**Error Rates.** As shown in Table 1, consistent with response time data, participants made fewer errors searching for happy expressions than angry expressions, as indicated by a significant main effect of emotion $F(1, 37) = 8.54, p = .006, \eta^2_p = .19$. Participants also made more errors on target trials than on non-target trials, $F(1, 37) = 27.54, p < .001, \eta^2_p = .43$, and with increasing set size, $F(3, 111) = 37.12, p < .001, \eta^2_p = .50$. These factors interacted as indicated by a significant Trial type × Set size interaction, $F(3, 111) = 17.18, p < .001, \eta^2_p = .32$. Error rates did not differ significantly between target and non-target trials at set size 1, $t(111) = 1.29, p = .199$, but more errors were made on target than non-target trials at set sizes 2, 4 and 6, $t$s(111) $> 2.65, ps < .009$. There was also a marginally significant Emotion × Set size interaction, $F(3, 111) = 2.31, p = .088, \eta^2_p = .06$. Although simple effects must be interpreted with caution, fewer errors were made in the happy than the angry task at set sizes 1 and 6 $t$s(111) $> 2.05, ps < .043$, but not at set sizes 2 and 4,
Figure 2. Response times for indicating the presence or absence of happy and angry targets amongst heterogeneous backgrounds as a function of set size in Experiment 1. Error bars depict standard errors of the mean.
ts(111) < 1.27, p > .207. All other interactive effects did not reach the threshold of significance, Fs < 0.55, p > .630.

Discussion

The aim of Experiment 1 was to determine the direction of the search advantage with schematic emotional faces when adhering to D.V. Becker et al.’s (2011) methodological recommendations. Consistent with the prediction that a HSE would emerge, participants were faster and more accurate in indicating the presence and absence of happy than of angry faces. To our knowledge, this is the first report of a HSE with schematic emotional faces without altering the face circumferences. The extant literature exclusively presents evidence for an ASE or no difference between search times for happy and angry expressions (D.V. Becker et al., 2011, Frischen et al., 2008).

The key difference between the current and previous studies is the use of heterogeneous backgrounds and therefore a task which required the processing of conjunctions of emotion relevant features rather than just one feature. It may be the case that participants complete the task searching for this feature when homogeneous backgrounds are used and a single feature differentiates the target from the background faces. Using this search strategy does not necessitate processing of all the information which would allow for the emotion to be identified. This means that differences in the speed of detecting happy and angry expressions may not reflect processes related to the emotional expression represented. In the current study, participants must search for a conjunction of features. All of the features which allow for recognition of the represented emotion must be processed. This means that any difference in detection time for happy and angry faces may be due to the emotional expressions represented by the stimuli. Given this is the first report of a HSE with schematic faces not due to altering the stimuli themselves, Experiments 2 and 3 were conducted to establish the robustness and reliability of this HSE in heterogeneous backgrounds.

Experiments 2

To determine whether the HSE in heterogeneous backgrounds observed in Experiment 1 is reliable, we seek to replicate this finding using similar methods in a discrimination search task. In these tasks, participants must still search to detect a target, but must then identify the nature of a target which is presented on every trial. This removes the need for non-target trials which provide no information about target detection and reduces the number of trials a participant must complete. Although using discrimination search tasks is not in line with the D.V. Becker et al. (2011), recommendation of using fixed target searches, previous research from our lab suggests that this methodological factor does not alter the outcome of results when using photographic faces (Savage et al., 2013). If the HSE observed in Experiment 1 was due to the use of heterogeneous backgrounds, a HSE should also be observed in Experiment 2.
Method

Participants, procedure, and data preparation and analysis. Participants were 32 undergraduate volunteers (8 males, $M = 20.19$, $SD = 5.40$) who completed a discrimination task. Rather than indicating the presence or absence of a target, a happy or angry target was present on each trial and participants were required to indicate whether it was the happy face or the angry face that was present on each trial. As such only target trials were included and these happy and angry target trials appeared mixed rather than blocked within each task. Trials were created as described in Experiment 1 resulting in 144 trials in total (72 happy and 72 angry target trials). Participants were familiarized with the target and background stimuli prior to commencing the task and were instructed to categorize the target (Happy or Angry) by pressing the right and left shift keys, with response mapping counterbalanced across participants. Data were processed in the same manner as in Experiment 1. Fewer than 9% of responses were excluded due to incorrect responses or outlying response times. Response time and error rate data were submitted to separate 2 (Target emotion: happy, angry) × 4 (Set Size: 1, 2, 4, 6) repeated measures ANOVAs.

Results

Response times. As predicted, results displayed in Figure 3 indicate that participants were faster to discriminate happy than angry faces. This was supported by a significant main effect of target emotion, $F(1, 31) = 18.22, p < .001, \eta_p^2 = .37$. This HSE was moderated by set size, $F(3, 93) = 4.32, p < .021, \eta_p^2 = .122$. There was no significant difference between discriminating happy and angry expressions at set size 1, $t(93) = 0.44, p = .66$, but faster discrimination of happy targets emerged at set sizes 2, 4, and 6, $ts(93) > 4.01, ps < .001$. Consistent with previous research, a main effect of set size was also observed, $F(3, 93) = 211.89, p < .001, \eta_p^2 = .870$. Each increase in set size resulted in significantly slower response times, $ts(93) > 4.47$ all $ps < .001$.

Error rates. Table 1 indicates that there was no significant difference in errors made on happy and angry trials overall, $F(1, 31) = 3.23, p = .082, \eta_p^2 = .09$, but overall error rates tended to increase as set size increased, $F(3, 93) = 39.21, p < .001, \eta_p^2 = .56$. This effect was moderated by the nature of the target, $F(3, 93) = 5.50, p = .004, \eta_p^2 = .15$. Follow up comparisons indicated that there was no difference in errors made on happy and angry trials at set sizes 1 and 2, $ts(93) < 0.93, ps > .356$, but more errors were committed on happy than angry trials at set sizes 4 and 6, $ts(93) > 2.23, ps < .028$.

Discussion

Experiment 2 replicated the finding of a HSE in heterogeneous backgrounds with schematic faces observed in Experiment 1. This finding demonstrates that the HSE is also observed in heterogeneous backgrounds in discrimination search tasks where there is a happy or an angry target present on each trial and the nature of the target must be identified. It also demonstrates that fixed
Figure 3. Response times for discriminating happy or angry targets without circumference amongst heterogeneous backgrounds as a function of set size in Experiment 2. Error bars depict standard errors of the mean.
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target search is not critical for the HSE to emerge. It seems likely that the HSE observed with schematic faces is due to background heterogeneity; however, there were some slight differences between the results of Experiment 1 and Experiment 2 that need consideration.

Firstly, in Experiment 1 there was no indication of an Emotion × Set size interaction, but in Experiment 2 a significant Emotion × Set size interaction emerged. At set size 1, the difference in discriminating happy and angry targets was not significant in Experiment 2, but at larger set sizes it was. Considering the key methodological difference between Experiments 1 and 2 provides a potential explanation for this. In Experiment 1 at set size 1, participants indicated the presence or absence of a happy or angry target and in doing so had to process the configuration of eye brow and mouth features to make a correct response. Thus, processing of all of the information necessary to identify the emotion was required to make a correct response. In Experiment 2, the target was always present and participants only had to indicate which target, happy or angry, was present on each trial. At set size 1, this discrimination could be solved featurally, i.e., by only looking at the mouth or only looking at the eye brows. Such a feature based solution was not available for accurate responding at larger set sizes. In Experiments 1 and 2, a HSE is observed when the conjunction of the eye brow and mouth features must be processed to respond correctly.

Secondly, error rates in Experiment 1 were consistent with response times. Fewer errors were made in the happy task where response time was fastest. In Experiments 2, happy faces were also generally discriminated faster, but where differences in error rates were observed there were more errors made on happy trials. There are a couple of potential explanations for this pattern of results.

Firstly, this difference could be due to the change in methodology and may speak to differences in the ease of discriminating happy and angry targets from background faces. In Experiment 1, if a participant had difficulty discriminating angry from scheming or sad faces and mistook a scheming or sad face for an angry face, this would be recorded as an error as they would indicate that an angry target was present when it was not. In Experiment 2, mistaking a scheming face for an angry face has different consequences. If this mistake was made on an angry target trial this would be recorded as a correct response, but if it was made on a happy target trial, it would be recorded as an error. Given that scheming and sad faces appeared equally on happy and angry target trials, mistaking a scheming or sad face for an angry face would have increased incorrect responding on happy target trials in Experiment 2 (whereas it would have increased incorrect responding in the angry task in Experiment 1).

A second potential explanation is that participants were trading off accuracy for speed on happy trials in Experiment 2. If this were the case we may find that faster response times are associated with more errors. Analysis of the data indicated no significant relationship between mean
response times and error rates in any condition. Additionally, trading off accuracy for speed should manifest in faster response times on incorrect trials. Mean response times did not differ between correct and incorrect trials at any set size, \( t < 1.35, p > .187 \). Looking at happy and angry trials separately, there was no difference between response times for correct and incorrect responses on angry trials, \( t(29) = 1.18, p = .247 \), but participants were significantly slower on incorrect happy trials than on correct happy trials, \( t(30) = 5.92, p < .001 \). This analysis suggests that participants were not sacrificing accuracy for speed on happy trials. Considering the results from Experiments 1 and 2 together along with these additional analyses suggests that the HSE observed in heterogeneous backgrounds is unlikely to be due to a speed accuracy trade off, i.e. participants prioritizing speed over accuracy selectively in happy trials, but rather to differences in the ease of identifying the happy and the angry faces amongst the sad/scheming backgrounds.

It is also important to note that the stimuli used in Experiments 1 and 2 have not previously been used in published research. The faces appeared without circumferences to eliminate the possibility that differences in detection time were driven by an interaction of facial features and the circumference of the face (Horstmann, et al., 2010; S.I. Becker et al., 2011). It may be the case that this particular set of stimuli elicits a HSE when presented without circumferences regardless of the background. Experiment 3 was designed to test this alternative hypothesis.

**Experiment 3**

In Experiment 3 we seek to determine whether the HSE in heterogeneous backgrounds observed in Experiments 1 and 2 is due to the absence of facial circumferences. To do this, we replicate Experiment 2 with the original Lipp et al. (2009), stimuli which include facial circumferences. Given that heterogeneous backgrounds are used, we predict that a HSE will be observed.

**Method**

Participants were 30 (7 males, \( M = 18.57, SD = 1.52 \)) undergraduate student volunteers. The apparatus, materials, and procedure were identical to those described in Experiment 2, except the un-altered stimuli from Lipp et al. (2009), including circumferences were utilized (see Figure 1, lower row). Thirteen percent of responses were excluded from analysis due to incorrect responses or outlying response times. Response times and error rates were analyzed using separate 2 (Target Emotion: Happy, Angry) \( \times 4 \) (Set Size: 1, 2, 4, 6) repeated measures ANOVAs.

**Results**

**Response times.** Results displayed in Figure 4 indicate that participants were faster to discriminate happy than angry faces. This was supported by a significant main effect of target emotion, \( F(1, 29) = 6.91, p = .014, \eta_p^2 = .192 \). A main effect of set size was also observed, \( F(3, 87) = 264.61, p < .001, \eta_p^2 = .901 \). Each increase in set size resulted in significantly longer response
times, $t > 4.17$ all $p < .001$. The Emotion $\times$ Set size interaction was not significant, $F(3, 87) = 1.89, p = .150, \eta_p^2 = .061$; however, inspection of response times suggests a trend consistent with Experiment 2 where discrimination times for happy and angry targets do not differ at set size 1, but appear to emerge at larger set sizes. Although simple effects must be interpreted with extreme caution given the lack of a significant interaction, there is some evidence to support this. Whereas there was no significant difference between discrimination times at set size 1 and 2, $t(87) < 1.34, p > .184$, happy faces were detected faster at set sizes 4 and 6, $t(87) > 2.45, p < .016$.

Error rates. Again the error rates displayed in Table 1 suggest an increase as set size increased, $F(3, 87) = 65.91, p < .001, \eta_p^2 = .69$, and in this experiment significantly more errors were made on happy than on angry trials, $F(1, 29) = 16.43, p < .001, \eta_p^2 = .36$. The factors of set size and emotion interacted significantly, $F(3, 87) = 3.46, p = .024, \eta_p^2 = .11$, such that errors made on happy and angry trials did not differ significantly at set sizes 1 and 2, $t(87) < 1.58, p > .117$, but more errors were made on happy than angry trials at set sizes 4 and 6, $t(87) > 4.16, p < .001$.

Discussion

The aim of Experiment 3 was to determine whether the HSE with schematic faces in heterogeneous backgrounds observed in Experiments 1 and 2 could be replicated using the original Lipp et al. (2009), stimuli which included facial circumferences. Although these exact same stimuli elicited an ASE when presented among homogeneous neutral backgrounds in the original Lipp et al. (2009) study, in the current study, amongst heterogeneous backgrounds, the predicted HSE was observed. Together, Experiments 1-3 suggest that happy schematic faces were detected more quickly in heterogeneous backgrounds when processing of a conjunction of eye brow and mouth features was necessary. These results are in line with the hypotheses made by D.V. Becker et al., that happy faces are processed more quickly and easily than angry expressions, and that the ASE reported in previous literature was due to the fact that low level visual confounds drove the search asymmetry in favor of angry faces. These studies, however, cannot speak to whether backgrounds must be heterogeneous within each trial for a HSE to emerge, or whether using homogenous backgrounds that change from trial to trial may also lead to a HSE.

Experiment 4 aimed to determine whether the HSE observed in Experiments 1-3 was only found when backgrounds were heterogeneous within each trial or whether having trials with homogenous backgrounds in a task where the nature of the background varied from trial to trial would also elicit a HSE. Participants searched through homogenous neutral, sad, or scheming backgrounds for happy and angry targets, but the nature of the background varied within the task. Although on each trial, the target differs from all of the background distractors by a single feature, in this task participants cannot search for a particular feature (either the eyebrows or the mouth) that defines the target as it changes from trial to trial. Based on the assumption that a HSE emerges
Figure 4. Response times for discriminating happy or angry targets with face circumferences amongst heterogeneous backgrounds as a function of set size in Experiment 3. Error bars depict standard errors of the mean.
when targets cannot be successfully detected using a feature search strategy, we predict that a HSE will emerge in the current task as successful performance across trials requires inspection of the combination of eyebrows and mouth.

**Experiment 4**

**Method**

**Participants.** Participants were 36 undergraduate students at The University of Queensland (4 males, $M = 19.75$, $SD = 3.82$) who received course credit for participation.

**Apparatus and Materials.** The apparatus and materials were the same as in Experiment 1 with the addition of a neutral schematic face (see Figure 1). This face was composed of the same eyes and nose as the emotional faces; however, the eyebrow and mouth were horizontal lines.

**Procedure.** The procedures of Experiment 4 were similar to Experiments 2 and 3; however, rather than using heterogeneous backgrounds of both sad and scheming faces, homogenous neutral, sad, or scheming backgrounds were used. Although the backgrounds were homogenous on each trial, the nature of the background was varied within the task. On half of the trials a happy face was present and on the other half, an angry face was present. Targets were presented alone or with 1, 3, or 5 distractors. On a third of trials the distractors were all neutral faces, on a third the distractors were all sad, and on the other third, the background were scheming. Each target was presented in each position at each set size with each of the backgrounds once and there were an equal number of trials at each set size resulting in 144 trials. Data were processed in the same manner as Experiments 1-3. Data from one participant could not be included as they did not provide a complete data set. Data were analyzed with a 2 (Target: happy, angry) $\times$ 2 (Background: neutral, sad, scheming) $\times$ 3 (Set size: 2, 4, 6) repeated measures ANOVA. Data from set size 1 was excluded from the ANOVA as no background distractors were present at set size 1 and a separate t-test was used to analyze responses times and errors for set size 1 trials.

**Results**

**Response Times.** Inspection of Figure 5 suggests that participants were overall significantly faster to respond on happy than angry target trials $F(1, 34) = 4.40$, $p = .043$, $\eta_p^2 = .12$. Additionally, as expected, participants were faster to search through smaller than larger set sizes, $F(2, 68) = 79.74$, $p < .001$, $\eta_p^2 = .70$. Participants were faster to find and categorize the target emotions at set size 2 than at set size 4 $t(68) = 3.16$, $p = .002$, but no quicker to categorize the target emotion at set size 4 and 6 $t(68) = 1.16$, $p = .250$. Additionally a significant main effect of background, $F(2, 68) = 93.02$, $p < .001$, $\eta_p^2 = .73$, indicated that participants were faster to search through neutral than scheming ($t(68) = 4.37$, $p < .001$) and sad backgrounds ($t(68) = 3.97$, $p < .001$). There was an interaction of set size and background, $F(4, 136) = 13.17$, $p < .001$, $\eta_p^2 = .28$. In neutral backgrounds, there was no significant response time increment for responding at larger set sizes (4
and 6) compared to smaller set sizes (2), \( ts < 1.18, p > .240 \). In sad and scheming backgrounds, participants were faster to detect a target at set size 2 than at set sizes 4 and 6, \( ts > 3.83, p < .001 \). The additional paired samples \( t \)-test for set size 1 response times revealed no differences in categorizing a happy or angry target at set size 1, \( t(35) = 1.26, p = .214 \).

**Error rates.** As in Experiments 2 and 3, participants made significantly more errors on happy trials than on angry trials overall, \( F(1, 34) = 13.71, p = .001, \eta_p^2 = .29 \). There was also a significant main effect of set size, \( F(2, 68) = 6.92, p = .003, \eta_p^2 = .17 \), and background, \( F(2, 68), p < .001, \eta_p^2 = .57 \), but these effects were qualified by two two-way interactions. There was a significant target by background effect, \( F(2, 68) = 4.45, p = .026, \eta_p^2 = .12 \), where participants made marginally more errors on happy than angry trials in sad backgrounds, \( t(68) = 1.92, p = .059 \), but not in neutral or scheming backgrounds, \( ts < 0.48, ps > .633 \). There was also a marginally significant interaction of background and set size, \( F(2, 68) = 4.45, p = .026, \eta_p^2 = .12 \). Error rates were significantly higher for large (6) than smaller set sizes (2) in scheming backgrounds, \( t(68) = 2.27, p = .026 \), but did not increase in neutral and sad backgrounds, \( ts < 0.98, p = .331 \). At set size 1, there was no difference in error rates for happy and angry targets, \( t(34) = 0.34, p = .737 \).

**Discussion**

The aim of Experiment 4 was to determine whether the HSE that was observed in Experiments 1-3 with heterogeneous backgrounds on each trial would be observed when backgrounds were homogeneous within a trial but heterogeneous from trial to trial. Consistent with our prediction, a HSE was observed.

Although within each trial, the target could be identified by just one feature, successful task performance across trials required attention to the combination of eyebrow and mouth features as no one feature defined the target across trials. These results suggest that the HSE emerges when the task requires attention to the conjunction of eyebrow and mouth features, and is not eliminated when the target differs from the background by a single feature that is unpredictable from trial to trial.

Participants were also faster to search through neutral than sad and scheming backgrounds. This suggests that there is some benefit for searching through backgrounds that do not share any defining features with the target. In fact, there was no time increment with increasing set sizes amongst neutral backgrounds suggesting that the targets ‘popped out’ of the neutral crowds. This was not the case for detecting targets amongst sad and scheming homogeneous background which differ from the target on one feature (either eyebrows or mouth), but share another feature. As the defining feature changed from trial to trial, participants still had to attend to the conjunction of eyebrow and mouth information. Together, the results from Experiments 1-4 provide evidence to
Figure 5. Response times for discriminating happy or angry targets amongst homogenous neutral, scheming, or sad backgrounds as a function of set size in Experiment 4. Error bars depict standard errors of the mean.
suggest that background heterogeneity is the key factor that leads to the HSE. However, there are a number of potential alternative explanations that need to be considered.

Firstly, the current results may be due to the use of emotional rather than neutral backgrounds. Previous experiments which have held backgrounds constant across emotion conditions have only used homogeneous backgrounds and have not investigated whether happy or angry faces are detected faster amongst other types of emotional backgrounds. It may be the case that the use of emotional (sad or scheming) faces as backgrounds in Experiments 1 - 4 leads to a HSE even in fully homogeneous backgrounds (both within trial and within task). Additionally, the stimuli used in Experiments 1, 2, and 4 without circumferences have not previously been used in the literature. Although an ASE was reported by Lipp et al. (2009), using similar stimuli, it may be the case that when circumferences are removed, search for happy faces is also facilitated. Experiment 3 confirmed that including the facial circumference did not lead to an ASE in heterogeneous backgrounds; however, it is unclear whether the stimuli without circumferences will always elicit a HSE even when presented amongst homogeneous backgrounds.

Experiment 5 aimed to test these alternative explanations. Participants completed six blocks of fixed-target searches for happy and angry faces in homogeneous neutral, sad, or scheming backgrounds. In doing so, all of the recommendations of D.V. Becker et al. (2011) were followed except the recommendation to use heterogeneous backgrounds. As the methods and stimuli utilized were similar to prior studies (e.g. Dickins & Lipp, 2013; Lipp et al., 2009), an ASE was predicted in homogenous backgrounds.

**Experiment 5**

**Methods**

**Participants.** Participants were 36 undergraduate volunteers (27 Females, M = 19.20, SD = 2.49), who received course credit.

**Apparatus and Materials.** The apparatus and materials were the same as in Experiment 4 with the addition of a neutral schematic face (see Figure 1).

**Procedure.** Participants searched for happy or angry targets amongst homogenous neutral, sad, or scheming backgrounds, yielding six tasks. The background faces were always constant within each task and all consisted of the same emotional face. The order of the tasks was counterbalanced across participants. Participants completed six blocks of 144 trials, one block for each target type within each background. Data were pre-processed as in Experiment 1. Results for each background were analyzed separately. Missing responses constituted 5% (neutral backgrounds), 7% (sad backgrounds), and 10% (scheming backgrounds). Data from one participant were not available in the scheming background task as s/he did not complete this task.
Results

Neutral backgrounds.

Response times. Contrary to predictions (Figure 6a), there was no time difference in indicating the presence or absence of happy and angry expressions amongst neutral faces, $F(1, 35) = 0.88, p = .355, \eta_p^2 = .02$. However, participants were overall faster to respond on target than non-target trials, $F(1, 35) = 12.88, p = .001, \eta_p^2 = .27$, and faster to respond at smaller than larger set sizes, $F(3, 105) = 16.47, p < .001, \eta_p^2 = .32$. Participants were faster to respond at set size 1 than at set sizes 2, 4 and 6, $t(105) = 2.70, p = .008$, but no difference in response times was observed at set sizes 2, 4, or 6, $t(105) < 1.26, p = .211$.

Error rates. As in the response time data, there was no significant difference in error rates between angry and happy tasks, $F(1, 35) = 0.89, p = .351, \eta_p^2 = .03$, (see Table 1). There was, however, a significant main effect of trial type, $F(1, 35) = 4.89, p = .03, \eta_p^2 = .12$, indicating that fewer errors were made on non-target trials than on target trials. In this task, more errors were also committed at smaller than at larger set sizes, $F(3, 105) = 18.16, p < .001, \eta_p^2 = .34$. More errors were made at set size 1 than at set sizes 2, 4, and 6, $ts(105) > 3.00, ps < .003$. No other effects were significant $Fs < 2.64, ps > .113$.

Sad backgrounds.

Response times. As can be seen in Figure 6b, overall response times did not differ as a function of target emotion, $F(1, 35) = 1.42, p = .242, \eta_p^2 = .04$. However, there were significant interactions of trial type and emotion, $F(1, 35) = 16.75, p < .001, \eta_p^2 = .33$, and set size $F(3, 105) = 8.47, p < .001, \eta_p^2 = .20$, as well as a significant three way Emotion by Trial type by Set size interaction, $F(3, 105) = 3.87, p = .013, \eta_p^2 = .10$. Analyzing target and non-target trials separately in order to follow this significant three way interaction, revealed the predicted ASE, $ts(105) > 2.92, ps < .004$, in target trials at all set sizes except size 1, $t(105) = .48, p = .632$, (significant Emotion by Set size interaction, $F(3, 105) = 3.21, p = .039, \eta_p^2 = .08$). There was no significant ASE on non-target trials at any set size, $F(3, 105) = 0.87, p = .436, \eta_p^2 = .03$. Additionally, there were omnibus main effects of trial type, $F(1, 35) = 21.10, p < .001, \eta_p^2 = .38$, and set size, $F(3, 105) = 104.04, p < .001, \eta_p^2 = .75$. Participants were slower to respond on non-target than target trials and slower to respond at each increase in set size $ts(105) > 3.44, ps < .001$. The Emotion $\times$ Set size interaction was not significant, $F(3, 105) = 0.98, p = .372, \eta_p^2 = .03$.

Error rates. As can be seen in Table 1, analysis of error rates revealed no significant effect of emotion or any interaction with the factor of emotion and trial type or set size $Fs > 2.10, ps > .113$. There was, however, a significant main effect of trial type, $F(1, 35) = 22.76, p < .001, \eta_p^2 = .39$, with more errors committed on target than on non-target trials. There was also a significant main effect of set size, $F(3, 105) = 4.02, p = .008, \eta_p^2 = .11$, with more errors committed at set size
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1 than at set sizes 2, 4, and 6, \( t(105) = 2.04, p < .044 \). This effect was moderated by trial type, \( F(3, 105) = 3.87, p = .015, \eta^2_p = .10 \). Follow up comparisons indicated no significant difference in error rates for target and non-target trials at set size 1, \( t(105) = 0.32, p = .747 \), but more errors were committed in target than non-target trials at set sizes 2, 4, and 6, \( t(105) > 2.53, ps < .013 \).

**Scheming backgrounds.**

Response times. As predicted, an ASE emerged (Figure 6c) in search amongst scheming faces. Participants were faster to indicate the presence and absence of angry than happy faces, as indicated by a main effect of emotion, \( F(1, 34) = 26.64, p < .001, \eta^2_p = .44 \). This main effect of emotion was moderated by set size, \( F(3, 102) = 41.26, p < .001, \eta^2_p = .55 \), and trial type, \( F(3, 102) = 12.34, p = .001, \eta^2_p = .27 \). The ASE was significant in target and non-target trials, \( t(102) > 9.84, ps < .001 \), and at all set sizes, \( t(102) > 3.44, ps < .001 \), but was significantly larger in non-target trials, \( t(102) = 4.97, p < .001 \), and significantly larger with each increase in set size, \( t(102) > 2.29, ps < .024 \). Overall, participants were faster to respond on target than non-target trials, \( F(1, 34) = 19.365, p < .001, \eta^2_p = .36 \), and slower to respond with each increase in set size, \( F(3, 102) = 112.16, p < .001, \eta^2_p = .77 \), \( t(102) > 3.72, ps < .001 \). All other effects were not significant, \( F_s < 2.07, p > .115 \).

Error rates. There was no overall difference in errors made in the happy and angry tasks, \( F(1, 34) = 1.92, p = .175, \eta^2_p = .05 \), (see Table 1). There were, however, significant main effects of set size, \( F(3, 102) = 12.26, p < .001, \eta^2_p = .27 \), and trial type, \( F(1, 34) = 22.99, p < .001, \eta^2_p = .40 \), with significantly more errors committed at set size 1 than at set size 2 and 4, \( t(102) = 3.95, p < .001 \), but not at set size 6, \( t(102) < 0.77, p > .443 \), and on target than non-target trials. There were also significant two way interactions of emotion and set size, \( F(3, 102) = 4.16, p = .010, \eta^2_p = .11 \), emotion and trial type, \( F(1, 34) = 11.97, p = .001, \eta^2_p = .26 \), and set size and emotion, \( F(3, 102) = 15.92, p < .001, \eta^2_p = .32 \). Finally, there was a significant three way interaction of emotion, trial type, and set size, \( F(3, 102) = 6.20, p = .001, \eta^2_p = .15 \). Following up this interaction by analyzing target and non-target trials separately revealed that on target trials, there was no difference in errors committed on happy and angry target trials at set sizes 1 and 2, \( t(102) < 0.41, ps > .683 \), but fewer errors were made on angry than happy target trials at set sizes 4 and 6, \( t(102) > 2.53, ps < .013 \). On non-target trials there were no significant effects or interactions of emotion, \( F_s < .99, ps > .398 \). Error rates only varied significantly as a function of set size, \( F(3, 102) = 12.40, p < .001, \eta^2_p = .27 \). More errors were committed at set size 1 than at set sizes 2, 4, and 6, \( t(102) > 3.52, ps < .001 \), on non-target trials.

**Discussion**

The aim of Experiment 5 was to isolate background heterogeneity as the factor leading to the HSE observed in Experiment 1. The results confirm that the HSE observed in Experiment 1 was
Figure 6. Response times for indicating the presence or absence of happy and angry targets amongst homogeneous (a) neutral, (b) sad, and (c) scheming backgrounds as a function of set size in Experiment 5. Error bars depict standard errors of the mean.
not due to the stimuli or the use of emotional stimuli as backgrounds, as here we find an ASE with the same stimuli in homogeneous emotional backgrounds. Where significant emotion effects were observed in error rates they also provided evidence for an ASE in homogeneous backgrounds. This implicates background heterogeneity as the key determinant of the HSE observed in Experiments 1-4.

Experiments 1-5 in the current study confirmed that applying the D.V. Becker et al. (2011) guidelines to ‘unconfound’ the face-in-the-crowd effect for photographic faces also results in a HSE in search for schematic faces. Experiments 2 and 3 showed that the finding of a HSE in heterogeneous backgrounds was replicable and was not due to the absence of the facial circumference. Experiment 4 demonstrated that the HSE was also observed when backgrounds were homogenous within trial but heterogeneous within the task. Experiment 5 isolated background heterogeneity as the key determinant of this effect, eliminating other potential explanations. These findings are important as the results from all previous studies investigating visual search for emotional schematic faces may have been due to methodological confounds identified by D.V. Becker et al. (2011). This is the first study in this domain to avoid all of these potential confounds and we find support for a HSE as predicted by D.V. Becker et al. (2011), which contradicts the majority of previous studies (e.g. Frischen et al., 2008; Horstmann, 2007, 2009). Given these novel findings it is important to consider the mechanism that may underlie this effect.

The current results do not implicate a particular feature (either eye brow or mouth) as ‘the feature’ that drives the ASE observed in Experiment 5 as the current study was not designed for this purpose and results demonstrate that neither the angry eye brows alone or the angry mouth alone can explain the faster detection of angry expressions. The results suggest that differences in the search strategy required for accurate task performance and that the use of these different strategies may influence the degree to which emotions are interpreted (D.V. Becker et al., 2011).

The main consequence of manipulating background heterogeneity was that Experiments 1-4 required the processing of the conjunction of eyebrow and mouth cues for accurate performance, whereas the tasks in Experiment 5 could be completed accurately using a feature based search strategy. Feature search describes a situation where the target is defined by a single feature like a color or shape. Conjunction search describes a situation where the target is defined by a combination of features for example, shape and color. In conjunction search, the background items share one of the target features, thus preventing the target from being found by attending to a single perceptual feature throughout the task. Accurate performance in Experiment 1-4 (except at set size 1 in Experiments 2, 3 and 4) thus required combining information from more than one feature (i.e. both mouth and eye brows) to identify the target because the sad and scheming background faces shared a feature with each of the targets. To perform the task accurately, participants had to attend
to all of the emotion defining features of the target and a HSE was observed. In Experiment 5 (and at set size 1 in Experiments 2, 3, and 4), participants could focus on a particular feature that would always signal the target within a given block of trials (either mouth or eye brows). Under these conditions, accurate responding did not require processing of all of the features that would allow the emotion to be recognized, and a HSE was not observed.

It is interesting to note that the HSE observed in Experiment 1 under the recommendations of D.V. Becker et al. (2011), was not evident as a difference in search efficiency, as would be indicated by a significant Emotion × Set size interaction, but as an overall difference in detection time that was also observed in non-target trials. Although there was a significant interaction in Experiment 2, and a similar non-significant trend in Experiment 3, this interaction was mainly driven by the absence of a difference in response times to happy and angry targets at set size 1. As discussed earlier, at this set size, Experiments 2, 3, and 4 are not comparable to Experiment 1, as processing of the conjunction of emotion relevant features was not required to discriminate happy and angry targets.

In the previous literature, differences in search efficiency have commonly been equated with differences in the set size effect, or the 'slope' of the RT × set size function (e.g. Treisman & Sato, 1990; Wolfe, 1994). Hence, the failure to observe a difference in search efficiency in the present study suggests that the HSE observed in heterogeneous backgrounds does not reflect differences in search efficiency, but on processes that occur either before the trial commences or after the target has been fixated on. Possible candidate processes include less hesitation in beginning scanning, a lower threshold for deciding that no target is present or faster response selection for one target (Horstmann, 2007).

One possible explanation for this effect, consistent with the literature, is that the HSE observed is due to a positivity bias. We tend to expect positive over negative expressions and experiences and the congruence between our expectations and an affectively positive stimulus such as a happy face can facilitate identification of that stimulus (e.g. Leppänen & Hietanen, 2003; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). The more efficient or accurate processing of mood congruent expressions has been observed in task requiring categorization of emotional stimuli (Leppänen & Hietanen, 2003) as well as detection of the onset of an emotional expression (Niedenthal et al., 2000) or the identification of an emotional stimulus from visual noise (Jolij & Meurs, 2011). It is clear that, at least under some circumstances, the ASE observed with schematic face stimuli is driven by non-emotion related perceptual differences between the happy and angry faces (S.I. Becker et al., 2011; Coelho, Cloete, & Wallis, 2010; Horstmann, et al., 2010). Because Experiments 1-4 (except at set size 1 in Experiments 2, 3 and 4) required conjunction rather than single feature processing, it may have been the case that perceptual differences no longer facilitated
the detection of angry features and the conjunction of features necessary for recognizing the emotional expression represented was processed. This may have allowed the positivity bias to be observed in the form of a HSE.

Experiment 6 aimed to test this emotional expectancy mechanism. Mood facilitates the processing of congruent emotional stimuli (Leppänen & Hietanen, 2003). If participants are faster to complete the happy search task because happy faces are congruent with their mood and are thus easier to process, it would be expected that mood would moderate the HSE observed when search for emotional faces in heterogeneous backgrounds. Target expression congruent with mood should be detected faster. This would manifest in an attenuated HSE for participants in a negative mood. Participants completed two search tasks (as in Experiment 1) but before each task they watched an emotional film clip to induce either a happy or a sad mood. It was predicted that inducing a negative mood would reduce the search advantage for happy expressions relative to inducing a positive mood.

**Experiment 6**

**Methods**

**Participants.** Sixty-two first year psychology students took part in Experiment 6 in return for course credit (11 males, $M = 19.68$, $SD = 8.19$). Data from two additional participants, one in the happy condition and one in the sad condition, could not be included in the analysis as they did not provide complete datasets.

**Stimuli.** The stimuli used were identical to those used in Experiment 1 with the addition of four emotional film clips. Mood was manipulated between subjects. Each participant was shown either two clips selected to induce a positive mood (Happiness) or two clips selected to induce a negative mood (Sadness). Sadness was selected as the negative mood as it endures for longer than other negative emotions like anger and fear (Verduyn, Delvaux, Coilli, Tuerlinckx, Van Mechelen, 2009). The first happy clip was from the movie ‘Finding Nemo’. The clip selected was 104 seconds in duration and depicted the character Dory speaking ‘whale’ (Kalokerinos, Greenaway, & Denson, 2015). The second happy clip was from the film ‘Despicable Me’. The clip lasted for 97 seconds and depicted a scene where Dr. Nefario shows main character, Gru, his latest inventions including ‘boogie robots’. The first sad film was from ‘The Lion King’. The scene selected depicted character, Simba, finding his father, Mufasa, dead (Kalokerinos et al., 2015). This clip lasted 122 seconds. The second sad clip selected was from the cartoon film ‘Up’. The clip (129 seconds in length), from the beginning of the film, depicts the main character Carl Fredricksen meeting, growing old with, and finally losing his wife. These clips were selected as they were all of a similar nature (cartoon films), and were of a similar age and familiarity to the majority of first year students.
Procedure. Experiment 6 took place in the same lab as Experiments 1-5. Before the commencement of the task, participants provided baseline ratings of their current mood. Participants were asked to indicate the extent to which they were experiencing a range of emotions on a scale from 1-9 where 1 was ‘not at all’, 5 was ‘somewhat’, and 9 was ‘a great deal’. Participants rated the extent to which they were experiencing 18 emotions. The emotions selected were used by Gross and Levenson (1995) for the rating of their emotion eliciting videos and included: Amusement, Anger, Anxiety, Confusion, Contempt, Disgust, Embarrassment, Fear, Guilt, Happiness, Interest, Joy, Love, Pride, Sadness, Shame, Surprise, and Unhappiness. Responses to the emotions of Happiness, Sadness, Unhappiness, and Joy were of most interest given the moods we attempted to induce. Participants were then presented with their first film clip - either Finding Nemo or Despicable Me for participants in the happy mood condition or Up or The Lion King for participants in the Sad conditions. The order of presentation of the films was counterbalanced across participants. After viewing the first clip, participants rated their emotional experience using the same 18 emotions. They were asked to rate how they were feeling during the film clip in order to gauge the peak intensity of their emotional experience. Participants then completed either the happy target search task or the angry target search task which was identical to the tasks used in Experiment 1. The order of these tasks was counterbalanced across participants. Next, the second happy or sad film clip was shown followed by another rating of the participant’s emotional experience during the clip and the second search task. Lastly, participants provided a final rating of their current emotional state.

Data preparation and analysis. Response time data were processed in the same manner as Experiments 1-5. To determine whether mood changed from before the mood manipulation, to during the mood manipulation, to after visual search tasks, as well as to determine whether self-reported mood was related to search performance, an index of negative affect was created by combining self-report ratings of Happiness and Joy (reverse scored), as well as Sadness and Unhappiness. We chose to create a single affect score from both positive and negative items as positive and negative items were highly correlated, $r(62) = .66, p < .001$, and loaded on to a single factor in an Exploratory Factor Analysis suggesting that positive mood and negative mood items were unlikely to be tapping into independent constructs. A negative affect score was created for each time-point (pre-mood manipulation, during the clips, and after the task) to determine whether mood changed through the course of the experiment. Additionally, each participant’s self-reported negative affect during the film clips was correlated with the magnitude of their HSE. A reliability analysis was conducted for this negative affect score as this measure was used to investigate the correlation between mood and the magnitude of the HSE. This reliability analysis indicated good internal consistency (Cronbach’s alpha = .89).
Results

Emotion ratings. Inspection of Figure 7a suggests that at baseline, there were no differences between the two conditions on the negative affect measure, \( t(60) = 0.02, p = .981 \). During the film clips, participants in the negative mood condition reported significantly higher negative affect than participants in the happy condition, \( t(60) = 14.79, p < .001 \), suggesting that the mood manipulation had the desired effect. After the experiment, participants in each condition, no longer differed in their ratings of negative affect, \( t(60) = 0.82, p = .415 \).

Response times. Response times were submitted to a 2 (Mood: happy, sad) × 2 (Target: happy, angry) × 2 (Trial type: target, non-target) × 4 (Set size: 1, 2, 4, 6) mixed ANOVA with mood manipulated between subjects, and target emotion, trial type, and set size manipulated within subjects. As can be seen in Figure 7b, participants were faster to respond in the happy task than in the angry task, \( F(1, 60) = 15.76, p < .001, \eta_p^2 = .21 \). There was also a main effect of trial type, \( F(1, 60) = 412.43, p < .001, \eta_p^2 = .87 \), where participants were faster to respond on target than on non-target trials. Additionally, response times varied with the number of stimuli on the screen, \( F(3, 180) = 1151.07, p < .001, \eta_p^2 = .95 \). Response times increased significantly at each set size, \( ts > 4.08, ps < .001 \). There was also a significant Target by Set size interaction, \( F(3, 180) = 184.17, p < .001, \eta_p^2 = .75 \). Response times on target trials were faster than on non-target trials at all set sizes, \( ts > 3.50, ps < .001 \). However, the magnitude of this difference was not significantly different at set sizes 1 and 2, \( t(180) = 0.27, \) but increased from set size 2 to 4 and 4 to 6, \( ts > 7.35, ps < .001 \). All other interactions were not significant \( Fs < 2.81, ps > .065 \).

Although the predicted Mood × Emotion interaction did not reach significance, \( F(1, 60) = 2.68, p = .107, \eta_p^2 = .04 \), as this was a key prediction, we followed up this effect to determine whether there was a trend for the HSE to be attenuated in the negative mood condition. Planned contrasts revealed that the HSE was significant in the sad mood condition, \( t(60) = 3.96, p < .001 \); however, the HSE was not significant in the happy mood condition, \( t(60) = 1.65, p = .104 \). This pattern is the reverse of what was predicted if a positive expectancy bias were to explain the HSE. Positive mood should increase the magnitude of the HSE and negative mood should decrease the HSE rather than vice versa. To further examine the relationship between negative mood and the HSE, we calculated a HSE score for each participant by taking the average response time difference between responding in the happy task and the angry task. We then calculated a correlation between participants’ HSE scores and the extent of self-reported negative affect during the film clips. This relationship was positive and significant, \( r(60) = .26, p = .043 \). As negative mood ratings during the film clips increased, so did the magnitude of the participant’s HSE (see Figure 7c). Looking at just positive items and negative items suggests that this pattern was not driven just by reduced positive mood or higher negative mood as separately, both positive mood items and negative mood items
were marginally correlated with the size of the HSE (\(r(62) = .217, p = .090\), and \(r(62) = .248, p = .052\), respectively).

**Error rates.** Consistent with response times, errors were lower in the happy search task than the angry search task (see Table 1), \(F(1, 60) = 13.37, p = .001, \eta_p^2 = .18\). Also consistent with response times, error rates varied with set size, \(F(3, 180) = 60.26, p < .001, \eta_p^2 = .50\). Error rates did not increase from set size 1 to 2, \(t(180) = 1.35, p = .10\), but did increase from set size 2 to 4 and 4 to 6, \(ts > 2.10, p < .037\). Unlike in response times, participants made more errors on target than on nontarget trials, \(F(1, 60) = 88.22, p < .001, \eta_p^2 = .60\). There was also a significant Trial type by Set size interaction, \(F(3, 180) = 40.39, p < .001, \eta_p^2 = .40\), where error rates were higher on nontarget than target trials at set size 1, \(t(180) = 2.44, p = .016\), but higher on target than nontarget trials at set sizes 4, and 6 \(ts > 5.60, ps < .001\). There was also a significant target emotion by Set size by Mood interaction, \(F(3, 180) = 3.39, p = .026, \eta_p^2 = .05\). In the happy mood condition, participants made significantly fewer errors in the happy task than the angry task, \(ts(180) < 2.09, ps < .038\), except at set size 6, \(t(180) = 0.23, p = .819\). For participants in the sad mood condition there was no difference in the number of errors made on happy and angry trials, \(ts(180) < 1.85, p > .066\), except at set size 2 where participants made fewer errors on happy trials, \(t(180) = 2.86, p = .005\). No other effects were significant, \(Fs < 2.45, p > .123\).

**Discussion**

The aim of Experiment 6 was to investigate the potential role of mood in the HSE observed in Experiments 1-4. In line with the previous literature in emotion categorization and identification, it was predicted that mood congruent stimuli would be processed with priority, resulting in an attenuation of the HSE for participants in a negative mood. Contrary to prediction, the HSE was larger for participants in the sad mood condition and there was a significant positive relationship between participants’ self-reported negative affect during the film clips and the magnitude of their HSE.

These results suggest that, visual search is unlike emotion categorization, where moods facilitate the categorization of congruent expressions and inhibit the categorization of incongruent expression. Negative mood did not facilitate the detection of the angry targets and inhibit the detection of the happy targets. Comparing the results of Experiment 1 to the current experiment suggests that the magnitude of the HSE in the sad condition was more similar to that seen in participants who had not undergone a mood manipulation. Further, it appears that the attenuated HSE in the happy condition is due to participants being faster to respond in the angry task. This suggests that positive mood may be improving the discrimination of angry faces from the
Figure 7. Figure 7a displays self-reported Negative Affect Scores before, during and after the mood manipulation as a function of mood condition. Figure 7b displays response times searching for the presence or absence of happy or angry targets as a function of set size displayed for positive and negative mood conditions separately. Figure 7c displays the positive relationship between the size of each participant’s HSE in the response time tasks and their self-report of negative affect in Experiment 6.
backgrounds. It is interesting to consider why this may be the case. The fact that the performance of participants in the negative mood condition produced the same pattern of results as seen in the original studies which involved no mood manipulation not only rules out a mood-congruent account, but also rules out a mood-repair account. Mood-repair refers to an attempt to up-regulate negative mood, which may be done by preferentially attending to positive information (Josephson, Singer, & Salovey, 1996). This could explain why happy expressions were detected faster than angry expressions; however, it cannot explain why a HSE of a similar magnitude was observed in experiments when negative mood was not induced. This account would only be plausible if participants in the earlier studies were all in a negative mood and were detecting the happy faces faster as an attempt to up-regulate positive mood. This seems unlikely given that previous lab based research suggests that people tend to have a slight bias towards feeling happy and positive most of the time (Diener & Diener, 1996).

A broader review of the literature investigating the influence of mood on attentional processes suggests that positive mood increases global processing (Gasper & Clore, 2002). Positive mood facilitates the processing of wholes rather than parts. This is relevant to the domain of face processing as extracting identity from facial cues involves the processing of conjunctions of features and the relations between these features (see Maurer, Le Grand, Mondloch, 2002 for a review). In line with this, happy mood has been found to facilitate holistic processing in the context of faces (Curby, Johnson, & Tyson, 2012). Search for emotional schematic targets in heterogeneous backgrounds, similarly requires the processing of conjunctions of features. It may be the case that happy mood allowed participants to perform the integration of eyebrow and mouth conjunctions necessary to complete the task more quickly. This is consistent with the results which suggest that positive mood improved performance in the difficult angry search task. Further research would be required to determine whether this is indeed the underlying mechanism for the effect of positive mood decreasing the magnitude of the HSE. Regardless, these results eliminate the evaluative context account as a likely plausible explanation for the HSE observed in Experiments 1-4. The underlying cause of the HSE observed for schematic faces in heterogeneous backgrounds in Experiments 1-4 and Experiment 6 requires further consideration.

**General Discussion**

The aim of the current investigation was to determine whether adhering to the recommendations of Becker et al. (2011) with schematic stimuli would results in a HSE as has already been demonstrated with photographic stimuli depicting real faces. Experiment 1-5 suggested this to be the case and isolated background heterogeneity as the key determinant of the effect. The potential of a positivity bias explaining these results was eliminated (Experiment 6). As such, the cause of the HSE in the current investigation requires further consideration. It may be the
case that other non-mood related emotional processes drive the effect. Alternatively, these results may be accounted for under a visual perception account.

**Alternative Emotion Account**

Unlike in emotion categorization and identification, in the current visual search paradigm, mood congruent emotional stimuli were not detected faster in crowds. If anything, positive mood facilitated performance in the detection of angry targets. This suggests that the happy expressions are not detected faster in the current experiment because participants in Experiment 1 (no mood manipulation) were in a generally positive mood and expecting positive expressions, facilitating their faster detection.

Other emotion based explanations of happy face advantages in search and categorization have been proposed, which may potentially explain the results. Some models of emotion perception suggest that expressions are initially categorized into superordinate valence categories and then into sub categories (Adolphs, 2002). It is possible that angry expressions were more slowly distinguished from background sad and scheming faces as they were all negative in valence whereas happy targets were the only positive expression displayed and thus more quickly distinguished from the more negatively valenced backgrounds. Another alternative, though hard to test explanation, is that happy faces have evolved to be detected with ease. Becker et al. (2011) propose that there may have been evolutionary pressure on both the expresser to produce clear display of affiliative intent, taking advantage of low level feature detectors in the visual system, as well as the perceiver to discriminate these signals accurately.

**Visual Perception Account**

An alternative explanation implicates the unavoidable emotion related perceptual differences between happy and angry targets. It is possible that the gestalt of the happy face was more easily discriminable from heterogeneous sad and scheming backgrounds than the angry gestalt. This could be due to the convergence of happy eye brow and mouth lines being easier to identify than the divergent lines of an angry face (cf. S.I. Becker et al., 2011; Horstmann, Scharlau, & Ansorge, 2006). Participants may have fixated on the angry target just as quickly as the happy target, but failed to identify it as a target as the gestalt was harder to discriminate among sad/scheming distractors which also feature divergent lines. Accuracy data from Experiments 1 - 3 support the idea that angry faces were more difficult to discriminate from the background faces. Failure to identify the target quickly would necessitate time consuming re-fixation on the target or prolong decision times, explaining the observed HSE in the intercept. Future research using eye tracking technology may allow us to determine the point at which the time increment for detecting angry faces in heterogeneous backgrounds arises.
If it is the case that search differences are sensitive to methodological changes and can be attributed to unavoidable emotion related visual confounds, it seems like these problems could be avoided and more ecological validity gained by using photographs of real faces. Unfortunately, recent research using photographic emotional faces demonstrates that these studies are also susceptible to the influence of unavoidable emotion related visual confounds. A recent study by Savage et al. (2013), demonstrated that the choice of face database can lead to either a HSE or an ASE. Even within the same database, the choice of stimuli matters. Angry faces were found faster than happy faces, but faces labeled exuberantly happy in the same database were detected faster still. These differences could not be explained by independent ratings of valence, arousal or expressive intensity. Further, Savage, Becker, and Lipp, 2015 recently demonstrated that the difference between two studies that yielded an ASE or a HSE using similar methods and faces from the same database could be explained by the inclusion of just three different expressive models even though a further five expressive models were identical across the two experiments. Given the fact that emotional faces must be visually non-identical in order to represent different emotions, the problem of emotion related confounds is unavoidable and problematic in the visual search paradigm. This highlights the importance of using convergent evidence across different stimuli and methods when drawing conclusions about the nature of emotion processing.

**Stimulus Ambiguity Account**

It has been suggested that the finding of an ASE in homogeneous backgrounds could be because the participants did not necessarily perceive the happy schematic faces as happy and perhaps also saw the ‘scheming’ faces as a variety of happy (deviously happy). This could account for slower search for happy faces in homogenous scheming backgrounds as the participants were confusing the happy and scheming faces which slowed target detection, but is unlikely to account for the faster detection of happy expressions in heterogeneous backgrounds. In heterogeneous backgrounds the presence of some scheming backgrounds on most trials should similarly slow search for happy targets to some extent rather than facilitating a HSE. There are further reasons why the stimulus ambiguity explanation is unlikely to provide a full account for the results observed. Firstly, participants were introduced to the stimuli at the beginning of the task and told which stimulus was the happy target. Secondly, in an unrelated experiment conducted to rate all of the stimuli used in Dickins and Lipp (2014), the faces used in Experiment 3 were rated for pleasantness and arousal. In this ratings study, participants also labeled the expression perceived on the faces (from the choices happiness, anger, sadness, surprise, nastiness, neutrality, or disgust). The majority of participants labeled the happy schematic faces as happy (17 of 26 responders) and all but two labeled the scheming face as nasty. In addition, the scheming face was rated as significantly less pleasant, $t(25) = 4.82, p < .001$ and significantly more arousing, $t(25) = 2.16, p = .041$, than the
happy face. Finally, the possibility that detection of happy faces was slowed in the presence of scheming faces due to stimulus confusability was tested by comparing search through sad and scheming backgrounds for happy and angry faces separately in Experiment 5 (fixed target search through homogeneous backgrounds). If stimulus confusion between happy and scheming targets caused slowed detection of happy targets, search for angry faces should not be affected by whether the background consisted of sad or scheming faces, but happy faces should be detected slower in scheming than in sad backgrounds. Analyzing the pattern of results for happy and angry faces separately indicated that participants were overall faster to find happy targets in sad than scheming backgrounds, $F(1, 34) = 27.79, p < .001, \eta_p^2 = .45$. This advantage also increased with increasing set size, $F(1, 34) = 8.83, p < .001, \eta_p^2 = .21$. The advantage for detecting happy faces in scheming backgrounds was significant at all set sizes, $t > 2.32, p < .026$, but increased as set sizes increased (e.g. the search advantage for happy faces in scheming backgrounds was significantly larger at set size 6 than set size 1, $t(35) = 5.05, p < .001$). Initially, this would appear consistent with a stimulus ambiguity account for slower detection of happy expressions in homogenous scheming backgrounds; however, analysis of the influence of sad and scheming backgrounds on search for angry targets also revealed significantly faster search for angry targets in scheming backgrounds, $F(1, 34) = 8.97, p = .005, \eta_p^2 = .20$, making this explanation less plausible.

**Conclusion**

It is possible that detection times in visual search for emotional faces may be influenced by both perceptual and emotional processes depending on task demands. If a task can be completed most efficiently by utilizing low level perceptual features then detection times primarily will reflect the influence of perception. When the efficiency of a more basic system is diminished by changing task demands, such as by introducing heterogeneous backgrounds and requiring the processing of a conjunction of features rather than the detection of one feature, the influence of emotion on detection times may be observed with a consequent reversal of the pattern of results – HSE vs. ASE. These results highlight the importance of apparently innocuous methodological choices for experimental designs in the study of emotion as well as the importance of using convergent evidence across different stimulus sets and methods when drawing conclusions about emotional expression processing.
References


Table 1
*Error data for Experiments 1-6 as a function of target emotion, set size, and trial type.*

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|       |       | (6.83) | (5.28) | (4.16) | (3.61) | (5.28) | (5.05) | (4.87) | (1.95) |

### Experiment 5b

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|       |       | (8.11) | (7.33) | (6.79) | (9.89) | (6.42) | (8.05) | (7.63) | (7.20) |

### Experiment 5c

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|       |       | (10.38) | (6.71) | (8.21) | (9.46) | (9.37) | (10.01) | (8.14) | (8.86) |

### Experiment 6

#### Positive Mood

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</table>

|       |       | (1.25) | (1.52) | (1.75) | (2.34) | (1.62) | (1.75) | (1.55) | (1.79) |

#### Negative Mood

<table>
<thead>
<tr>
<th></th>
<th>Happy</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(0.61)</td>
<td>(1.33)</td>
<td>(1.75)</td>
<td>(2.34)</td>
<td>(1.36)</td>
<td>(0.93)</td>
</tr>
<tr>
<td>Happy</td>
<td>1.97</td>
<td>5.91</td>
<td>13.26</td>
<td>17.38</td>
<td>5.02</td>
<td>3.94</td>
<td>4.12</td>
</tr>
<tr>
<td>Angry</td>
<td>3.05</td>
<td>10.04</td>
<td>12.72</td>
<td>18.10</td>
<td>8.24</td>
<td>6.45</td>
<td>5.02</td>
</tr>
</tbody>
</table>

|       |       | (1.25) | (1.52) | (1.75) | (2.34) | (1.62) | (1.75) | (1.55) | (1.79) |

*Note.* Values presented are the mean error percentage in each condition. Numbers in parentheses denote one standard deviation. * denotes error rates for all happy and angry trials at set size 1 for Experiment 4 (no backgrounds are present at set size 1)
Chapter 4.1
The Effect of Poser Race on the Happy Categorization Advantage Depends on Stimulus Type, Set Size, and Presentation Duration
Abstract

The question as to whether poser race affects the happy categorization advantage, the faster categorization of happy than of negative emotional expressions, has been answered inconsistently. Hugenberg (2005) found the happy categorization advantage only for own race faces whereas faster categorization of angry expressions was evident for other race faces. Kubota and Ito (2007) found a happy categorization advantage for both own race and other race faces. These results have vastly different implications for understanding the influence of race cues on the processing of emotional expressions. The current study replicates the results of both prior studies and indicates that face type (computer generated vs. photographic), presentation duration, and especially stimulus set size influences the happy categorization advantage as well as the moderating effect of poser race.
Facial expressions of emotion play a vital role in human interactions. Our emotional expressions convey our intentions and internal states in a “universal language” (Ekman et al., 1987). The ability to quickly and accurately recognize the emotional expressions of others not only facilitates social interactions (Hobson, Ouston, & Lee, 1988), but also plays a role in facilitating our survival. Thus, the processing of emotional faces has fascinated researchers for a number of decades (see Adolphs, 2002 for a review). A robust finding arising from studies investigating speeded emotion recognition is that happy facial expressions are categorized faster than other emotional expressions including neutral (Hugdahl, Iversen, & Jonhson, 1993), sad (Kirita & Endo, 1995), disgusted (Leppänen & Hietanen, 2003) and angry expressions (Billings, Harrison, & Alden, 1993). This effect is referred to as the happy categorization advantage.

An interesting twist on the happy categorization advantage was reported in a study by Hugenberg (2005) who demonstrated that the perception of emotion depends crucially on the race of the poser. In this study, the race of the face was found to moderate the typical happy categorization advantage. Using a speeded emotion categorization paradigm, Caucasian participants were presented with computer generated African and Caucasian faces expressing happiness and anger/sadness. The happy categorization advantage was only evident with own race (Caucasian) faces. For other race (African) faces, Caucasian participants were significantly faster to categorize angry/sad than happy expressions. A moderating influence of race on the speed of emotion categorization has also been reported by Bijlstra, Holland, and Wigboldus (Experiment 1; 2010). Similarly, other facial cues of group membership, such as gender, have been found to moderate the happy categorization advantage (Biljstra et al., 2010; Experiment 2; Hugenberg & Sczesney, 2006). It has been proposed that cues of race and gender induced an evaluative context that facilitated the categorization of evaluatively congruent expressions (Leppänen & Hietanen, 2003). According to this evaluative context hypothesis, negative evaluations elicited by cues such as other race membership should facilitate categorization of evaluatively congruent angry expressions, whereas positive evaluations elicited by cues such as own race membership should facilitate categorization of evaluatively congruent happy expressions.

In contrast to these findings, using event-related potentials (ERPs) to investigate the time course of face processing, Kubota and Ito (2007) found evidence to suggest that race cues do not necessarily influence the perception of emotional expressions. In a speeded emotion categorization task, Caucasian participants were presented with own (Caucasian) and other race (African) faces displaying happy, neutral and angry expressions. Electro-cortical activity as well as response times were recorded. Categorization times revealed the typical happy categorization advantage: Caucasian participants were faster to categorize happy expressions compared with angry and neutral expressions regardless of the race of the face. Results also indicated that overall, participants were
slower to decode emotional expressions in other race faces; however, there was no evidence to suggest that processing emotion on other race faces was influenced by the evaluative context elicited by the face.

The findings of Kubota and Ito (2007) stand in contrast to those of Hugenberg (2005) and lead to different conclusions about the influence of race when processing emotional expressions. On one hand, poser race was found to influence the perception of emotion, on the other, race did not appear to play a role. Understanding the source of this discrepancy is important because at this point, two competing theories exist regarding how cues of race influence emotion recognition. Moreover, the results of these two studies have been discussed in terms of their implications for theories of person perception as well as face processing without any attempt to reconcile these existing differences in the literature. Clearly it is important to determine whether or not the two sets of results are replicable and to delineate the sources of the different results. Determining the replicability of these effects and reconciling the differences between the two studies will allow for more informed development of theory relating to face processing and person perception.

Closer examination of the methods employed in the Hugenberg (2005) and Kubota and Ito (2007) studies indicates three main points of difference: stimulus presentation duration, stimulus type (photographic vs. computer generated), and set size. Past research has demonstrated that these methodological parameters can lead to differences in the attentional and perceptual demands required for accurate task performance. A closer examination of the effects of manipulating these parameters within the framework of theories of perception and attention can lead to specific predictions about the importance of each factor when investigating the influence of race on emotion categorization. The specific manner in which each factor may affect task performance is discussed in greater depth below.

Firstly, the presentation duration of the face stimuli differed between studies. Hugenberg (2005) presented stimuli for only 200 ms so inspection time was limited. Kubota and Ito (2007) presented stimuli for 750 ms for the purposes of measuring ERPs; however, the mean categorization times were faster than this meaning that participants had more time than required to extract task relevant information. Shortening stimulus presentation durations has the effect of limiting sensory input. Past research has found that limiting sensory input by shortening presentation duration can strengthen the influence of task irrelevant information on focal task performance (Lavie & de Fockert, 2003). Thus, in the context of emotion categorization, shorter presentation durations may result in stronger distractor interference effects as indicated by a stronger moderating influence of poser race on emotion categorization. Differing presentation duration is, however, an unlikely explanation for the disparity between the results of Hugenberg (2005) and Kubota and Ito (2007) as
increasing presentation duration and thus sensory input weakens but does not change the nature of
distractor effects (Lavie & de Fockert, 2003).

Secondly, Hugenberg (2005) used computer generated faces to control for low level
perceptual features whereas photographic faces were used by Kubota and Ito (2007). The use of
computer generated faces allows the experimenter to control for differences in facial physiognomy
that arise from the idiosyncratic way in which different individuals express emotions. It has been
argued that computer generated faces maintain ecological validity but allow for tighter control over
the stimuli. Hugenberg (2005) predicted that results based on the use of realistic computer
generated faces would be analogous to results that would emerge if photographic faces were used.
However, computer generated face identities tend to be more uniform compared to photographic
faces, and a set of computer generated faces lacks the variability that would be observed in a
selection of photographic face, especially in the way specific emotions are expressed. Thus far the
similarities and differences in the processing of computer generated versus photographic faces have
not been systematically investigated. Therefore, it is not possible to make specific predictions about
whether or not computer generated faces are functionally equivalent to photographic faces when
investigating the influence of poser race on emotion categorization.

Finally, the number of individual posers used differed between experiments. Kubota and Ito
(2007) used 10 Caucasian and 10 African posers expressing each emotion whereas Hugenberg
(2005) used four computer generated posers of each race. The use of small stimulus sets increases
the chance that effects are driven by stimulus specific characteristics rather than reflecting category
level effects (Purcell, Livingstone, & Skov, 1996; Livingstone & Brewer, 2002). Additionally, the
set size dictates the number of times a stimulus will be repeated as well as the heterogeneity of the
stimulus set. These factors have been found to influence perceptual processing demands required to
complete a task. Repeated presentations of the same stimuli have been found to increase the speed
and accuracy of stimulus categorization suggesting lower perceptual processing demands on
subsequent presentations (Ellis, Young, & Flude, 1990; Ellis, Young, Flude, & Hay, 1987;
Schweinberger, Pfütze, & Sommer, 1995). Similarly, stimulus set heterogeneity has been associated
with greater demands on perceptual processing resources in emotion search tasks (Öhman, Juth, &
Ludqvist, 2010).

The extent to which a focal task demands perceptual processing resources has been found to
have consequences for the fate of task irrelevant information. More specifically, when a task
requires fewer perceptual processing resources than are available, the focus of attention can ‘spill’
onto task irrelevant information which can then influence performance on the focal task. When
demands on perceptual processing resources are high, attention is narrowed and is focused only on
task relevant information. Task performance is less likely to be influenced by task irrelevant
information when perceptual load demands are high. This phenomenon has been described within the Perceptual Load Theory (Lavie, 1995, 2004; Murray, Machado, & Knight, 2010). Previous research has found that task irrelevant cues of race can influence task performance when perceptual processing demands are low, but do not when perceptual processing demands are high (Murray et al., 2010).

The overall aim of this study is to assess the influence of poser race on the categorization of emotion and to account for discrepancies in previous studies (Hugenberg, 2005; Kubota & Ito, 2007). We predict that the modulation of emotion categorization by race cues is affected by perceptual load demands and will emerge under conditions of low (small homogenous stimulus sets), but not high perceptual load (large heterogeneous stimulus sets) in accord with Perceptual Load Theory (Lavie, 1995, 2004; Murray et al., 2010). To this end, a systematic examination of key experimental parameters across three experiments was conducted to determine the impact of (i) stimulus presentation duration (limited [200 ms] vs. unlimited), (ii) stimulus type (photographic vs. computer generated faces), and (iii) stimulus set size (small vs. large) on the effect of poser race on the speed with which happy and angry facial expressions are categorized.

**Experiment 1**

Experiment 1a was a direct replication of Hugenberg (2005). It was hypothesized that happy Caucasian faces would be categorized faster than angry Caucasian faces but that for African faces, angry expressions would be categorized faster than happy expressions. Experiment 1b aimed to investigate the influence of presentation duration by replacing the short presentation duration used by Hugenberg (2005) with an unlimited presentation duration. In Experiment 1c, a small homogeneous set of photographic faces rather than computer generated faces was used. Finally, Experiment 1d investigated the influence of stimulus set heterogeneity by utilizing a large and variable stimulus set instead of a small homogenous set. In line with the findings of Kubota and Ito (2007) it was expected that happy faces would be categorized faster regardless of poser race in Experiment 1d.

**Method**

**Participants.** Participants were 26 Caucasian first year psychology students at the University of Queensland (6 males, Age $M = 17.84$, $SD = .83$), all of whom received course credit for participation. An additional three participants were excluded as they did not identify as Caucasian.

**Experiment 1a.**

**Stimuli.** Computer generated faces were produced using FaceGen Modeller 3.5. Firstly, four different male facial structure templates were generated. Using the morph function, angry and happy versions of each poser were created. Using the color function only the skin tone of the face
was changed to produce an “African” and a “Caucasian” version of each of the four facial structures. This process resulted in 16 stimuli: 4 posers × 2 skin tones × 2 expressions. These faces were grayscaled and dropped onto a gray background 520 × 390 pixels in size (see Figure 1 for examples).

![Figure 1](image.png)

*Figure 1.* Example computer generated stimuli displaying the same structural template expressing happiness and anger with skin tone dark and light.

**Measures.** Participants were asked to categorize the emotion of the target face as happy or angry as quickly and accurately as possible. On each trial, participants were presented with a fixation cross for 1000 ms. Subsequently, a stimulus appeared on a black background and was then replaced after 200 ms by a plain gray box matched in size (520 × 390 pixels) and color (gray) to the background of the stimuli. If no response was made, the next trial commenced after 3000 ms. Stimuli were presented in a randomized order. The 16 stimuli were presented five times each resulting in 80 trials.

**Experiment 1b.**

**Stimuli and Measures.** The computer generated faces used in Experiment 1a were utilized in Experiment 1b. Experiment 1b was identical to Experiment 1a except that the stimuli were
presented until a response was made rather than for only 200 ms. As in Experiment 1a, if no response was made, the next trial commenced 3000 ms after the stimulus was presented.

Experiment 1c.

Stimuli and Measures. To match the uniformity of the computer generated faces\(^2\), but use photographs of real faces, one stereotypical African male poser and one stereotypical Caucasian male poser were selected from the NimStim database (posers 23 and 40; Tottenham et al., 2009). The open mouthed happy and open mouthed angry expressions for each poser were selected resulting in four stimuli. Images were prepared using the photo editing program Photoshop. Grayscale faces were dropped onto a gray background, 520 \(\times\) 390 pixels in size. Presentation parameters were the same as in Experiment 1b and each of the 4 face stimuli was presented 20 times in a randomized order resulting in 80 trials.

Experiment 1d.

Stimuli and Measures. To match the large stimulus set used by Kubota and Ito (2007), 40 images of male faces were used (10 happy Caucasian, 10 happy African, 10 angry Caucasian and 10 angry African faces) and each individual appeared only once in the set. Faces were sourced from the Productive Aging Database (Minear & Park, 2002), the NimStim Set of Facial Expressions (Tottenham et al., 2009), the Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2005), and the Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Öhman, 1998. All faces selected as other race faces were labeled as African or African American in their respective databases. Accessing a wide range of databases was required to source a sufficient number of different other race posers expressing anger and happiness. Images were edited so that only the head was shown. The necks, clothing, and backgrounds of the photos were removed to maintain consistency across photos from different databases. Images were resized so that the faces occupied the same area in the image. The method remained consistent with Experiments 1b and 1c except that the stimuli were replaced. The 40 stimuli were presented two times each in a randomized sequence resulting in 80 trials.

Procedure. Each participant completed all four emotion categorization tasks in a small computer lab in groups of no more than 8. Each participant was seated in front of a 1024x768 pixel CRT monitor with an 85 Hz refresh rate attached to a computer running DMDX (Forster & Forster, 2003). Participants were separated by partitions to minimize distraction. On each trial, across all tasks, the time from the onset of the stimulus until the response was made was recorded. In all tasks, participants responded by pressing the left and right shift keys on a standard keyboard using the index finger of each hand. Response mapping was counterbalanced across participants but the

\(^2\) In a set of computer generated faces, although each differs in structure, the faces appear very similar to each other and the expression of emotion is identical.
button labels remained constant for each participant throughout the four tasks. The order of the
tasks was counterbalanced apart from the constraint that Experiment 1a and 1b and Experiment 1c
and 1d were paired together.

Results

Before analyses were conducted, responses faster than 100 ms or three standard deviations
faster or slower than each participant’s mean were identified as within-subjects outliers and
recorded as missing. Across the tasks, the error rate was quite low (< 6% across all tasks). Of all
responses, 9% (Experiment 1a), 6% (Experiment 1b), 7% (Experiment 1c), 7% (Experiment 1d)
were excluded from analysis due to error or slow response times. For all Experiments (1-3),
categorization times were log transformed to minimize the influence of the naturally occurring
skewness of response time data. Analyses were conducted using these transformed response times.
For ease of interpretation, raw categorization times are reported and displayed in figures. There was
no significant influence of task order on results and outcomes did not differ as a function of
participant gender. As such, results are reported collapsed across these factors. Data were analysed
using a 2 (Poser Race: African, Caucasian) × 2 (Poser emotion: angry, happy) repeated measures
ANOVA.

Experiment 1a. In replication of Hugenberg (2005), categorization times displayed in
Figure 2a indicate that the happy categorization advantage emerged for Caucasian faces. For
African faces, the opposite pattern of results was evident. African angry faces were categorized
faster than African happy faces. The results of the repeated measures ANOVA confirm this,
yielding a Race × Emotion interaction, $F(1, 25) = 18.11, p < .001, \eta^2_p = .42$. Participants were
significantly faster to categorize Caucasian happy ($M = 560 \text{ ms}, SD = 84.07 \text{ ms}$) than Caucasian
angry faces ($M = 584 \text{ ms}, SD = 81.48 \text{ ms}$), $t(25) = 3.55, p = .002$, and were significantly faster to
categorize African angry ($M = 555 \text{ ms}, SD = 71.71 \text{ ms}$) than African happy faces ($M = 574 \text{ ms}, SD
= 76.73 \text{ ms}$), $t(25) = 2.31, p = .029$.

Experiment 1b. As seen in Figure 1b, when presentation duration was not limited and
computer generated faces were used, no significant difference in categorization times emerged, all
$F(1,25) < 3.48, p > .074$.

Experiment 1c. Figure 2c displays emotion categorization times when stimulus set size was
small but photographic faces were used. The happy categorization advantage emerged for own race
faces. For other race faces there was no difference in categorization times for happy and angry
faces. Results of a repeated measures ANOVA support this. A significant main effect of emotion
emerged, $F(1, 25) = 5.59, p = .025, \eta^2_p = .17$ which was moderated by the race of the face as
indicated by a Race × Emotion interaction, $F(1, 25) = 18.83, p < .001, \eta^2_p = .40$. Caucasian happy
faces ($M = 588 \text{ ms}, SD = 98.21 \text{ ms}$) were categorized faster than Caucasian angry faces ($M = 639$
ms, $SD = 101.58$ ms), $t(25) = 4.69, p < .001$, whereas there was no difference in categorization times for African angry ($M = 609$ ms, $SD = 109.09$ ms) and African happy faces ($M = 609$ ms, $SD = 86.74$ ms), $t(25) = .94, p = .357$.

**Experiment 1d.** Consistent with the findings of Kubota and Ito (2007), results displayed in Figure 2d indicate that when the stimulus set was heterogeneous, the happy categorization advantage emerged regardless of the race of the face. Happy expressions ($M = 633$ ms, $SD = 134.38$ ms) were categorized faster than angry expressions ($M = 671$ ms, $SD = 139.82$ ms), $F(1, 25) = 17.24, p < .001, \eta^2_p = .41$. This happy categorization advantage was not moderated by the race of the face, as indicated by the non-significant Race $\times$ Emotion interaction, $F(1, 25) = .02, p = .884, \eta^2_p = .00$. Also consistent with past findings, participants were slower to decode emotional

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**Figure 2.** Figures 2a, 2b, 2c, and 2d display results from Experiments 1a, 1b, 1c and 1d respectively. Graphs represent categorization times for angry and happy faces as a function of the race of the face. Error bars represent one SEM.
expressions on other race faces ($M = 664, SD = 139.67$) than on own race faces ($M = 640 \text{ ms}, SD = 132.47 \text{ ms}$), $F(1, 25) = 8.65, p = .007, \eta_p^2 = .26$.

**Discussion**

The aims of Experiment 1 were twofold. Firstly, we aimed to replicate the results of Hugenberg (2005), finding evidence for a happy categorization advantage for own race faces, but an angry categorization advantage for other race faces. Through a direct replication of the methods utilized by Hugenberg (2005), the same pattern of results was observed. Secondly, we aimed to determine the factors which led to the different pattern of results reported by Kubota and Ito (2007). Presentation duration, (200 ms vs. unlimited), stimulus type (photographic vs. computer generated faces) and stimulus set size (small vs. large) were identified as factors that differed between the previous studies. It was predicted that stimulus set and thus the perceptual load demands of the task would determine whether or not race moderated the speed of emotion categorization.

As predicted, the key finding from this series of studies was the importance of set size or stimulus set heterogeneity on the effect of poser race on emotion categorization. When the stimulus set was large and heterogeneous, race cues did not moderate the happy advantage (e.g. Experiment 1d) whereas they did when the stimulus set was small and homogeneous (e.g. Experiment 1c).

Using a large stimulus set has a number of consequences. Firstly, large stimulus sets imply that results for a category of stimuli are reflective of responses to a number of different representatives of that category. It also means that stimuli were repeated less often resulting in higher task demands, as each stimulus face must be processed *de novo*.

Findings from studies of repetition priming and visual search reinforce the importance of considering the composition of the stimulus set. A number of studies (Ellis, et al., 1990; Ellis, et al., 1987; Schweinberger, et al., 1995) provide evidence that responses to facial stimuli change over repeated presentations (responses become quicker and more accurate) suggesting that repetition leads to decreased perceptual processing requirements. Further, in an investigation of the importance of stimulus set heterogeneity in visual search, it was suggested that repeated presentation of the same stimuli resulted in perceptual learning which led to more efficient emotion recognition of familiar faces compared with novel faces (Öhman et al., 2010). If emotion categorization judgments made on subsequent viewings of a face are less perceptually demanding, judgments made on these subsequent exposures may not necessarily reflect on the processing that occurs when that face is first encountered. As predicted by Perceptual Load Theory (Lavie, 1995, 2004), at low load (small homogenous stimulus sets) task irrelevant race information influenced focal task performance, whereas at high load (large heterogeneous stimulus sets) distractor effects of task irrelevant information no longer emerged.
Results also indicate that presentation duration may play an important role, at least for computer generated faces. This can be concluded as significant differences in categorization times as a function of both the race and the emotion of the face emerged when the presentation duration was limited to 200 ms. When participants could view the computer generated stimuli until a response was made, no significant differences in categorization times emerged. These results are somewhat consistent with past studies which have found that limiting sensory input increases distractor effects (Lavie & de Fockert, 2003). When photographic faces were used, significant differences in categorization times did emerge as a function of the race and emotional expression of the face when presentation duration was unlimited. Thus, it remains to be seen whether presentation duration is important in emotion categorization tasks that utilize photographic faces.

With unlimited presentation durations, the happy categorization advantage emerged for photographic faces, but not for computer generated faces. However, the possibility remains that presentation duration may also influence the effect of race cues on emotion categorization for photographic faces. Experiment 2 was designed to assess this.

Experiment 2

Experiment 2a, in replication of the procedure of Experiment 1c, utilized a homogeneous set of 4 faces. Experiment 2b, in replication of Experiment 1d utilized a heterogeneous set of 40 faces. In the current experiment, however, presentation duration was limited to 200 ms. This manipulation was used in order to establish the relative importance (if any) of presentation duration on the influence of race in emotion categorization tasks with photographic stimuli.

Method

Participants. Participants were 24 volunteers recruited at The University of Queensland (9 males, Age $M = 24.45$ $SD = 6.33$). All participants identified as Caucasian.

Stimuli, Measures, and Procedure. Experiment 2a and 2b were carried out in exactly the same manner as Experiments 1c and 1d except that stimuli were presented to participants for 200 ms and then replaced with a gray rectangle $520 \times 390$ pixels in size rather than the stimulus being presented until a response was made.

Results

As in Experiment 1, before analyses were conducted, responses faster than 100 ms or three standard deviations faster or slower than each participant’s mean were identified as within-subjects outliers and recorded as missing. Again, error rates were quite low (< 7% error across both tasks). Of all responses, 8% (Experiment 1a), 8% (Experiment 1b) were excluded from analysis due to errors or slow response times. The data from one participant could not be included for analysis in Experiment 2b as all trials timed out before a response was made so no response times were recorded by the program. There was no significant influence of task order on results and outcomes
did not differ as a function of participant gender. As such, results are reported collapsed across these factors. Data were analysed using a 2 (Poser Race: African, Caucasian) × 2 (Poser emotion: angry, happy) repeated measures ANOVA.

**Experiment 2a.** Figure 3a displays the emotion categorization times as a function of poser race and emotion. Consistent with the findings of Experiment 1c, the happy categorization advantage emerged for own race faces, but not for other race faces. Results indicate a marginally significant main effect of emotion, $F(1, 23) = 4.04, p = .056, \eta^2_p = .15$, moderated by the race of the face as indicated by a significant Race × Emotion interaction, $F(1, 23) = 16.07, p = .001, \eta^2_p = .41$. Caucasian happy faces ($M = 518$ ms, $SD = 47.62$ ms) were categorized significantly faster than Caucasian angry faces ($M = 558$ ms, $SD = 49.35$ ms), $t(23) = 4.35, p < .001$. There was, however, no difference in categorization times for African angry ($M = 538$ ms, $SD = 61.20$ ms) or happy faces ($M = 546$ ms, $SD = 50.54$), $t(23) = 1.12, p = .274$.

**Experiment 2b.** Displayed in Figure 3b are the categorization times for Experiment 2b. Consistent with the findings of Kubota and Ito (2007), as well as the results of Experiment 1d, happy faces ($M = 532$ ms, $SD = 66.53$ ms) were categorized faster than angry faces ($M = 552$ ms, $SD = 73.32$ ms) regardless of the race of the face; main effect of emotion, $F(1, 22) = 6.65, p = .017, \eta^2_p = .23$. This happy categorization advantage was not moderated by the race of the face as indicated by a non-significant Race × Emotion interaction, $F(1, 22) = .79, p = .384, \eta^2_p = .04$. Consistent with past results, participants were also slower to categorize emotional expressions on other race ($M = 549$ ms, $SD = 70.63$ ms) compared with own race faces ($M = 534$ ms, $SD = 66.96$ ms), $F(1, 22) = 7.78, p = .011, \eta^2_p = .26$.

![Figure 3a](image1.png) ![Figure 3b](image2.png)

**Figure 3.** Figure 3a and 3b display results from Experiments 2a and 2b respectively. Graphs represent categorization times for angry and happy faces as a function of the race of the face. Error bars represent one SEM.
Discussion

Results from Experiment 2 suggested that presentation duration does not influence emotion categorization in tasks using photographic own and other race faces. Regardless of presentation duration, Experiment 2a demonstrated that small homogenous stimulus sets or photographic faces yield a happy categorization advantage only for own race faces, whereas larger heterogeneous sets result in a happy categorization advantage for both own and other race faces. These results add further support to the notion that when perceptual demands are low, distracting task irrelevant race cues may influence performance on the central categorization task whereas when perceptual processing demands are high, the focus of attention is narrowed and the distracting effect of race is eliminated. Although presentation duration was vital for the emergence of any difference in categorization times using computer generated faces, presentation duration did not change the pattern of results when photographic faces were used.

Experiment 3

Given the results of Experiments 1 and 2, it appears that the main determinate of whether race cues will influence the happy categorization advantage is stimulus set size. However, Experiments 1 and 2 investigated the difference between homogeneous (Experiment 1c and 2a) and heterogeneous sets (Experiment 1d and 2b) using only photographic faces. Thus it remains to be seen whether, as with photographic faces, utilizing a heterogeneous set of computer generated faces will lead to a happy categorization advantage for both Caucasian and African faces or whether race cues will continue to moderate the happy advantage. Generating faces using computer software such as FaceGen 3.5 allows for different ‘identities’ to be created by varying facial structure as well as skin tone; however, manipulating the emotional expression of the face is less flexible. Generating an angry or happy expression involves changing one setting which morphs each individual in the same way by presenting the same shaped grin or grimace and by morphing the eyes and the brows in exactly the same way.

The resulting set of faces, although each facial structure and thus identity is different, cannot match the heterogeneity of a set of photographic faces in the range of idiosyncratic ways in which emotions are expressed. This allows us to investigate whether the effect of heterogeneity found in both Experiments 1 and 2 is a reflection of heterogeneity in identity alone or whether it is heterogeneity in the manner in which emotion is expressed that eliminates the influence of race on the happy advantage. If identity heterogeneity is sufficient to disrupt the influence of race on the happy categorization advantage it is predicted that, as seen in Experiment 1d, emotion and race will not interact in the current tasks and a happy advantage will be present for both Caucasian and African faces. If, however, variability in the way emotions are expressed is a necessary contributing
factor, it is predicted that results from the current study will more closely resemble those of Experiment 1a and that poser race will moderate the happy categorization advantage.

**Method**

**Participants.** Participants were 25 volunteers recruited at The University of Queensland (6 males, Age $M = 22.13$ $SD = 3.21$). Participants received either AU$10 or course credit for participation. All participants identified as Caucasian.

**Stimuli.** Forty new faces were generated using FaceGen modeller 3.5. Within the FaceGen application, gender was locked to male and age was locked to young adult to match the gender and age of the photographic set used in Experiments 1 and 2. Race was locked to ‘European’ to generate the Caucasian faces and ‘African’ to generate the African faces. To generate each identity the ‘Generate Random’ button was pressed. This function asks the program to generate a random facial structure within the bounds requested by the user. After each random face was generated, emotion was applied by using the morph function to set the face to either a happy or an angry expression. Altogether, 40 unique identities (10 Caucasian angry, 10 Caucasian happy, 10 African angry, and 10 African happy) were generated. Ratings were collected for these stimuli along with the stimuli used in Experiments 1 and 2 to determine whether differences in emotional intensity or arousal either within or across sets could explain the differences observed in categorization times. Analysis of the rating data indicates that this was not the case (see Appendix for details).

**Measures and Procedure.** Experiment 3a and 3b were carried out in exactly the same manner as Experiments 2b and 1d except that the 40 photographic stimuli were replaced with the 40 new computer generated stimuli. In Experiment 3a, each stimulus was presented for 200 ms and then replaced with a gray rectangle $520 \times 390$ pixels in size. In Experiment 3b, stimuli were presented until a response was made.

**Results**

As above, within-subject outliers were recorded as missing. Error rates remained low ($< 5\%$ error across both tasks). Of all responses, 7% (Experiment 3a), 6% (Experiment 3b) were excluded from analysis due to error or slow response times. There was no significant influence of task order on results and outcomes did not differ as a function of participant gender. As such, results are reported collapsed across these factors. Data were analysed using a 2 (Poser Race: African, Caucasian) × 2 (Poser emotion: angry, happy) repeated measures ANOVA.

**Experiment 3a.** As can be seen in Figure 4a, the happy categorization advantage emerged for Caucasian faces but not for African faces. This was confirmed by a significant Race × Emotion interaction, $F(1, 24) = 7.38, p = .010, \eta_p^2 = .25$. Caucasian happy faces ($M = 567$ ms, $SD = 79.95$ ms) were categorized faster than Caucasian angry faces ($M = 594$ ms, $SD = 103.14$ ms), $t(24) =$
2.99, \(p = .007\), whereas there was no difference in categorization times for African angry (\(M = 577\) ms, \(SD = 94.58\) ms) and African happy faces (\(M = 583\) ms, \(SD = 83.22\) ms), \(t(24) = .88, p = .388\).

**Experiment 3b.** As seen in Figure 4b, when presentation duration of the computer generated faces was not limited, no overall difference in emotion categorization times emerged, 
\[ F(1, 24) = .10, p = .756, \eta_p^2 = .01. \] The Race \(\times\) Emotion interaction was significant, \(F(1, 24) = 4.45, p = .046, \eta_p^2 = .16\), reflecting faster categorization of happy Caucasian than of happy African faces, \(t(24) = 2.98, p = .006\), whereas there was no difference for angry expressions, \(t(24) = .13, p = .896\). There were, however, no significant differences in categorization times for happy (\(M = 590\) ms, \(SD = 112.05\) ms) and angry Caucasian faces (\(M = 607\) ms, \(SD = 115.31\) ms), \(t(24) = 1.72, p = .099\), or for angry (\(M = 610\) ms, \(SD = 112.40\) ms) and happy African faces (\(M = 621\) ms, \(SD = 101.59\) ms), \(t(24) = 1.18, p = .247\). There was also a main effect of race \(F(1, 24) = 12.76, p = .002, \eta_p^2 = .35\). Participants were slower to decode emotional expressions on African (\(M = 615\) ms, \(SD = 98.70\) ms) than on Caucasian Face (\(M = 598\) ms, \(SD = 108.67\) ms).

**Discussion**

The aim of Experiment 3 was to determine whether identity heterogeneity was sufficient to eliminate the moderating effect of race on the happy categorization advantage as observed in Experiment 1d and 2b. It was predicted that if increasing identity heterogeneity were sufficient to eliminate the moderating influence of race, that no Race by Emotion interaction should be evident but rather the happy advantage should be evident for both Caucasian and African Faces. The results from Experiment 3a suggested, however, that it may be the variability in the way emotions are
expressed that plays a role in decreasing the influence of race on the happy advantage; poser race influenced emotion categorization in the current task.

Interestingly, in Experiment 3b the happy categorization advantage did not emerge for either Caucasian or African Faces. These results reflect those of Experiment 1b where computer generated faces were also presented for an unlimited duration and no significant effects emerged. This provides further evidence to suggest that presentation time is an important factor in determining the presence or absence of the happy categorization advantage in sets of computer generated faces as well as further evidence to suggest that computer generated faces and photographic faces are not functionally equivalent in the investigation of race and emotion processing.

**General Discussion**

This series of studies aimed to clarify the influence of poser race on the processing of emotional expressions, specifically on the happy categorization advantage, the observation that happy emotional expressions are categorized faster than angry emotional expressions. In so doing, we aimed to identify the factors that account for the inconsistent findings reported in prior literature. This analysis has implications for research methodology by providing insights into the relative impact of different aspects of experimental design. It also has conceptual implications for theories of face processing and person perception as these variations in experimental methodology can also be associated with differences in facial identity familiarity.

Hugenberg (2005) found that race moderated the happy categorization advantage, faster categorization was evident for own race, but not for other race faces, whereas Kubota and Ito (2007) found no moderating influence of race. Based on an analysis within the framework of perceptual load theory (Lavie, 1995, 2004; Murray et al., 2010), we predicted that differences in stimulus set size and the associated difference in task specific perceptual load demands would mostly account for the disparity between the results of Hugenberg (2005) and Kubota and Ito (2007). The present investigation replicated the results of both prior studies and showed that stimulus set size was indeed the main factor contributing to the different patterns of results. However, stimulus type (computer generated vs. photographic), and presentation duration also influenced the nature of the interaction between race cues and emotional expressions.

**Implications for Experimental Design**

Results from the current research suggest that parameters which influence the perceptual and attentional processing demands of a given task can lead to quite different results. These parameters are usually selected by the experimenter not for theoretical reasons but based on pragmatics (availability of stimulus materials) or unspecified experience (a procedure that “works” is traditioned within a laboratory or in published research). However, the current data indicate that manipulating parameters like presentation duration, stimulus type, and stimulus set size within each
task and the variations in perceptual and attention demands associated with these parameter changes can lead to quite different patterns of results. In the context of interpreting research findings, the current data highlight the importance of considering how task specific variance associated with lower level perceptual or attentional processes may affect task performance. Relevant to this is the observation that differing task demands have supported different conclusions about the importance of poser race on the processing of facial emotional expressions in past research (Hugenberg, 2005; Kubota & Ito, 2007).

The current findings demonstrate an influence of stimulus presentation duration under some circumstances. By merely altering stimulus presentation duration from 200 ms to an unlimited duration, a strong effect (i.e. Race by Emotion interaction [Experiment 1a and Experiment 3a]) was eliminated completely or reduced (Experiment 1b and Experiment 3b). Although it may be tempting to suggest that reducing the stimulus presentation duration should also increase perceptual load demands, this is not the case. Previous research has dissociated the effects of increasing perceptual load and degrading the quality of sensory input by limiting presentation duration (Lavie & de Fockert, 2003). Whereas increasing perceptual load demands decreased the influences of task irrelevant information on focal task performance, limiting presentation duration has been found to increase the distracting influence of task irrelevant information.

This may explain why increasing presentation duration decreased the influence of race cues on emotion categorization (e.g. Experiment 1b and Experiment 3b). However, it is important to note that varying stimulus presentation duration only influenced the pattern of results in experiments with computer generated faces and had no effect on the processing of photographic faces. Although the reason for this difference across stimulus types remains unclear, these results highlight an important difference in the manner in which computer generated and photographic faces are processed. Moreover, it emphasizes that the selection of the presentation duration (and other parameters that may limit sensory input) is an important consideration especially in studies that use simple, computer generated or schematic face stimuli.

The current results also suggest that the nature of the face stimuli used can affect the pattern of results. It has been argued that the use of computer generated faces preserves ecological validity and allows for tight experimental control of low level perceptual features that may affect task performance, but are not related to the process under investigation. Indeed, Hugenberg (2005) assumed that results based on studies employing realistic computer generated faces would not differ from those obtained with photographic faces. This is a common assumption in the literature as computer generated or schematic faces are frequently used in investigations of emotion processing (Horstmann, 2009; Leppänen & Hietanen, 2004).
In contrast to this assumption, the present results indicate that computer generated faces are not functionally equivalent to photographic faces when investigating the influence of poser race on emotion categorization. For computer generated faces, differences in the speed of categorizing happy and angry own and other race faces were only evident when presentation duration was limited. For photographic faces, the same effects emerged at both short and unlimited presentation durations. This may reflect on the manner in which emotional expressions are currently created for computer generated faces – the same morphing algorithm distorting facial features is used for all individuals to produce a particular emotional expression. This limits variability in the manner in which emotions are expressed on each of the computer generated faces and means that the variability that is inherently large in a set of photographic faces is not matched using a set of computer generated faces. Although this problem may be overcome in the future with the use of more sophisticated face generation tools, presently caution seems necessary when interpreting the results of studies that rely exclusively on computer generated or schematic faces. Results from studies utilizing computer generated or schematic faces should be complemented with studies employing photographic faces to determine whether the effects found with computer generated faces also apply to real faces (Lipp, Price, & Tellegen, 2009a,b).

The results of the current study suggest that the main determinant as to whether race moderates the categorization of emotional expression is set size as the moderating effect or race emerges only if a small number of individual faces are used (Hugenberg, 2005), but not when a larger number of different faces is employed (Kubota & Ito, 2007). Increasing stimulus set size has a number of consequences for stimulus processing. Compared to a small stimulus set, in large stimulus sets individual faces are repeated fewer times to obtain the same number of trials meaning that the stimulus variability across trials is higher. There is evidence to suggest that repetition has an impact on perceptual load demands in face processing as the repetition of faces has been found to decrease perceptual processing demands in emotional search tasks (Öhman et al., 2010). Further to this, it has been found that familiar faces are processed more efficiently and with greater accuracy than novel faces (Ellis et al., 1990; Ellis et al., 1987; Schweinberger et al., 1995).

Manipulating requirements for perceptual resource within task has consequences for the processing of task irrelevant information (Perceptual Load Theory; Lavie, 1995, 2004; Murray et al., 2010). When demands on perceptual processing resources are low, these resources can spill over onto task irrelevant information which can then influence responding to task relevant information. For example, negative stereotypes of racial outgroups may influence the processing of emotional expressions when perceptual processing demands are low. Conversely, when perceptual processing demands are high, the focus of attention is narrowed to only task relevant information meaning that task irrelevant race cues have little influence on the speed of emotion categorization.
Increasing stimulus set size may also increase cognitive load demands as information about each individual is stored in working memory. Familiarity which can develop over repeated presentations of the same face has been found to reduce demands on working memory (Jackson & Raymond, 2008). Increased cognitive load with large set sizes is, however, an unlikely explanation for the current pattern of results as the effects of increasing cognitive and perceptual load on distractor processing have been disassociated (Lavie, Hirst, de Fockert, Viding, & 2004). Increasing perceptual load decreases the influence of task irrelevant information on focal task performance. In contrast, increasing cognitive load has been found to strengthen the influence of distracting task irrelevant information. If the effect of increasing set size on the interaction between race and emotion processing were explained by increased cognitive load demands, then, extrapolating from past research, we would predict a stronger moderating influence of poser race on emotion categorization rather than the absence of such moderation as observed in the current investigation (Experiment 1d and 2b).

Beyond replicating the results of Hugenberg (2005) and Kubota and Ito (2007), the current results highlight how the selection of specific task parameters and the associated lower level perceptual and attentional processes driven by them can moderate processing requirements to yield quite different experimental results. There is little doubt that social cognitive methodologies can provide valuable and unique insights into social and interpersonal phenomena. However, the validity of testing theories of social and interpersonal phenomena using the tools provided by cognitive psychology may be compromised when task specific variance and methodological “side-effects” are not fully accounted for.

Implications for Face Processing Theory

Beyond the obvious implications for experimental design and method development, the current results can also be taken to inform and extend current theories of face and person perception. The selection of stimulus set size also influences the level of familiarity with the face identities contained within in each set. To obtain the same number of trials, with a small stimulus set each face is repeated a number of times whereas with a large stimulus set each individual is repeated only a few times. Repeated presentation of the same stimuli leads to familiarity with the different individual identities which, in past research, has been found to influence the processing of emotional expressions (Schweinberger, Burton, Kelly, 1999; Schweinberger & Soukup, 1998).

This flags a potential alternative explanation for the present results - that familiarity may be a boundary condition constraining the moderating effect of race on emotion categorization. Using fMRI techniques, Hart, Whalen, Shin, McInerney, Fischer, and Rausch (2000) found similar amygdala activation in response to both novel ingroup and outgroup faces; however, amygdala activation decreased over repeated presentation of the same individuals for ingroup but not
outgroup faces. The observation that amygdala activation and thus responding to unfamiliar faces is similar regardless of race may explain why cues of race did not moderate the categorization of emotion in the large stimulus set where stimuli were unfamiliar. When stimuli are familiar, however, amygdala activation and thus emotional responding to own and other race faces differs, potentially leading to the observed differences in emotion categorization for own and other race faces.

The results from Experiment 3 seem somewhat inconsistent with this account as a large set of computer generated identities was used and poser race was found to moderate emotion categorization. However, other results from the present study suggest that computer generated faces are not functional equivalents for photographic faces and it is unclear whether the different computer generated identities were actually processed as such. The results of the current study warrant further investigation of the differences between processing cues such as race and emotion on familiar and unfamiliar faces.

These current results present interesting implications for further development of face processing theory. Early models proposed that cues of identity, race, and emotion amongst others, were processed by separate, independent pathways (Bruce & Young, 1986). However, later models have incorporated the growing body of evidence suggesting that the processing of cues such as race and gender can influence the processing of emotional expressions suggesting that these components can influence each other (Haxby, Hoffman, & Gobbini, 2000). It is clear from the current results that race and emotion do interact under some conditions; however, this moderating influence of race on emotion may be bounded by identity. In the current study, although the interaction of race and emotion was the primary focus of investigation, a potential moderating influence of identity familiarity also emerged. The findings of the current study emphasize the importance of investigating the nature of the interactions between all of the multiple dimensions on which faces differ as the influence of one cue such as race on another such as emotional expression may be dependent on yet another cue such as identity. To do this, research in face processing and person perception must move from investigating the processing of just one or two facial cues in isolation towards investigating the complex interplay of the multiple cues simultaneously present on the face.

In addition to considering the role of stimulus repetition/familiarity, it is also interesting to consider the theoretical implication of limiting the presentation duration of the stimuli. Limiting stimulus duration has the effect of limiting the amount of information that can be gathered from a face. A real world proxy for limiting stimulus duration may be encountering an ambiguous emotional expression or viewing an emotional faces is only in the periphery. The finding that angry expressions were categorized faster than happy expressions on African American faces in the 200ms presentation condition, but not others, may imply that task irrelevant cues like race may have
a greater influence on emotion perception under conditions where limited information is available or the stimulus is ambiguous.

**Conclusion**

The present results demonstrate, consistent with the findings of Hugenberg (2005), that under specific task conditions, poser race can moderate the categorization of happy and angry faces resulting in a happy categorization advantage for own race (Caucasian) faces, but a categorization advantage for angry other race (African) faces. However, in line with the findings of Kubota and Ito (2007), when a more heterogeneous stimulus set consisting of many “real” individual posers was used, the happy categorization advantage emerged regardless of race. A systematic investigation of the task parameters leading to these disparate results identified stimulus set size as the main contributing factor, although the importance of stimulus type and presentation duration was also evident.

These results affirm the importance of considering the implications of methodological decisions and their lower level perceptual and attentional processing corollaries for the outcome of research in social cognition. They also suggest that familiarity of a face may play a critical role in whether or not cues of racial group membership affect processing of emotional expression. This finding has implications for our understanding of the effects of social categorization as well as for face perception in general by suggesting that the manner in which novel and familiar faces are processed is remarkably different.
References


STIMULUS DURATION, TYPE, AND SET SIZE MATTER


Appendix

To determine whether differences in emotional intensity or arousal within or across stimulus sets provided an alternative explanation for the observed results, ratings data were collected for all 100 stimuli used across Experiments 1-3.

Method

Twenty-four Caucasian participants (10 males, Age \( M = 28.00, \ SD = 14.02 \)) rated each stimulus face on intensity and arousal online. Each face was presented one at a time on screen and participants were asked to “Please rate how emotionally arousing you find each face from 1 = Calm to 7 = Arousing” and to “On a scale from 1 to 100 please rate how intensely the emotion is being expressed. 0 indicates that the face is expressing absolutely no emotion and 100 indicates that the person is expressing the emotion as strongly as possible”. The order of stimuli was randomized for each participant and blocked within stimulus sets.

Results

A full set of data were available for 18 participants in arousal ratings and 19 participants in intensity ratings as not all participants completed the entire questionnaire. Averaged arousal and intensity ratings were submitted to a \( 4 \times 2 \times 2 \) ANOVA. Angry expressions were rated as more arousing and intense than happy expressions, both \( F_s > 16.97, ps < .001, \eta_p^2 s > .53 \). Additionally, a main effect of set emerged in both arousal and intensity ratings, both \( F_s > 19.93, ps < .001, \eta_p^2 s > .48 \). The two sets of computer generated faces did not differ in arousal or intensity, \( ts < 1, ns \), and were rated as less arousing and intense than the heterogeneous set of real faces, \( ts > 2.25, p < .029 \), which was rated as less arousing and intense than the homogenous set of real faces, \( ts > 2.63, p < .012 \). In intensity ratings, a Set \( \times \) Emotion interaction emerged, \( F(3, 54) = 5.68, p = .007, \eta_p^2 = .65 \), reflecting that the difference in rated intensity between happy and angry faces was bigger for the computer generated sets than for the real faces sets. Finally, in intensity ratings there was a Set \( \times \) Race interaction, \( F(3, 54) = 13.14, p < .001, \eta_p^2 = .57 \), reflecting that Black faces were rated as more intense than White faces in the homogeneous real face set, \( t(54) = 6.68, p < .001 \), but not in the other sets, \( ts < 1, ns \). No other effects were significant.

Discussion

Although differences emerged between sets and between emotions, intensity and arousal ratings could not provide an explanation for the pattern of results observed in categorization times. Firstly, whereas interactions between race and emotion emerged in some of the categorization tasks, such an interaction was not found within any set in either intensity or arousal ratings. As well,
overall intensity and arousal ratings were higher for angry than happy faces. For moderately intense/arousing stimuli such as faces, past research suggests that this high intensity/arousal should lead to faster categorization of negative (angry) stimuli (Robinson, Storbeck, Meier, Kirkeby, 2004; Purkis, Lipp, Edwards, & Barnes, 2009) rather than the happy categorization advantage which was more commonly observed here.

Secondly, differences in rated arousal and intensity across sets could not provide an alternative explanation as to why race moderated the happy categorization advantage under some conditions but not others. If this were the case we would expect that the faces within the heterogeneous real set would be overall more or less arousing or intense than the faces in the other three sets. This was not the case.

Finally, the Set × Emotion and Set × Race interactions that emerged in intensity ratings cannot explain the current results. In the categorization task, poser race was found to moderate emotion categorization times for both sets of computer generated faces even though, regardless of race, angry faces were rated as more intense than happy faces. Finally, intensity ratings from the homogenous set of real faces would predict faster categorization of negative expressions, especially on African faces, as African faces were rated as more intense. The opposite was found; participants were overall faster to categorize happy expressions regardless of the race of the face. Overall it seems highly unlikely that differences in rated emotional intensity or arousal provide an alternative explanation either for the results within each categorization task or as to why race influences the categorization of emotion under some conditions but not others.
Chapter 4.2
Why Does Stimulus Set Size Moderate the Influence of Race on Emotion Categorization? A Follow up Investigation
Abstract
Across three experiments, Chapter 4.1 demonstrated that stimulus type, presentation duration and most importantly stimulus set size altered the interaction of race and emotion in emotion categorization. It was suggested that this was due to differences in the perceptual load demands of the tasks with larger stimulus sets being more perceptually demanding. However, in Chapter 4.1, the number of stimuli in the task varied simultaneously with the number of repetitions of each stimulus making it unclear whether the effect was due to variability in the stimulus set size or the number of repetitions of each stimulus. To investigate the perceptual load account, participants categorized emotional targets presented in small (low perceptual load) or large sets of distractors (high perceptual load) at the same time as task irrelevant Black and White (Experiment 1) or Asian and Caucasian faces (Experiment 2). Results did not support the perceptual load account as no differences were observed in the influence of the race cues on emotion categorization under low or high perceptual load demands even though task irrelevant race cues did influence emotion categorization in a task where emotional targets were not presented amongst distractors. Subsequently, two categorization tasks manipulated stimulus set size and the number of repetitions of each stimulus independently (Experiment 3). Results indicated that stimulus set size rather than the number of repetitions alters the influence race cues of emotion categorization.
Chapter 4.1 presented a series of studies aimed at reconciling an inconsistency in the literature investigating the influence of facial cues of race on the categorization of emotional expression. Hugenberg (2005) reported that race moderates speeded categorization of emotion, happy expressions were categorized faster than angry expressions on White faces, but angry expressions were categorized faster than happy expressions on Black faces. Conversely, Kubota and Ito (2007), using a similar methodology found a happy categorization advantage for both White and Black faces. Chapter 4.1 demonstrated that stimulus type (computer generated vs photographic), presentation duration (200ms vs unlimited), and most importantly, stimulus set size determined whether or not race cues would moderate the categorization of emotion.

In Chapter 4.1, it was proposed that the varying influence of race on emotion categorization as a function of set size may be mediated by perceptual load. Previous research has demonstrated that increasing perceptual load demand, i.e. increasing the amount of perceptual processing required in a task, decreases in influence of other concurrently present visual information on focal task performance (Lavie, 1995). In one study investigating the role of perceptual load, participants’ main task was to search through arrays of either 1, 2, 4, or 6 random letter strings to find the one string that was a name and then categorize it as Asian or European. During the task, Caucasian or Asian faces were presented to the left or right of the search array. The presence of these flanking Asian and Caucasian faces facilitated categorization of race congruent names and slowed categorization of race incongruent names. However, this effect was only observed when the focal task had only a small number of letter strings to search through and not when there were a large number of items to process (Murray, Machado, & Knight, 2011).

Although perceptual load theory generally manipulates perceptual load by increasing the number of items or distractors in the focal task and the task irrelevant information is peripheral to the focal task, it was thought that repeated exposure and thus perceptual familiarity with a face could similarly correspond with a low perceptual load task when the number of faces in the set was smaller, and with higher perceptual load demand when the stimulus set was larger. This could potentially explain why race cues influence emotion categorization at small set size (low load) but not at large set sizes (high load). This explanation is yet to be tested and is only one of many potential mediators. Chapter 4.2 presents a series of attempts to better understand the influence of race on emotion categorization and why it varies with different task parameters, particularly with changes in set size.

**Experiment 1**

The aim of Experiment 1 was to test the perceptual load account for the results reported in Chapter 4.1. To do this, a commonly used paradigm for investigating the role of perceptual load was adapted for use with emotional faces (Murray et al., 2011). In the key test of the perceptual
load account, participants searched for and then categorized happy and angry schematic face targets in circular arrays of other emotional but neither happy nor angry faces (sad and scheming, see Figure 1). On each trial, an own or other race face was presented to the left or right of the search array. It was predicted that when perceptual load demand was low at small search array sizes (1 and 2), the race of the flanker faces would facilitate or inhibit the categorization of the emotional target faces in line with the evaluation elicited by the flanker. Own race flankers would facilitate the categorization of happy targets and inhibit the categorization of angry targets whereas other race flankers would facilitate the categorization of angry targets and inhibit the categorization of happy targets. At larger search array sizes, the heightened perceptual demands of the central search task would attenuate the influence of task irrelevant flanker on target categorization.

In adapting this perceptual load paradigm for use with faces, a number of assumptions were made that needed to be tested. Firstly, it was assumed that the schematic faces used would be processed similarly to photographic and computer generated faces and that typical face effects such as the happy categorization advantage should be observed. Schematic faces were strategically selected as targets for the current investigation as they only contain emotional information. Using photographs of real faces brings with it not only emotional expression information, but also multiple other sources of information including identity information and social category cues. These additional sources of information in the face can interact with emotion perception due to both the bottom up influence of shared perceptual features as well as the top down influence of evaluations and associations. As we were specifically interested in the influence of associations elicited by own and other race target irrelevant flanker faces, if photographic faces were used as targets it would be difficult or impossible to tease apart the emotion recognition process occurring for the target face separate from the influence of the other information in the face. Having said that, schematic faces are not real faces, so a number of experiments were run to determine whether the typical patterns of results found with photographic faces would be found with schematic face stimuli. To test this, participants also completed an emotion categorization task with an additional no/go instruction. Participants categorized target faces as happy or angry, but inhibited their response if the face was sad or scheming. It was predicted that a happy categorization advantage would be observed.

Secondly, it was assumed that own and other race flankers should influence the categorization of a target emotional expression. Previous research has demonstrated that happy expressions are categorized faster than angry expressions on own race and angry expressions are categorized faster on other race than on own race faces (Hugenberg, 2005). As this effect is likely due to the evaluation elicited in response to race cues facilitating or inhibiting the categorization of the emotional expression, it was expected that a similar pattern would be observed here even though the race cues were peripheral to the emotional targets.
Thirdly, it was necessary to establish baseline performance on the new visual search task without the presence of own and other race flankers. In the majority of visual search tasks with schematic faces, an anger superiority effect, faster detection of angry than happy targets is observed. In the current task, however, target categorization was also required and happy faces are typically categorized faster than angry targets. Visual search tasks using schematic faces also typically use homogenous backgrounds where each distractor face is identical, as such it was important to determine the pattern of results in this adapted paradigm.

**Method**

**Participants.** Participants were 32 first year volunteers (8 males, \( M = 20.19, \ SD = 5.40 \)) who received course credit for taking part. All participants identified as Caucasian.

**Stimuli.** Stimuli were identical to those used in Chapter 3. All faces shared in common, two gray circles representing eyes and a triangle representing the nose. Different expressions were created using an upright or inverted curved line representing the mouth and two inward or outward pointing diagonal lines above the eyes representing eye brows. Four different emotional expressions (Happy, Angry, Sad, and Scheming) were created by swapping the eye brow lines and inverting the curve of the mouth (see Figure 1). Each image was \( 85 \times 115 \) pixels in size. The stimuli were matched in brightness and contrast. Own and other race flankers were sourced from the Nimstim database (Tottenham et al., 2009). Four Caucasian and four African American posers with neutral expressions were selected. The images were edited so that just the head was presented. Images were resized and dropped onto a white background \( 250 \times 300 \) pixels in size.

![Figure 1. Schematic stimuli used in Experiments 1 and 2. Emotions depicted from left to right are happy, angry, sad, and scheming.](image)

**Procedure.** The experiment took place in a small group testing laboratory with six testing terminals. Each participant was seated behind a 17” monitor with a screen resolution of \( 1024 \times 786 \) pixels and a refresh rate of 85 Hz. Stimulus presentation and response collection was executed by the software program, DMDX (Forster & Forster, 2003). Participants responded using the right and left shift keys on a standard keyboard. All participants completed the four tasks described below with the order of tasks counterbalanced using a Latin square. Response mapping was counterbalanced across participants but remained consistent for each participant from task to task. In each
task participants received feedback upon making an incorrect response. When an incorrect response was made, the word ‘WRONG’ presented at the bottom of the screen for 500ms.

**Emotion categorization task.** Participants categorized happy and angry targets as quickly and accurately as possible. Participants were additionally instructed to withhold responding when a sad or scheming face was presented. Sad and scheming trials were included to ensure that participants were looking at all the emotion relevant information in the schematic faces and not just using a single feature to categorize the happy and angry stimuli. On each trial, a fixation cross was presented in the center of the screen for 1000ms. This was replaced by a happy, angry, sad, or scheming face which was removed after 200ms. The blank screen remained for 2500ms or until a response was made. Happy and angry targets were presented 42 times each with sad and scheming faces presented 14 times each.

**Emotion categorization task with flankers.** As above, participants categorized happy and angry schematic targets while withholding responding to sad and scheming targets. The time course of each trial was also identical, except that an own or other race flanker was also presented, vertically centered, to the left or right each target for 200ms. Each flanker (4 Caucasian and 4 African America) was presented to the left and to the right of each happy and angry target 4 times and each flanker was presented to the left or right of each sad and scheming target twice resulting in 192 trials.

**Visual search task.** This experiment proceeded as described in Experiment 2 included in Chapter 3. On each trial, participants indicated whether a happy or an angry face was present. These target happy and angry faces were presented amongst heterogeneous backgrounds of sad and scheming faces. On each trial a black fixation cross was presented in the center of the screen for 500ms. This was replaced by a circular search array centered around the fixation cross. Targets were presented alone or with 1, 3, or 5 background distractor faces. These backgrounds consisted of random combinations of sad and scheming faces. Across the target conditions, the backgrounds were held constant. All together there were 72 happy and 72 angry target trials (144 trials in total).

**Visual search task with flankers.** This task was designed as above, however, an own or other race flanker face was presented to the left or the right of the search array on each trial. As before a happy target was present on half of the trials and an angry target presented on the other half. Half of the time an own race flanker (Caucasian) was present and half of the time an other race flanker (African American) was presented. These flankers were presented to the left and to the right an equal number of times. Each target was presented at each position in the array at each search array size with a flanker of each race to the left and to the right of the search array twice. This resulted in 384 trials completed across two blocks of 192 trials.
Data preparation and analysis. For each task all incorrect responses and response times faster than 100ms or more than three standard deviations away from a participant’s mean response time were removed as invalid responses. This constituted approximately 10% of responses on the categorization task, 10% of trials in the categorization task with flankers, 9% of responses in the visual search task and 9% of the responses in the visual search task with flankers. Data from two participant could not be included in the visual search task with flankers, one because they did not provide a complete data set, and the other because they were performing at chance (error rate >50%).

Results

Emotion categorization task. As can be seen in Figure 2a, a happy categorization advantage was observed. Participants were significantly faster to categorize happy than angry schematic faces, \(t(31) = 4.78, p < .001\).

Emotion categorization task with flankers. Inspection of Figure 2b demonstrates that, participants were faster to categorize happy than angry targets, \(F(1, 31) = 30.85, p < .001, \eta_p^2 = .50\), but this effect was moderated by the race of the flanking faces, \(F(1, 31) = 9.09, p = .005, \eta_p^2 = .23\). Although the happy categorization advantage was significant in the presence of both own and other race flankers, \(ts(31) > 2.71, p = .011\), the happy advantage was significantly larger when an own race face was present, \(t(31) = 4.26, p < .001\). There was no significant main effect of race, \(F(1, 31) = 0.43, p = .516, \eta_p^2 = .01\).

Visual search task. As reported in Chapter 2 Experiment 2, participants were significantly faster to discriminate happy than angry faces, \(F(1, 31) = 18.22, p < .001, \eta_p^2 = .37\). This Happiness Superiority Effect (HSE) was observed at all search array sizes, \(ts(93) > 4.01, ps < .001\), except search array size 1, \(t(93) = 0.44, p = .66\), (significant Emotion by Set size interaction, \(F(3, 93) = 4.32, p < .021, \eta_p^2 = .122\)). There was also a main effect of search array size, \(F(3, 93) = 211.89, p < .001, \eta_p^2 = .870\), where response times slowed with each increase in search array size, \(ts(93) > 4.47\) all \(ps < .001\).

Visual search task with flankers. As above, there was a significant HSE, \(F(1, 29) = 16.52, p < .001, \eta_p^2 = .36\), which was moderated by search array size, \(F(3, 87) = 14.24, p < .001, \eta_p^2 = .33\) (see Figure 2c). The happy search advantage did not reach significance at search array sizes 1 and 2, \(t(87) < 1.19, p > .237\), but was significant at search array sizes 4 and 6, \(t(87) > 3.60 < .001\). A search array size main effect was also observed, \(F(3, 87) = 254.33, p < .001, \eta_p^2 = .90\), where each increase in search array size lead to an increase in response times, \(ts > 2.24, ps < .030\). No other effects or interactions, including interactions with flanker race, reached significance, \(Fs < 1.58, ps > .219\).
Figure 2. Figure 2a represents the response times for categorizing happy and angry faces in emotion categorization task. Figure 2b presents response time for categorizing happy and angry faces in various backgrounds sizes as a function of the race of the concurrently present flanker face. Figure 2c represents discrimination times for happy and angry targets present on trials with either White or Black flankers as a function of set size. Error bars represent one SEM.
Discussion

The results of Experiment 1 suggested that all of the assumptions made that were necessary for a perceptual load effect on emotion categorization to be observed in the modified task were met. The happy categorization advantage typically observed with photographic faces was replicated with schematic faces, and this happy categorization advantage was moderated by the presence of own and other race flankers. Consistent with the categorization task, there was also a happy advantage observed in the visual search task. However, in the visual search task with flankers, there was no evidence of a moderating influence of the own and other race flankers at any search array size. This finding is not consistent with the existing perceptual load literature. Typically, in similar studies, task irrelevant information presented alongside the focal task interferes with performance when the focal task does not require much perceptual processing (small search array sizes), but no longer interferes with performance as the perceptual load requirements of the task increase (larger search array sizes).

Although this finding has been demonstrated a number of times (see Lavie, 2005 for a review), experiments investigating perceptual load typically do not involve faces. In fact, there is some evidence to suggest that faces are immune to perceptual load effects. In one study, the presence of task irrelevant famous faces was shown to influence performance on a focal task even when perceptual load demands were high (Lavie, Ro, & Russell, 2003). Despite this, attempts to investigate the effect of task irrelevant own and other race flankers on focal task performance have shown a typical perceptual load effect where race cues influenced focal task performance at small search array sizes, but not at large search array sizes (Murray et al., 2010).

There are a number of reasons why no perceptual load effect was observed in the current study. A number of these explanations were eliminated in the pre-tests described. The schematic faces used elicited a happy categorization advantage that is typically observed with photographic faces, and this effect was moderated by the presence of own and other race flankers. It may be the case, however, that perceptual load was already high at, even at small search array sizes, or that the test of the perceptual load effect was underpowered even though a large number of trials were used and the number of participants was consistent with the previous literature (Murray et al., 2010). As null effects can occur for any number of reasons, it may also be the case that the schematic targets were not processed like real faces even though the pre-tests demonstrated patterns of results with the schematic faces that are typically observed when photographic faces are used. The failure to find an effect of perceptual load may also be due to seemingly unimportant methodological differences such as the race of the faces used - Experiment 1 used Caucasian and African American faces whereas the Murray et al., (2010) study use Caucasian and Asian faces.
Experiment 2

Experiment 2 aimed to replicate the perceptual load effect observed by Murray et al. (2010) using a similar paradigm, as well as investigate the role of own and other race flankers on visual search again using other race flankers who were Asian rather than African American. In two tasks, participants searched through search arrays composed of strings of scrambled letters of various sizes for names which were to be categorized as European or Asian and searched for happy or angry targets amongst distractor faces that were neither happy nor angry. In both of these tasks, own and other race Caucasian and Asian faces were presented to the left and right of the search arrays to assess whether the influence of task irrelevant race cues diminished as perceptual load increased.

Method

Participants. Participants were 40 first year students (10 males, $M = 19.39\ SD = 4.48$) who received course credit for participation. One additional participant was excluded as they did not identify as being from a European/Caucasian background.

Stimuli. The same schematic face stimuli used in Experiment 1, were again used in Experiment 2, however, the own and other race flankers were replaced with four new Caucasian and four Asian faces with neutral expressions from the Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2005). For the name discrimination task, four typical Chinese names were selected. These names were selected based on their popularity. Four European names starting with the same letter as the Chinese names and matched in length were also generated. These names were presented in capital letters in black 24 point Arial font on a white background. The names were ‘BOB WOOD’, ‘DAVE LAW’, ‘FRED CROW’, ‘PETE YORK’, ‘BAO WONG’, ‘DONG LAU’, ‘FENG CHEN’, ‘PENG YANG’. Distractors consisted of eight strings of scrambled letters matched in length to the 8 target names.

Procedure. Experiment 2 proceeded in a similar manner to Experiment 1 with the following differences. Participants completed two search tasks. As in Experiment 1, one of the tasks involved searching for and then categorizing happy and angry schematic faces amongst heterogeneous backgrounds of sad and scheming faces, the other involved searching for names amongst strings of scrambled letters and then categorizing them as European or Asian. In both of these tasks, an own or other race flanker was presented to the left or the right of the search array on each trial. The search tasks were similar to the Experiment 1 visual search with flankers task, however, a new set of flankers was used. In Experiment 2, Asian rather than African American other race faces were presented. Also, each target name or face was presented at each of the six array positions at each search array size (1, 2, 4, or 6) with a flanker of each race to the left and to the right of the search array once rather than twice resulting in 192 trials in each task rather than 384. The faces and names
were also presented in a single vertical column at the center of the screen rather than in a circular array.

**Data preparation and analysis.** Response times were processed in the same manner described in Experiment 1. Incorrect and outlying responses accounted for 7% of responses in the names search task and 13% of responses in the emotion search task. Data from one participant were not included in the analysis of the faces task as they had an error rate approaching chance (49%).

Data were submitted to a 2 (Target name: European, Asian) × 2 (Flanker race: Caucasian, Asian) × 4 (Search array size: 1, 2, 4, 6) repeated measures ANOVA for the name search task and a 2 (Target emotion: happy, angry) × 2 (Flanker race: Caucasian, Asian) × 4 (Search array size: 1, 2, 4, 6) repeated measures ANOVA for the emotion search task.

**Results**

**Name search task.** Results displayed in Figure 3a suggest, as expected, that there was a significant main effect of search array size, \(F(3, 117) = 545.81, p < .001, \eta_p^2 = .93\). Response times slowed significantly with each increase in search array size, \(ts > 8.48, ps < .001\). Participants were also significantly faster to categorize European than Asian names, \(F(1, 39) = 26.91, p < .001, \eta_p^2 = .41\). These two main effects were qualified by three significant two way interactions. The search array size × Target name interaction, \(F(3, 117) = 7.64, p < .001, \eta_p^2 = .16\), indicated the faster categorization of Caucasian than Asian names present at search array sizes 2, 4, and 6, \(ts > 3.32, ps = .001\), but not a search array size 1, \(t(117) = 0.80, p = .475\). The search array size × Flanker race interaction, \(F(3, 117) = 3.87, p = .017, \eta_p^2 = .09\), reflected that participants were significantly faster to respond in the presence of an Asian than a Caucasian flanker at search array size 2, \(t(117) = 2.94, p = .004\), but not at search array sizes 1, 4, and 6, \(ts < 1.11, ps > .269\). Finally, the Target name × Flanker race interaction, \(F(1, 39) = 4.15, p = .049, \eta_p^2 = .10\), suggested that Asian names were categorized marginally faster in the presence of an Asian flanker than in the presence of a Caucasian flanker, \(t(39) = 1.93, p = .061\). The European names were categorized at a similar speed regardless of the race of the flanker face, \(t(39) = 0.94, p = .353\). The main effect of flanker race and the predicted three way interaction of search array size, target name and flaker race were not significant \(Fs < .549, ps > .472\).

Although the predicted three way interaction was not significant, as perceptual load theory predicted an influence of flanker race on name categorization (Flanker race × Target name interaction) at small, but not large search array sizes, we analyzed the Target name × Flanker race interaction at each search array size to determine whether these data at least show a similar trend to Murray et al. (2010). Consistent with the findings of Murray et al. (2010), there was a significant influence of flanker race on target name categorization at search array size 1, \(F(1, 39) = 4.93, p = .032, \eta_p^2 = .11\), but not at search array sizes 2, 4, and 6, \(Fs < 1.94, ps > .172\).
**Emotion search task.** Consistent with Experiment 1, participants were significantly faster to search for and then categorize happy than angry targets, $F(1, 38) = 42.60, p < .001, \eta^2_p = .53$, (see Figure 3b). Participants were also faster to respond at smaller than at larger search array sizes, $F(3, 114) = 297.38, p < .001, \eta_p^2 = .89$. There was a significant increase in response times at each increase in search array size, $t > 4.45, ps < .001$. As in Experiment 1 there was also a significant Target emotion $\times$ Search array size interaction, $F(3, 114) = 11.36, p < .001, \eta_p^2 = .23$. This reflected that the happy search advantage was significant at search array sizes 2, 4, and 6, $t > 3.85, ps < .001$, but not a search array size 1, $t(114) = 0.94, p = .349$. All other effects and interactions did not reach significance, $Fs < 1.97, ps > .115$.

As the perceptual load theory predicts an interaction of target emotion and flanker race at small, but not large search array sizes, we conducted additional planned analyses even though the three way Target emotion $\times$ Flanker race $\times$ Search array size interaction was not significant. Analysis of the Target emotion $\times$ Flanker race interaction separately at each search array size revealed no significant influence of flanker race on target emotion categorization at any search array size, $Fs < 1.68, ps > .203$.

**Discussion**

Again, the results of Experiment 2 suggested that perceptual load did not moderate the influence of race cues on emotion categorization. In the search with faces task, participants were faster to search for and then categorize happy than angry targets, but there was no evidence to suggest that their responses were influenced by the race of the flankers or that this influence diminished as search array size increased. Consistent with the literature, the results from the name task provided some evidence to suggest that task irrelevant race flankers could influence discrimination of European and Asian names more so at small than at large search array sizes.

It is still a possibility that the perceptual load account may explain why stimulus set size influences the role of race in emotion categorization, but that the paradigm used was not sensitive enough to detect it. It may have been the case that the task was already perceptually demanding even at small search array sizes. In the new modified method used, accurate task performance required integrating information from both the eye brow and mouth lines for each target or distractor. It is possible that participants were under high perceptual load at all set sizes meaning that no influence of the own and other race flankers was observed at any set size. This may be addressed by making the focal task less perceptually demanding, perhaps by using homogenous neutral backgrounds so the targets are easier to detect. However, using this method may increase the chance that performance on the central search task is driven by low level perceptual features rather than processes related to interpreting the emotion on the faces. Future research may address this issue.
We failed to find evidence for a role of perceptual load on the influence of race on emotion.

Figure 3, displays results from Experiment 2. Figure 3a shows categorization times for Asian and European names presented with either Caucasian or Asian flankers as a function of set size. Figure 3b represents discrimination times for happy and angry targets as a function of the race of the flanking face at varying set sizes. Error bars represent one SEM.

Figure 3. Figure 3, displays results from Experiment 2. Figure 3a shows categorization times for Asian and European names presented with either Caucasian or Asian flankers as a function of set size. Figure 3b represents discrimination times for happy and angry targets as a function of the race of the flanking face at varying set sizes. Error bars represent one SEM.
categorization. Other potential moderators need to be considered. In the experiments presented in Chapter 4.1, the role of set size could have been due either to the number of repetitions or the number of facial stimuli used. As the trial length was controlled across all tasks, tasks with small set sizes meant a large number of repetitions of each stimulus, whereas a large stimulus set meant only a few repetitions. Thus, it was unclear whether set size, or the number of repetitions of each stimulus influenced whether race moderated emotion categorization. The proposed perceptual load account assumed that it was the repetition of the stimuli leading to perceptual expertise that was driving the effect; however, having a large set size also means that many exemplars of each racial category are presented. Together, these many exemplars may appear less stereotypic of the groups they represent and lessen the salience of the race cue when the unique form of each person’s emotional expression must be decoded. Disentangling the influences of set size and repetition may help to determine whether this is the case.

**Experiment 3**

Experiment 3 aimed to investigate the role of stimulus set size and the role of stimulus repetition independently. In Experiment 3a, stimulus set size was directly manipulated. In Experiment 3b, the number of presentations of each stimulus was manipulated to investigate the role of stimulus repetition. If stimulus set heterogeneity explains the diminished influence of race cues on emotion categorization, we should observe an influence of race at small but not large set sizes. The number of repetitions should not influence results (Experiment 3a). If the number of repetitions is important, it may be possible to observe the transition from one pattern of result where race and emotion interact with a small number of repetitions of a given stimulus, to the other, where a happy advantage is observed for White and Black faces, when stimuli are repeated a number of times (Experiment 3b).

**Methods**

**Participants.** Participants were 31 (Experiment 3a; 8 males, $M = 19.39$, $SD = 2.74$) and 27 (Experiment 3b, 5 males, $M = 18.81$, $SD = 1.71$) undergraduate volunteers who received course credit for participation.

**Stimuli.** The stimuli used in the current tasks depicted 30 African American and 30 Caucasian posers expressing either happiness or anger. The set was similar to that used in Chapter 4.1 with stimuli drawn from Productive Aging Database (Minear & Park, 2004), the Nimstim Set of Facial Expressions (Tottenham et al., 2009), the Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2005), the Karolinska Directed Emotional Faces (Lundqvist, Flykt, & Ohman, 1998) but was extended by including a selection of the stimuli used by Kubota and Ito (2007). In line with Chapter 4.1, each face was resized for consistency with the other stimuli, grayscaled and dropped on a gray background $520 \times 390$ pixels in size.
Procedure. As in Experiments 1 and 2, Experiments 3a and 3b were conducted in a small group computer lab with six testing terminals. Stimulus presentation and response collection was conducted in the same manner as Experiments 1 and 2. For both tasks, on each trial a white fixation cross was presented on a black background for 1000ms. This was replaced with one of the stimulus faces which was presented for 200ms and then removed. The screen remained blank until a response was made or for 3000ms. Stimulus presentation was randomized.

**Experiment 3a - Investigating the role of set size.** In this task, participants completed a set of five categorization tasks. Each task required participants to categorize faces as happy or angry as quickly and accurately as possible. The five tasks were almost identical in nature except that a different number of stimuli were used in each task. At stimulus set size 1, one stimulus of each type was used resulting in 4 individuals being represented, at set size 2, two stimuli of each type were used resulting in 8 individuals being represented and so on. For each of these tasks a subset of the full stimulus set was used. The stimuli used in each set were counterbalanced across participants so that different participants saw different faces at small and larger sets. Within each task, each stimulus was presented 10 times, this resulted in 40 trials in the stimulus set size 1 task, 80 trials in the stimulus set size 2 task, 120 trials in the set size 3 task, 160 trials in the stimuli set size 4 task and 200 trials in the set size 5 task. Altogether, each participant saw each stimulus the same number of times (10 times). The order of the tasks was counterbalanced across participants.

**Experiment 3b - Investigating the role of repetition.** The task was similar to Experiment 3a in that participants were required to categorize a face as happy or angry on each trial. Experiment 3b, however, consisted of only one task and only a subset of 20 faces (ten Black and ten White faces expressing either happiness or anger) was used. Within the task, one individual representing each category was presented either once, twice, four times, eight times or 16 times. This resulted in 124 trials. The faces used at each level of repetition varied across participants.

**Data processing and analysis.** As in Experiments 1 and 2, incorrect responses and response times faster that 100ms or more than three standard deviations away from a participant’s mean response time were excluded from analysis. This constituted 6% of responses in Experiment 3a and Experiment 3b. Three participants could not be included in the full analysis of Experiment 3a as they did not complete all five tasks. Response times were submitted to a 2 (Race: White, Black) × 2 (Emotion: angry, happy) × 5 (Stimulus set size: 4, 8, 12, 16, 20) repeated measures ANOVA for Experiment 3a and a 2 (Race: White, Black) × 2 (Emotion: angry, happy) × 5 (Number of repetitions: 1, 2, 4, 8, 16) repeated measures ANOVA for Experiment 3b.

**Results**

**Experiment 3a.** As can be seen in Figure 4a, overall, participants were faster to categorize happy than angry faces, $F(1, 27) = 32.23, p < .001, \eta^2_p = .54$. They were also faster to categorize
emotional expressions on own than on other race faces, $F(1, 27) = 16.81, p < .001, \eta^2_p = .38$.

Further to this, the stimulus set size used influenced overall response times, $F(4, 108) = 3.16, p = .024, \eta^2_p = .54$. Response times were significantly slower at larger stimulus set sizes than at smaller set sizes (e.g. responses at stimulus set size 20 were significantly slower than at stimulus set size 4, $t(108) = 2.50, p = .014$. There was a marginal stimulus set size × race effect, $F(1, 27) = 2.37, p = .079, \eta^2_p = .08$, reflecting the trend for a speed advantage for categorizing expressions on own race faces at some larger set sizes (12 and 20), $t_s > 2.41, ps < .023$, not at some smaller set sizes (4, 8, 16), $t_s < 1.66, ps > .109$. No other effects, including the predicted Race × Emotion × Set size interaction, were significant, $F_s < 1.87, ps > .183$.

**Experiment 3b.** The predicted three way race by emotion by number of repetitions interaction did not reach significance. Additionally, no other main effects or interactions reached significance, $F_s < 1.28, ps > .269$ (see Figure 4b).

**Discussion**

Experiments 3a and 3b aimed to disentangle whether the moderating influence of set size on the Race × Emotion interaction reported in Chapter 4.1 was due to the number of stimuli presented (Experiment 3a) or the number of repetitions of each stimulus (Experiment 3b). If it was due to the number of stimuli presented, it was predicted that a happy advantage would be observed for White but not Black faces at small set sizes, but a happy advantage would be observed for both White and Black faces at large set sizes. If it was due to the number of repetitions, it was predicted that a happy advantage for White but not Black faces would be observed for stimuli that were repeated a large number of times, but not when the stimuli were repeated only a few times. Neither of these predictions were supported by the results. There were no significant effects observed at all in Experiment 3b investigating the role of repetition. Additionally, in Experiment 3a, there was no three way interaction. There was a happy advantage for both White and Black faces and a speed advantage for categorizing expressions on own race faces but this did not vary as set size increased.

Although the results did not support the prediction, it is important to consider that the manipulation of set size was fully within subjects. There were likely carry over effects across the tasks. As such, participants were all exposed to a large set of stimuli across the series of tasks. This may explain why overall, the pattern of results observed reflected what would be expected at a large set size, as participants were essentially exposed to a large set of stimuli across the full course of the experiment.

Results from Experiment 3a suggest that the effect of exposure to a range of stimuli can carry across tasks. As such, a similar study manipulating stimulus set size fully between participants may be more effective at uncovering the role of set size. The results from Experiment 3b suggest that repeating different faces a different amount of times may abolish both effects of emotion and
Figure 4. Results from Experiment 3 are displayed. Graphs represent categorization times for happy and angry expressions displayed as a function of the race of the face and the number of stimuli presented in the task (Figure 4a, Experiment 3a) or the number of repetitions of each stimulus (Figure 4b, Experiment 3b).
the influence of race on emotion categorization. Of course, it is difficult to obtain stable condition means with only 1 trial from each participant per condition so the failure to find the predicted effects may also be due to power issues rather the absence of a true effect. It may also be the case that presenting stimuli different numbers of changed how the task was performed. Responses to the commonly seen faces may have been learned so that rather than processing the expression, participants are responding to emotion unrelated group membership, identity or low level perceptual cues. When the faces which were not repeated or only repeated once or twice appeared, they were surprising and unexpected which may have contributed to statistical noise in the response times measure for those conditions (which already only have a few trials per condition). This added noise may explain the absence of effect typically observed in the literature.

**General Discussion**

The aim of this study was to determine why the number of stimuli used in an emotion categorization task influences the degree to which cues of race influence speeded emotion categorization. This role of stimulus set size was identified in a systematic investigation described in Chapter 4.1. It was proposed that differences in perceptual load between tasks with small and large stimulus sets may mediate the influence of stimulus set size on the Race by Emotion interaction. Experiments 1 and 2 aimed to test this explicitly using a novel procedure adapted from the perceptual load literature. Despite each of the pre-tests producing results consistent with assumptions based on the previous literature, we found no evidence to support the perceptual load account.

Although the perceptual load account provided an elegant explanation for the results in Chapter 4.1, it is not all together surprising that we failed to find evidence to support its role in the current context. The validity of the perceptual load account has come under the scrutiny of some researchers. They argue that the diminished influence of task irrelevant information under perceptual load may be a result of the many items on the display diluting the salience or importance of the irrelevant information (Tsai, & Benoni, 2010). Additionally, perceptual load effects are typically observed when the task irrelevant information is spatially distinct from the target relevant information rather than an aspect of the target as is the case with the race and emotional expression of facial stimuli.

Given that the explanation provided in Chapter 4.1 could not be validated, Experiment 3 aimed to disentangle exactly which element of having a large vs. a small set size influenced results. In Chapter 4.1, each task was 80 trials in length meaning the stimulus set size was confounded with the number of repetitions of each stimulus. Although Experiments 3a and 3b did not definitively demonstrate that the number of repetitions or the number of stimuli was the key factor affecting how race cues influence emotion categorization, Experiment 3a suggested that the effect of being
exposed to a large variety of own and other race emotional stimuli may be a more likely explanation than an explanation based on the number of repetitions of a stimulus.

As such, it must be considered why presenting participants with a wide range of faces from a particular category may influence the degree to which race cues influence emotion categorization. One potential explanation is that presenting a wide range of exemplars of other race faces causes participants to view out groups as more heterogeneous. Previous studies manipulating perceptions of outgroup homogeneity have found that when participants were subtly manipulated to see a racial out group as more heterogeneous, they showed less of an own race bias on a race IAT (Brauer, & Er-rafy, 2011). It may be the case that showing participants a wide range of other race faces expressing different emotions also subtly increased perceptions of out-group heterogeneity leading to race cues being only weakly evaluated as positive or negative or not at all. This would result in race cues having less of an influence on emotion categorization speed.

This could be tested in a number of ways. One possibility would be to use a previously established method of manipulating outgroup heterogeneity and then followed this with an emotion categorization task that typically produces an influence of race on emotion categorization. If the influence of race is attenuated under these conditions, this may suggest that the subtle manipulation of outgroup heterogeneity is the mechanism underlying the influence of set size on the Race × Emotion interaction. Alternatively, participants could be passively exposed to a wide range of own and other race faces expressing different emotions. Implicit race bias could then be measured with an IAT. If the other race bias is attenuated compared to a control group, this may provide further evidence to support the role of differences in perceived out-group heterogeneity as a mechanism. If being exposed to a variety of faces does indeed influence perceptions of outgroup heterogeneity, this would be another example of a top-down influence on the processing of multiple facial cues. This would be consistent with models of person construal such as the dynamic interactive model of person construal (Freeman & Ambady, 2011).

These experiments together suggest that, if the mechanism underlying the role of stimulus set size on the Race by Emotion interaction in emotion categorization is to be understood, further research will be required. Additionally, it highlights that much work remains if we want to better understand the complex nature of the interactions between multiple facial cues under various context. Finally, if we are to better understand which elements of a face are prioritized or preferentially processed in face to face interactions outside of the laboratory, finding converging evidence across multiple methods will also be necessary.
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Chapter 5
The Influence of Facial Sex cues on Emotional Expression Recognition is not Fixed
Abstract

The speed of recognizing facial expressions of emotion is influenced by a range of factors including other concurrently present facial information such as a person’s sex. Typically, when participants categorize happy and angry expressions on male and female faces, faster categorization of happy than angry expressions is observed for female but not male face. Using the very same stimuli across tasks, we demonstrate that this interaction depends on the social context elicited by the task. Altering the gender context by presenting male and female emotional faces in separate emotion categorization tasks rather than together in a single task changed the way sex cues influenced emotion categorization. Changing the emotional context by presenting happy and angry expressions in separate tasks alongside neutral faces did not. These results suggest that the interaction of multiple facial cues such as the influence of sex on emotion perception is dependent on the social categories made salient by the task.
When researching the processing of emotional expressions, it is easy to overlook the fact that emotional expressions are encountered on faces that carry rich social contextual information, and that these faces are seen within the broader context of the body and its surrounds. In striving for experimental control in past studies investigating emotion perception, often, only White young adult faces are presented, and behavioral responses are aggregated across a number of trials. This approach makes the implicit assumptions that emotion perception is independent of other facial characteristics of the face on screen, and does not, for instance, differ for male and female faces. It is also assumed that emotion perception is driven only by the face on screen, regardless of the other faces seen within the task or in recently completed tasks (e.g. Billings, Harrison, & Alden, 1993; Crews & Harrison, 1994; Kirita & Endo, 1995; Leppänen & Hietanen, 2003, 2004; Savage, Lipp, Craig, Becker, & Horstmann, 2011; Surguladze, Young, Senior, Brebion, Travis, & Phillips, 2004; Tracy & Robins, 2008). In natural interactions, emotional expressions are seen on a range of faces varying in gender, race, and age and these same faces can be encountered under different circumstances. We know that social category information like sex, race, and age can influence emotion perception (e.g. Aguado, Garcia-Gutierrez, & Serrano-Pedraza, 2009; Atkinson, Tipple, Burt, & Young, 2005; Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007; Craig, Mallan, & Lipp, 2012; Craig, Lipp, & Mallan, 2014; Hess, Adams, Grammer, & Kleck, 2009; Hugenberg, 2005, Hugenberg & Sczesny, 2006; Hutchings & Haddock, 2008; Karnadewi & Lipp, 2011; Sacco & Hugenberg, 2009), but the different settings in which these faces are encountered may alter the salience of these social categories and thus, their influence on emotion perception. For example, anger expressed by a woman working in a male dominated profession may be processed differently than anger expressed by the same woman if she worked in a place that had an equal split of women and men or that was dominated by women. Currently, there is little research addressing whether the influence of social category information on emotion perception changes as a function of the context a faces is encountered in.

One way of investigating the influence of social categories on emotion perception and whether their influence varies as a function of the broader social context is by measuring changes in the magnitude of the happy categorization advantage across different task settings. The happy categorization advantage refers to the finding that happy facial expressions are categorized faster than neutral (Hugdahl, Iversen, & Johnsen, 1993) or negative expressions including anger (Billings, et al., 1993), sadness (Kirita & Endo, 1995), and disgust (Leppänen & Hietanen, 2003, 2004). This happy advantage is hypothesized to be due to a positive expectancy bias – a tendency towards expecting positive encounters and occurrences (Leppänen & Hietanen, 2003; Hugenberg, 2005). This perspective is supported by the finding that a similar speed advantage is also observed in the categorization of other emotional stimuli such as words (Stenberg, Wiking, & Dahl, 1998) and
images as positive or negative particularly if they are low in arousal (Purkis, Lipp, Edwards, & Barnes, 2009). Additionally, the happy categorization advantage is sensitive to changes in evaluative context. For example, Leppänen and Hietanen (2003) demonstrated that happy expressions were categorized faster than expressions of disgust when smelling a pleasant smell, but that this effect disappeared when participants were exposed to an unpleasant smell.

The happy categorization advantage has been used to investigate the influence of social categories on emotion perception as the happy categorization advantage not only fluctuates with changes in the evaluative context as manipulated by smell, but can also fluctuate as a function of the social category cues present on the faces that are being categorized even when these social category cues are not explicitly relevant for task performance. For example, in studies investigating the influence of race on emotion categorization, Caucasian participants were faster to categorize happiness than anger on White faces, but were faster to categorize anger than happiness on Black faces (Craig et al., 2012; Hugenberg, 2005). A similar influence of race on emotion perception has been demonstrated for White Dutch Participants categorizing expressions on White and Moroccan Dutch face (Bijlstra, Holland, & Wigboldus, 2010). Similarly, happiness was categorized faster than anger on female faces, but this effect was either reduced or absent for male faces (Becker, et al., 2007; Bijlstra, et al., 2010; Hugenberg & Sczesny, 2006). These findings suggest that the magnitude of the happy categorization advantage is sensitive to the influence of social category information on emotion perception.

Prior investigations of the influence of social category cues like sex on emotion perception have suggested a number of potential mechanisms to explain these interactions. Hugenberg and Sczesny (2006), for instance, proposed a response priming account assuming that the evaluation of women as more positive than men (Women are Wonderful Effect; Eagly, Mladinic, & Otto, 1991) facilitates the categorization of happiness expressed by a female. On the other hand, Becker, et al., (2007) and Hess et al., (2009), provided evidence to suggest that the female facial structure tends to overlap with cues of happiness whereas the male facial structure shares cues that overlap with expressions of anger facilitating the categorization of happiness on female faces and anger on male faces. Although these proposals do not explicitly discount the influence of broader contextual information, they are couched in terms of the information presented on a particular face that is to be categorized on a given trial. Thus, they would predict that sex cues should have the same influence on emotional expression recognition for a given emotional face across all situations. As such, any experiment requiring the categorization of the same facial stimulus set should produce a comparable pattern of results regardless of the nature of the other faces seen within the task, or in recently completed tasks.
Contrary to these proposals, evidence has emerged to suggest that the influence of social category information on emotion perception is sensitive to the context in which the task is performed, including the context set by the other faces viewed within a given task. Extending prior work by Hugenberg (Hugenberg, 2005, Hugenberg & Sczesny, 2006) and Bijlstra, et al. (2010), Lipp, Craig, and Dat (2015), asked Caucasian participants to categorize happy and angry expressions on male Caucasian faces, presented either among male African American faces, or among female Caucasian faces. For the same set of male Caucasian faces, a happy categorization advantage was found if presented amongst male African American faces, but not if presented amongst female Caucasian (or female African American) faces. These findings suggest that cues of ‘maleness’ and ‘Whiteness’ will differentially influence emotion categorization if their relevance or salience is manipulated by changing the other faces presented on different trials within the same task. This finding is somewhat consistent with the finding that implicit evaluations of a given target can also vary as a function of the situation (Mitchell, Nosek, & Banaji, 2003). These findings indicate that the influence of social category cues on emotion processing is not constant, but flexible and dependent on the context set, for instance, by the other faces presented in a particular task.

Presenting faces that vary along particular social dimensions, such as sex or race, within the same task altered emotion perception for the male Caucasian faces, even when that dimension was not explicitly relevant to the task. However, from this finding, it remains unclear whether the moderating influence of sex cues on emotion perception depends on the presence of both male and female faces in close temporal proximity within the same task, or whether a similar influence can be observed across longer time periods such as across successive tasks. Likewise, it remains unclear whether the influence of sex cues on emotion perception is dependent on categorizing positive and negative expressions within a single task. To address these questions, three experiments were conducted using the same emotional male and female faces, but the specific task contexts in which these faces appeared were manipulated. These experiments were conducted with the aim of understanding whether the influence of social category information on the perception of facial emotional expressions presented in a particular task is influenced by social contexts that are created implicitly by other faces presented within and across tasks.

In Experiment 1, male and female Caucasian faces expressing happiness and anger were presented within one emotion categorization task in order to confirm that the typical influence of sex cues on emotion perception is observed with the current stimulus set and to provide a baseline against which to compare the results of Experiments 2 and 3. In Experiment 2, the gender context was manipulated to be less salient. The male and female faces used in Experiment 1 were presented in two separate tasks, one using only male faces and the other, only female faces. In Experiment 3, the emotional context was manipulated relative to Experiment 1. Happy and angry expressions were
presented in separate tasks and participants were asked to categorize these emotional expressions relative to neutral expressions. Together these three Experiments were designed to determine whether the influence of sex on emotion perception is dependent on presenting both male and female faces and/or positively and negatively valenced expressions within a single task.

Consistent with past research (e.g. Bijlstra et al., 2010; Lipp, Craig, et al., 2015), it is hypothesized that sex cues will influence emotion categorization (Experiment 1). This influence will be absent, however, if faces of only one sex are presented within a single task (Experiment 2) as the salience of the social category of sex will be reduced if male and female faces are presented separately. Changing the emotion context, but presenting both male and female faces in a single task will not alter the salience of the social category of sex and the influence of sex cues on emotion perception will emerge even though the emotional expressions of anger and happiness are viewed in separate tasks (Experiment 3).

**Experiment 1**

Experiment 1 was conducted to confirm that the current stimuli and procedures replicate the effect of facial sex cues on emotion perception observed in previous research (e.g. Becker et al., 2007; Bijlstra et al., 2010; Hugenberg & Sczesny, 2006). This is necessary given prior findings that the influence of face sex on emotion perception can differ across stimulus sets (Lipp, Karnadewi, Craig, & Cronin, 2015) and to provide a baseline for the comparison of subsequent results.

Participants categorized happy and angry expressions on male and female Caucasian faces presented together within in a single task. Consistent with the previous literature, it was predicted that happy expressions would be categorized faster than angry expressions when displayed on female faces, but that this effect would be significantly reduced or absent for male faces (Becker et al., 2007; Bijlstra et al., 2010; Hugenberg & Sczesny, 2006).

**Method**

**Participants.** Participants were 30 undergraduate volunteers (7 males, $M = 18.57$, $SD = 1.52$) who received partial course credit for participation.

**Stimuli.** The closed mouthed happy and angry expressions of nine male and nine female posers (models 01, 02, 03, 05, 06, 07, 08, 09, 10 and 20, 22, 23, 24, 25, 28, 34, 36, 37) were drawn from the NimStim database (Tottenham et al., 2009). These images were edited so that only the head was shown (necks, clothing, etc. were removed). Images were converted to grayscale, resized, and centered on a gray background $390 \times 262$ pixels in size.

**Procedure.** The experiment took place in a group testing laboratory with six testing terminals. Each participant was seated in front of a 17” CRT monitor with a screen resolution of $1024 \times 768$ pixels and a refresh rate of 85 Hz. Stimulus presentation and response recording was executed in DMDX (Forster & Forster, 2003). Participants completed a single task and were
instructed both verbally and in writing to categorize the male and female faces expressing happiness or anger presented one at a time as ‘happy’ or ‘angry’ as quickly and accurately as possible.

On each trial a white fixation cross was presented on a black background for 1000ms. This was replaced by an emotional face which remained on screen until a response was made or for 3000ms. Stimuli were presented in a random order and participants indicated their response using the right and left shift keys. Response mapping was counterbalanced across participants. Response times were recorded from the onset of each stimulus until a button press was made. Each individual picture was shown twice resulting in 72 trials (18 poses × 2 expressions × 2 presentations).

Data processing and analysis. Incorrect responses and response times faster than 100ms and more than three standard deviations away from each participant’s mean were scored as errors comprising less than 8% of responses. Response times and error rates were submitted to separate 2 (Sex: male, female) × 2 (Emotion: happy, angry) repeated measures ANOVAs.

Results

Response times. As can be seen in Figure 1, participants were overall faster to categorize happy than angry faces, $F(1, 29) = 6.35, p = .018, \eta_p^2 = .18$, and overall faster to categorize expressions on male than on female faces, $F(1, 29) = 4.60, p = .040, \eta_p^2 = .14$. These main effects were moderated by a Sex × Emotion interaction, $F(1, 29) = 19.70, p < .001, \eta_p^2 = .41$. Follow up analyses indicated that happy expressions were categorized faster than angry expressions when displayed on female faces, $t(29) = 5.10, p < .001$. For male faces, the response time difference between happy and angry expressions was not significant and trended in the opposite direction, $t(29) = 1.17, p = .252$.

Accuracy. Analysis of error rates revealed no significant main effects or interactions, all $Fs < 2.87, ps > .101$. However, inspection of the pattern of error rates (see Table 1) suggests that it is consistent with the response times. Participants tended to make fewer errors categorizing happy than angry expressions posed by females, but tended to make a similar number of errors categorizing male expressions of happiness or anger.

Discussion

Experiment 1 replicated the Sex × Emotion interaction previously reported in the literature. Consistent with Becker et al. (2007), Bijlstra, et al. (2010), and Hugenberg and Sczesny (2006), a happy categorization advantage was observed for female, but not for male faces. Having obtained a set of baseline data, we now turn to addressing the question of whether this pattern of results depends on making the social category of sex salient by presenting both male and female faces within the same task. Experiment 2 aimed to investigate how happy and angry expressions are

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3 For each experiment, participant gender was included as a between subjects factor in an initial analysis. This analysis revealed no significant main effects or interactions. As such, results are reported collapsed across this factor.
Figure 1. Categorization time for happy and angry expressions as a function of the sex of the expresser in Experiment 1. Error bars represent one SEM.
categorized when the salience of the sex category is reduced by holding the sex of the faces constant within a task. Participants categorized happy and angry expressions displayed on male faces in one task and happy and angry expressions on female faces in the other. If categorization speed is driven only by the individual stimuli, results should replicate Experiment 1. However, if altering the gender context does change the influence of sex cues on emotion categorization, we may observe faster categorization of happy than angry expressions for both male and female faces, a pattern that is consistent with the evaluative congruence explanations of the happy categorization advantage (e.g. Leppänen & Hietanen, 2003). Finally, presenting male and female faces across different task enables an assessment of the conditions required to make the social category of sex salient – i.e. is it necessary to present male and female faces in the same task or is the same effect observed across tasks?

Experiment 2

Method

Participants. Participants were 83 undergraduate student volunteers (32 males, $M = 19.49$, $SD = 3.54$), who received partial course credit for participation.

Stimuli, procedure, data preparation and analysis. The stimuli used in Experiment 2 were the same as those used in Experiment 1 and it was carried out under the same conditions. The current experiment consisted of two tasks. Male happy and angry faces were categorized in one task and female happy and angry faces were categorized in the other. The order of the tasks was counterbalanced. In each task, each stimulus face was presented four times resulting in 72 trials in each task and 144 trials across the two tasks. Data were prepared in the same manner as for Experiment 1. Less than 6% of responses were excluded as incorrect or invalid. Data from one participant could not be included in the analyses as they provided no valid responses in one task and another participant provided invalid response on 86% of trials in one task although including this person in the analysis does not change the overall pattern of results. Response time and accuracy data were initially submitted to a $2 \times 2$ repeated measures ANOVA.

Results

Response times. Consistent with the previous literature, overall, participants were faster to categorize happy than angry expressions, $F(1, 80) = 22.82, p < .001, \eta_p^2 = .22$, and this was moderated by the sex of the face, $F(1, 80) = 10.08, p = .002, \eta_p^2 = .11$ (see Figure 2 inset). Participants were faster to categorize happiness than anger on male and female faces, $t(80) > 2.12, ps < .037$; however, this effect was stronger for female faces, $t(80) = 4.49, p < .001$. There was no main effect of the gender of the face, $F(1, 80) = 0.02, p = .889, \eta_p^2 = .00$. 
Accuracy. Overall, participants tended to categorize happy expressions more accurately than angry expressions, $F(1, 80) = 5.66, p = .020, \eta^2_p = .07$. This main effect of emotion was qualified by a significant Sex $\times$ Emotion interaction, $F(1, 80) = 8.28, p = .005, \eta^2_p = .09$. There was no significant difference in error rates for categorizing happiness and anger on male faces, $t(80) = 0.18, p = .865$; however, consistent with response times, participants were significantly more accurate in categorizing happiness than anger displayed on female faces, $t(80) = 4.27, p < .001$. There was no main effect of the sex of the face, $F(1, 80) = 0.21, p = .665, \eta^2_p = .00$.

Comparison to the standard results (Experiment 1). Contrary to Experiment 1, Experiment 2 yielded a happy face advantage for male and female faces. To determine whether the patterns of results differed significantly across Experiments, data from Experiments 1 and 2 were submitted to 2 (Sex: male, female) $\times$ 2 (Emotion: happy, angry) $\times$ 2 (Experiment: experiment 1, experiment 2) mixed ANOVAs.

Response times. Although both Experiments 1 and 2 produced a significant Sex $\times$ Emotion interaction, comparing the two experiments revealed that the two studies produced significantly different patterns of results as indicated by a significant Sex $\times$ Emotion $\times$ Experiment interaction, $F(1, 109) = 5.15, p = .025, \eta^2_p = .05$. Considering the results of Experiments 1 and 2 separately suggests that this interaction is likely due to a trend towards categorizing male expressions of anger faster than male expressions of happiness in Experiment 1, and male expression of happiness faster than anger in Experiment 2 as described in the aggregated results of Experiments 1 and 2.

Accuracy. There were no statistically significant differences in the patterns of error rates across Experiments 1 and 2, $Fs < 1$.

The role of task sequence. Experiment 1 has shown that presenting male and female faces within the same task affects emotion perception. To determine whether emotion perception on male/female faces differs as a function of having categorized emotional expressions on female/male faces first, i.e., whether the effect of face sex on emotion perception seen within a task would also be evident across tasks, response time and error rate data from Experiment 2 were submitted to 2 (Sex: male, female) $\times$ 2 (Emotion: happy, angry) $\times$ 2 (Task sequence: male task first, female task first) mixed ANOVAs.

Response times. As can be seen in Figure 2, task sequence did influence results. This was confirmed by a significant Sex $\times$ Emotion $\times$ Task sequence interaction, $F(1, 79) = 6.63, p = .012, \eta^2_p = .08$. This three way interaction was followed up by analyzing the interaction between sex and emotion for each task sequence separately.

When participants completed the categorization task with male faces first, they were overall faster to categorize happy than angry expressions, $F(1, 40) = 13.77, p = .001, \eta^2_p = .26$. This main effect of emotion was qualified by a Sex $\times$ Emotion interaction, $F(1, 40) = 12.05, p = .001, \eta^2_p = \ldots$
Participants were significantly faster to categorize happy than angry expressions on female faces, \( t(40) = 5.06, p < .001 \), but not on male faces, \( t(40) = 0.15, p = .882 \).

When participants completed the female emotion categorization task first, overall there was a main effect of emotion. Happy expressions were categorized faster than angry faces, \( F(1, 39) = 9.67, p = .003, \eta^2_p = .20 \), but the Sex \( \times \) Emotion interaction was not significant, \( F(1, 39) = 0.40, p = .529, \eta^2_p = .01 \). Follow up analyses confirmed that happiness was categorized significantly faster than anger on male faces, \( t(39) = 2.50, p = .017 \), and on female faces, \( t(39) = 3.06, p = .004 \).

Additional analyses conducted to follow up the significant three way Sex \( \times \) Emotion \( \times \) Task sequence interaction demonstrated that the happy categorization advantage was significantly larger for the second task completed regardless of whether the male or female task was completed first, \( ts > 3.34, ps < .002 \).

**Accuracy.** There was no significant influence of task sequence on error rates, \( Fs < 1, ps > .388 \). However, inspection of error rates in Table 1 suggests a numerical trend in the same direction as for the response times. Consistent with response times, analyzing the Sex \( \times \) Emotion interaction separately for the two sequences indicated that the interaction of sex and emotion was significant in participants who completed the male task first, \( F(1, 40) = 5.21, p = .028, \eta^2_p = .12 \), but not for those who completed the female task first, \( F(1, 39) = 3.03, p = .090, \eta^2_p = .07 \).

**Discussion**

The aim of Experiment 2 was to determine whether the influence of sex on emotion perception reported in the literature (e.g. Becker et al., 2007; Bijlstra et al., 2010; Hugenberg & Sczesny, 2006) and replicated in Experiment 1 was dependent on making the social category of sex salient by presenting both male and female faces within a single task or whether it would also be observed if male and female faces were presented in separate tasks. The results of the omnibus analysis suggest an effect of face sex on emotion perception even if face sex does not vary within a task. However, comparing the results of Experiment 2 to those of Experiment 1 directly indicated a difference in the pattern of results across procedures. Experiment 2 yielded a happy categorization advantage for male faces that was not evident in Experiment 1. This suggests that presenting male faces among female faces may eliminate a happy categorization advantage for male faces that otherwise would be evident, for instance, if the same faces are presented alone or among male other race faces.

However, this conclusion is qualified by the results of the supplementary analysis that assessed the effect of task sequence. The happy categorization advantage for male faces was only evident after participants had categorized female faces, but not if they categorized the male faces...
Figure 2. Categorization time for happy and angry expressions as a function of the sex of the expresser and the order of completing the two tasks in Experiment 2. Inset graph represents categorization times for happy and angry male and female expressions averaged across both task orders. Error bars represent one SEM.
before the females. This suggests two conclusions. First, the happy categorization advantage for male Caucasian faces suggested by the overall analysis reflects on the performance of a subset of participants, i.e., those who had performed an expression categorization task with female faces first. Thus, the ‘default’ pattern of results for emotion categorization on male Caucasian faces, as shown by those who performed the task with male faces first, is the absence of a happy categorization advantage. A happy categorization advantage for Caucasian male faces emerged only when these faces were presented after female Caucasian faces had been categorized. This finding seems counterintuitive as one might have expected the same pattern of results when presenting male faces in a context of female faces, be it simultaneously or in succession.

Second, emotion perception is affected not only by the other faces presented in the same task, but also by faces presented in a previous task. This expands the notion of what can constitute a ‘context’ which may influence emotion perception. Prior studies had shown that contexts created by the other faces presented within a task can affect emotion perception on male Caucasian faces (Lipp, Craig, et al., 2015). The current study indicates that such an influence is also exerted by faces presented in recently completed tasks. It should be noted that this effect of faces seen in a prior task does not seem limited to emotion perception on male Caucasian faces. The happy categorization advantage was significantly larger for the task completed second regardless of whether the second task contained male or female faces. Thus, having categorized emotion on one set of faces seemed to enhance the happy categorization advantage for the other set of faces. Viewed from the perspective of experimental design, the current findings may have wider implications for research on social categorization and face processing. It appears that prior exposure to faces representing one subset of a particular social category (i.e. on males or only females) will affect performance with faces from a second subset of this social category calling into question the often used strategy of asking participants to complete a number of tasks relating to a particular research question.

Taken together, the results suggest that the influence of sex cues on emotion perception is specific to the gender context elicited by the task. As such, explanations for the influence of sex

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1 Although an interaction with task sequence was not initially predicted, analysis of a similar dataset from our lab supports this pattern of results. Twenty-six participants (5 males, 19.54, SD = 3.66) categorised anger and happiness on Caucasian male and female faces presented in separate tasks. Although the three way Task by Sex by Emotion interaction was not significant, F(1, 24) = 1.42, p = .245, ηp² = .06, as the sample size was comparably small, planned contrasts were conducted examining the pattern of results for each task sequence separately. They revealed different patterns of results for the two task sequences. Consistent with the findings of Experiment 2, for participants who completed the male task first, a significant Sex by Emotion interaction was observed, F(1, 11) = 5.80, p = .035, ηp² = .35, in the absence of any main effects of sex or emotion Fs < 1. There was no significant difference in categorization times for happy (M = 617.42, SD = 69.98) and angry (M = 608.02, SD = 59.92) male faces, t(11) = 1.04, p = .302, but happy expressions (M = 597.01, SD = 60.42) were categorized faster than angry expressions (M = 618.47, SD = 51.47) on female faces, t(11) = 2.37, p = .037. For those who completed the female task first, only a significant main effect of emotion emerged, F(1, 13) = 7.49, p = .015, ηp² = .38. Happy expressions were categorized faster than angry expressions for male faces (M = 574.85, SD = 36.83 vs. M = 587.56, SD = 41.38) and female faces (M = 570.80, SD = 46.07 vs. M = 595.78, SD = 44.27). The main effect of sex and the Sex by Emotion interaction were not significant for this task sequence, Fs < 1.71, ps > .213.
cues on emotion perception that only consider the information available on the current face being categorized and thus predict a consistent pattern of results for a specific set of stimuli are incomplete. The influence of sex on emotion perception is at least partly modulated by the contexts created by recently observed faces, either seen within the task at hand seen in other recently completed tasks.

**Experiment 3**

The gender context set by presenting both male and female faces within one task or separately across two tasks matters, but does it matter whether both positively and negatively valenced expressions are presented within a task? There is some reason to predict that altering the emotional context by presenting positive and negative expressions in separate tasks rather than within the same task may affect the influence that sex cues have on emotion perception. Bijlstra et al. (2010) assessed whether different patterns of results were observed for the influence of race and sex on emotion categorization when completing a dual valenced task (with happy and sad or angry faces) or a single valenced task (where only sad and angry faces were presented). Results suggested that, overall, implicit evaluations of gender influenced emotion categorization in the dual valenced task, but that stereotypes about gender influenced categorization in the single valenced task. When comparing response times to angry male and female expressions across tasks (where both evaluations and stereotypes should have the same influence on response times), no influence of the type of task was observed, but there was a difference in how quickly male and female expressions of sadness were categorized depending on whether the other faces within the task were happy or angry, consistent with the prediction of different outcomes based on the influence of evaluations and stereotypes. Subsequently Bijlstra, Holland, Dotsch, Hugenberg, & Wigboldus (2014) replicated this effect and provided further support for emotional stereotypes as the underlying mechanism influencing response times in the single valenced task. These results suggest that emotion contexts may matter. Importantly, these previous results cannot answer whether the influence of sex cues on the happy categorization advantage is dependent on the emotion contexts as this particular investigation did not include a positive single valenced categorization task for comparison.

Since the influence of altering the gender contexts was characterized by a change in response to the happy expressions, it seems particularly relevant to determine whether the results observed in Experiment 1 were dependent on the emotion context elicited by the task. This will also provide an indication of whether the difference in emotion perception observed in Experiment 2 was simply due to changing the nature of the task in some way or whether it was specific to varying the gender context of the task.
Experiments 1 and 2 demonstrated that the interaction between sex cues and emotion perception is affected by the sex of the faces shown within and between tasks. Experiment 3 aimed to investigate whether sex cues influence the categorization of happy and angry expressions when the emotion context was altered – i.e. when happy and angry expressions were presented in separate tasks rather than together in one task. This will allow us to determine whether sex cues influence categorization of a particular emotional expression in a constant manner regardless of the other emotional expressions presented. Participants categorized happy and neutral expressions displayed on male and female faces in one task and angry and neutral expressions on male and female faces in the other. Although Bijlstra et al., (2010) demonstrated that different influences of sex and race cues on emotion categorization can be observed depending on whether a single valenced or dual valence task is completed, it is predicted that presenting male and female faces together is key to observing the typical influence of face sex on emotion perception observed in Experiment 1 and the previous literature. Thus, as the conditions in Experiment 3 are comparable to Experiment 1, it is predicted that the results of Experiment 3 will replicate the results of Experiment 1.

Methods

Participants. Participants were 29 undergraduate volunteers who had not participated in Experiments 1 or 2 (8 males, $M = 19.31$, $SD = 2.81$).

Stimuli. In addition to the happy and angry expressions utilized in Experiments 1 and 2, the neutral expressions for each poser were used in the current experiment. These images were edited in the same manner as described in Experiment 1.

Procedure. As in Experiment 2, participants were instructed that they would complete two tasks. They were instructed to categorize the faces based on the emotion expressed – as happy or neutral in one task, and as angry or neutral in the other task. Task order and response mapping were counterbalanced across participants, but the response button for categorizing the neutral faces remained constant across the two tasks. The sex of the faces was varied within each task. In each task, each male or female face appeared with a Happy/Angry and Neutral expression twice resulting in 72 trials in each task and 144 trials all together.
Data reduction and Analysis. As in Experiments 1 and 2, invalid responses (less than 11% of responses) were removed. Data were submitted to a 2 (Sex: male, female) × 2 (Emotion: emotional, neutral) × 2 (Task: angry, happy) repeated measures ANOVA

Results

Response times. As can be seen in Figure 3, participants were overall faster to discriminate between happy and neutral faces than angry and neutral faces (main effect of task, $F(1, 28) = 6.88$, $p = .014$, $\eta_p^2 = .20$) and faster to categorize emotional than neutral faces, (main effect of emotion, $F(1, 28) = 4.87$, $p = .036$, $\eta_p^2 = .15$). There was also a significant Sex × Emotion interaction, $F(1, 28) = 5.86$, $p = .022$, $\eta_p^2 = .17$. These effects were superseded by a significant three way sex × Emotion × Task interaction, $F(1, 28) = 7.24$, $p = .012$, $\eta_p^2 = .21$.

This three way interaction was followed up with separate analyses for each of the two tasks – the happy and angry tasks. In the happy task, expressions were categorized significantly faster on female than on male faces, $F(1, 28) = 6.19$, $p = .019$, $\eta_p^2 = .18$, but there was no difference in how fast happy and neutral faces were categorized and no interaction of sex and emotional expression categorization, $Fs < 1.70$, $ps > .202$.

In the angry task, there was no main effect of sex indicating no difference in the speed with which expressions were categorized on male and female faces, $F(1, 28) = 0.77$, $p = .388$, $\eta_p^2 = .03$. However, participants were faster to categorize angry than neutral faces, $F(1, 28) = 4.65$, $p = .040$, $\eta_p^2 = .14$. This main effect of emotion was moderated by a Sex × Emotion interaction, $F(1, 28) = 8.51$, $p = .007$, $\eta_p^2 = .23$. Follow up analyses indicated that participants were faster to categorize angry than neutral expressions on male faces, $t(28) = 3.70$, $p < .001$, but not on female faces, $t(28) = 0.42$, $p = .678$.

Accuracy. Consistent with response times, participants made significantly fewer errors discriminating happy than angry from neutral expressions, $F(1, 28) = 20.94$, $p < .001$, $\eta_p^2 = .43$. They were also more accurate in categorizing neutral than emotional faces, $F(1, 28) = 8.04$, $p = .008$, $\eta_p^2 = .22$, and there was a marginally significant Sex × Emotion interaction, $F(1, 28) = 4.00$, $p = .055$, $\eta_p^2 = .13$. These effects were superseded by a significant higher order three way Task × Sex × Emotion interaction, $F(1, 28) = 20.02$, $p < .001$, $\eta_p^2 = .42$.

As with response times, this three way interaction was followed up with separate analyses for each of the two tasks. In the happy task, there were no significant main effects or interactions.

An additional analysis was conducted including task sequence as a between subjects factor. This analysis revealed a significant Task by Task sequence interaction, $F(1, 27) = 6.08$, $p = .020$, $\eta_p^2 = .18$. This reflected that participants who completed the angry task first were overall faster to respond in the happy task than the angry task, $t(27) = 3.64$, $p = .002$ but participants who completed the angry task second were no faster to respond in either the happy or the angry task, $t(27) = 0.24$, $p = .812$. This effect is likely to reflect that the discrimination between neutral and angry faces is harder than the discrimination between neutral and happy faces. Participants in the happy task first condition would have become familiar with the neutral faces in their first task facilitating their performance on the subsequent angry/neutral task. There were no further effects of task sequence all $Fs < 1$. 

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3 An additional analysis was conducted including task sequence as a between subjects factor. This analysis revealed a significant Task by Task sequence interaction, $F(1, 27) = 6.08$, $p = .020$, $\eta_p^2 = .18$. This reflected that participants who completed the angry task first were overall faster to respond in the happy task than the angry task, $t(27) = 3.64$, $p = .002$ but participants who completed the angry task second were no faster to respond in either the happy or the angry task, $t(27) = 0.24$, $p = .812$. This effect is likely to reflect that the discrimination between neutral and angry faces is harder than the discrimination between neutral and happy faces. Participants in the happy task first condition would have become familiar with the neutral faces in their first task facilitating their performance on the subsequent angry/neutral task. There were no further effects of task sequence all $Fs < 1$. 

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There was a trend towards more accurate categorization of neutral than happy expressions, \( F(1, 28) = 2.96, p = .096, \eta_p^2 = .10 \); however, a marginally significant Sex \( \times \) Emotion interaction, \( F(1, 28) = 3.03, p = .093, \eta_p^2 = .10 \), indicated greater accuracy in categorizing neutral than happy expressions on male faces, \( t(28) = 2.67, p = .013 \), but no difference in accuracy categorizing happy and neutral expressions on female faces, \( t(28) = 0.21, p = .835 \).

In the angry task, consistent with response times, there was no main effect of sex indicating no difference in the accuracy with which expressions were recognized on male and female faces, \( F(1, 28) = 0.60, p = .446, \eta_p^2 = .02 \). However, participants were, overall, more accurate at categorizing neutral than angry faces, \( F(1, 28) = 6.69, p = .015, \eta_p^2 = .19 \). This main effect of emotion was moderated by the sex of the face, \( F(1, 28) = 15.81, p < .001, \eta_p^2 = .36 \). Participants were more accurate to categorize neutral than angry expressions on female faces, \( t(28) = 5.62, p < .001 \), but there was no difference in the accuracy of categorizing angry than neutral expressions on male faces, \( t(28) = 0.00, p = 1.00 \).

Comparison to the standard results (Experiment 1). As for Experiment 2, the data from the relevant conditions in Experiment 3 were compared to the standard pattern of results in Experiment 1. This was to determine whether sex cues influenced the recognition of happiness and anger similarly when happy and angry expressions were presented in separate tasks or within the same task. To do this, categorization times and error rates for happy and angry male and female faces from Experiments 1 and 3 were submitted to a \( 2 \) (Sex: male, female) \( \times \) \( 2 \) (Emotion: happy, angry) \( \times \) \( 2 \) (Experiment: experiment 1, experiment 3) mixed ANOVA.

Response times. There was no difference between the patterns of categorization times in the two Experiments with no significant main effects or interactions involving the experiment factor, all \( F_s < 1, ps > .665 \). The results of the ANOVA including data from Experiments 1 and 3 together demonstrate that participants were overall faster to categorize happy than angry faces, \( F(1, 57) = 10.56, p = .002, \eta_p^2 = .16 \), and overall faster to categorize expressions on male than on female faces, \( F(1, 57) = 7.62, p = .008, \eta_p^2 = .12 \). These main effects were moderated by a Sex \( \times \) Emotion interaction, \( F(1, 57) = 31.72, p < .001, \eta_p^2 = .36 \). Follow up analyses indicated that happy expressions were categorized faster than angry expressions when displayed on female, \( t(57) = 5.10, p < .001 \), but not male faces, \( t(57) = 1.17, p = .247 \).

Accuracy. The results of the \( 2 \) (Sex: male, female) \( \times \) \( 2 \) (Emotion: happy, angry) \( \times \) \( 2 \) (Experiment: Experiment 1, Experiment 3) mixed ANOVA indicated that discriminating emotional from neutral faces was more difficult than discriminating happy from angry faces as significantly more errors were made in Experiment 3 than Experiment 1, \( F(1, 57) = 27.33, p < .001, \eta_p^2 = .32 \). A significant Experiment \( \times \) Emotion interaction, \( F(1, 57) = 6.17, p = .016, \eta_p^2 = .10 \), suggested that this was because angry faces were harder to discriminate from neutral faces than happy faces, as
follow up analyses indicated that participants made significantly fewer errors categorizing angry expressions in Experiment 1 than Experiment 3, $t(57) = 4.73, p < .001$, but had comparable accuracy categorizing happy expressions in the two Experiments, $t(57) = 1.22, p = .228$. There was no two way Task $\times$ Sex interaction and no three way Task $\times$ Sex $\times$ Emotion interaction suggesting no differences in the influence of sex on emotion categorization between Experiment 1 and 3.

Overall, considering the results of Experiments 1 and 3 together, participants made fewer errors categorizing happiness than anger, $F(1, 57) = 17.72, p < .001$, $\eta_p^2 = .23$, but this was moderated by the sex of the face (significant Sex $\times$ Emotion interaction, $F(1, 57) = 8.55, p = .005$, $\eta_p^2 = .13$). Consistent with response times, this interaction reflected that happy expressions were categorized with greater accuracy than angry expressions when displayed by females, $t(57) = 7.40, p < .001$, but no difference in accuracy was observed in categorizing happiness and anger displayed on male faces, $t(57) = 1.17, p = .247$.

**Discussion**

The aim of Experiment 3 was to determine whether altering the emotion context changed the influence of sex cues on emotion perception. As predicted, comparing the results of Experiments 1 and 3 suggested that the influence of sex on emotion categorization in the two tasks did not differ. This suggests that the emotion context elicited by presenting happy and angry faces together within one task does not affect how sex cues influence emotion categorization as long as the gender context is comparable. Although studies by Bijlstra and colleagues (2010, 2014) demonstrated that changing emotional contexts from happy vs. sad or angry to sad vs. angry can determine whether evaluations or stereotypes influence emotion categorization, the influence of sex cues on the categorization of happiness and anger observed in Experiment 1 and in the previous literature is not dependent on the presence of both positively and negatively valenced expressions within a single task.

As a side note, it is interesting that a significant happy categorization advantage was not observed when happy male and female faces were categorized in a task with neutral expressions. This is in contrast to past findings that happy faces were categorized faster than neutral and angry or disgusted faces (Hugdahl et al., 1993; Leppänen & Hietanen, 2004). It is likely that the current results differ from the past findings because of methodological differences between the current study and the past research. One key contributor may have been that, in previous studies, participants had to categorize faces with three response options (e.g. Happy, Neutral, and Angry/Disgusted). Slower response times to neutral faces may have been due to neutral and disgust or neutral and angry expressions being more easily confused with each other than neutral and happy expressions. When all three expressions are presented within one task, this could result in slower response times to neutral and angry/disgusted faces relative to happy faces, producing a happy
Figure 3. Categorization time for happy, angry and neutral expressions as a function of the sex of the expresser for both the Angry/Neutral task and the Happy/Neutral tasks of Experiment 3. The inset graph represents the same data omitting the neutral conditions. Error bars represent one SEM.
categorization advantage for happy vs. neutral faces. The confusability of neutral and negative expressions in these past studies may have been exacerbated as each face was presented for a limited duration of between 180ms and 200ms rather than until a response was made. Consistent with this proposal, error rates reported in this Experiment 3 and by Hugdahl et al. (1993) were significantly higher in the angry and neutral conditions than in the happy condition.

As another side note, it is also interesting that a significant Sex × Emotion interaction was observed in the angry/neutral task but not in the happy/neutral task. The Women are Wonderful Hypothesis proposes that both men and women are positively evaluated, but women are evaluated as more positive than men (Eagly et al., 1991). If the interaction of sex and emotion reflects response priming by the relatively positive evaluation of female faces (Hugenberg & Sczesny, 2006), then an influence of sex on emotion should have been apparent in the happy/neutral task, but not in the angry/neutral task – the opposite of what was observed. The results we observed may reflect that angry male expressions are easier to distinguish from neutral than angry female expressions, perhaps due to the physiognomy of the prototypical male and female face (Becker et al., 2007; Hess et al., 2009). This pattern of results may also have emerged because men are stereotypically more likely to be associated with expressing anger than women (Plant, Hyde, Keltner, & Devine, 2000) as emotion stereotypes have been found to influence emotion categorization in single valence categorization tasks (Bijlstra et al., 2010, 2014).

**General Discussion**

The overall aim of this study was to determine whether the influence of social category information present on a face, such sex cues, influences the perception of emotion in a uniform and consistent manner or whether this influence is dependent on the social contexts made salient by the task. More specifically, it was investigated whether the finding that happy expressions are categorized faster than angry expressions when posed by a female but not a male, was the default response or due to the task emphasizing the gender dimension by presenting both male and female faces. Across three experiments using the same face stimuli, it was demonstrated that this typical pattern of results depended on the gender context elicited by presenting both male and female faces within a single task. Presenting these same male and female faces in separate tasks produced a significantly different aggregate pattern of results. This change in results was specific to manipulating the gender context and not just due to a change in the task parameters as manipulating the emotion context by presenting happy and angry expressions in separate tasks did not influence the speed of categorizing these male and female emotional faces.

Previous studies have shown that the faces presented within a task can render a particular social dimension salient. For example, presenting the same happy and angry White male faces along with female faces or male other race faces, led to different happy categorization advantages for
White male faces depending on the social category memberships of the other faces (Lipp, Craig, et al., 2015). From these initial studies, it was unclear whether the absence of a happy categorization advantage for male faces presented among female faces reflected a default response that was altered when these faces were presented in a context in which race was made salient. It was also unclear whether the typical pattern observed was a product of the emotional context elicited by presenting both positively and negatively valenced stimuli as a previous investigation showed a differential influence of sex cues on emotion categorization depending on whether positive and negative expressions or only negative expressions were presented within the task (Bijlstra et al., 2010).

The current results indicate that the absence of a happy categorization advantage when male faces are presented among female faces is indeed the default, as it is also evident if the male faces are presented alone as the first task. However, the current study also identified a new condition under which a happy categorization advantage for male faces can be observed, namely when categorization of expressions on male faces follows a task that requires expression categorization on female face. This adds to prior evidence that the influence of sex cues on emotion perception is not fixed but is flexible (e.g. Bijlstra et al., 2010, 2014) and dependent on whether the gender dimension is salient (Lipp, Craig, et al., 2015). The results also demonstrate that when both male and female faces are presented, the influence of sex cues on the recognition of expressions of happiness and anger is not dependent on the presentation of both positively and negatively valenced expressions within a single task.

Interestingly, the reason why the aggregate pattern of results in Experiment 2 did not replicate Experiment 1, was because participants who completed the female task first showed a different pattern of results to those who completed the male task first – namely a happy categorization advantage for both male and female faces. It was unexpected to find that a happy categorization advantage only emerged for male faces after the completion of an emotion categorization task with female faces. If anything, within the current literature, it would have been expected that a happy categorization advantage for male faces would be observed if that task was completed first, and that it may be reduced after completing the female task. This would have been expected as going from the female to the male task would make the gender context salient. There are obviously other factors at play that were not anticipated in previous research.

Considering the results of Experiment 2 in a different way may provide some insight. In Experiment 2, it was found that the Happy Categorization Advantage was significantly larger in the second task completed regardless of whether the second task involved categorizing expressions on female or male faces. This suggests that practice or experience may be changing the relative speed of categorizing expressions. To examine this further, we looked more closely at the results each task by comparing the pattern of results for the first presentation of each stimulus (block 1) to
subsequent presentations of the stimulus (blocks 2-4). Although the presence and magnitude of the Happy Categorization Advantage did not change significantly within the course of the tasks, there was a numerical trend towards a change in how quickly participants responded to happy and angry male faces. For participants who completed the male task first, a 34ms anger advantage was observed in the first block (the first presentation of each stimulus face). This disappeared across subsequent blocks (1ms and 15ms angry advantages in blocks 2, and 3 and a 3ms happy advantage in block 4). For those who completed the male task second, there was initially not much of a difference in the speed of categorizing happiness and anger (3ms angry advantage). From block 2 onwards, there was evidence for a happy advantage (28ms, 16ms, 23ms advantages in blocks 2, 3, and 4 respectively). In the female tasks, this same pattern of a happy advantage emerging across the course of the task was not observed. When participants completed the female task first, there was a 39ms happy advantage observed from block 1 which was maintained throughout the course of the task (47ms, 29m, and 24ms happy advantages in blocks 2, 3, and 4 respectively). For participants who completed the female task second, again a relatively consistent, although slightly larger, happy advantage was observed across blocks (51ms, 44ms, 48ms, and 50ms happy advantage in blocks 1, 2, 3, and 4 respectively). These trends suggest that experience with the task tends increase the magnitude of the happy categorization advantage and that this experience effect seems to transfer to a subsequent task explaining why the Happy Categorization Advantage was larger in the second task regardless of whether female and male faces were categorized. Conducting a similar analysis on the results of Experiment 1 suggested no trend towards a larger happy categorization advantage with experience for male faces (14ms anger advantage in both blocks 1 and 2) or female faces (64 and 52ms happy advantage for blocks 1 and 2 respectively). This analysis suggests that the influence of experience on categorization performance is specific to tasks where faces of only one sex are presented.

We can only speculate as to why experience with the emotion categorization task with only male or female faces facilitates a happy categorization advantage in a subsequent task, but not when both male and female faces were presented within the task. It is possible that the effect of experience was only observed when the stimulus set was homogeneous (when only stimuli of one sex were used) as the presence of only male or only female faces in the task reduced the salience or relevance of gender and potentially increased the relevance of emotion which may have enhanced experience benefits that occurred in the emotion categorization task. As this is only speculative at this point, further research will be needed to address why this effect was observed.

Implications for Theory

These results are consistent with current models of person perception such as the dynamic interactive theory of person construal (Freeman & Ambady, 2011) and also extend our
understanding in this area of person construal. *The dynamic interactive theory of person construal* posits that faces come to be categorized by their race, sex, age, and emotional expression by a system influenced by bottom-up visual facial structure information as well as top-down higher order information, goals, and associations. Upon viewing a face, cue level nodes are activated in response to particular features, such as the shape of the eye brow ridge or the jaw. These cue level nodes can provide bottom-up input into multiple category (sex, emotion, race, and age) level nodes. Person construal also happens under the top-down influence of higher order cognitive states, including a person’s current goals, motivations, and expectations. Importantly, the interaction of social cues can change from moment to moment as a person’s current goals, motivations and expectations change. This is reflected in the model by a stronger weight being placed on particular categories and cues due to the person’s current higher order cognitive states.

Across all tasks, the same set of faces was used; however, the same pattern of results was not always observed. This demonstrates that the influence of sex cues on emotion perception is not only the result of a bottom-up stimulus driven process. There are also clear top-down influences at play. *The dynamic interactive theory of person construal* (Freeman & Ambady, 2011), when it was originally proposed, did not elaborate much on the range of possible sources of top-down influence. As such, these results provide further evidence to help refine our understanding of when top-down influences alter the way in which multiple facial cues like sex and emotion interact. These findings demonstrate that the other faces seen within a task as well as previously completed tasks are sources of top-down influence to be considered in the process of person construal. When looking at the influence of sex cues on emotional expression perception, the degree to which the sex category is salient matters. The salience of a dimension can be manipulated implicitly by the faces present within a task or across tasks.

**Implications for Research Design**

The current experiments highlight just how important it is in studies of face processing and person perception to consider the processing of a particular stimulus in the context of other stimuli presented in previous tasks or on previous trials within the same task. It is tempting to assume that performance on a particular trial is just as it would have been if it were the first and only trial the participant had encountered, free from the influence of the particulars of the experimental procedure. This is clearly not the case. Given the current results, it is wise to collect samples that have sufficient power to detect task sequence effects as well as potential changes in performance between earlier and later trials. Averaging results across different task sequences could produce aggregate patterns of results that do not adequately reflect the performance of different sub groups.
Conclusion

The current findings demonstrate that explanations for the interaction of multiple facial cues which are based on the processing of individual stimuli and do not consider the context in which they are presented are insufficient. Whether explanations focus on the physical structure of the face or the association, evaluations, or stereotypes related to social category information available from the face, studies interested in understanding how multiple facial cues are integrated must additionally consider which elements of the face are made salient by the task at hand. Future studies should consider implementing designs where age, sex, race, and emotion are all varied together within a task and made differentially salient across tasks if we are to come closer to understanding how these multiple cues are integrated or influence each other in more natural settings.
References


Table 1.

*Error percentages for Experiments 1-3. Values in brackets represent 1 standard deviation.*

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angry</td>
<td>5.37 (4.94)</td>
<td>8.33 (6.96)</td>
</tr>
<tr>
<td>Happy</td>
<td>5.55 (5.84)</td>
<td>4.44 (6.91)</td>
</tr>
<tr>
<td><strong>Experiment 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male task first</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angry</td>
<td>5.35 (6.47)</td>
<td>6.64 (6.18)</td>
</tr>
<tr>
<td>Happy</td>
<td>5.56 (5.56)</td>
<td>3.86 (3.87)</td>
</tr>
<tr>
<td>Female task first</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angry</td>
<td>5.34 (4.37)</td>
<td>6.88 (4.71)</td>
</tr>
<tr>
<td>Happy</td>
<td>4.93 (4.15)</td>
<td>4.72 (3.94)</td>
</tr>
<tr>
<td><strong>Experiment 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Happy task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Happy</td>
<td>11.30 (7.92)</td>
<td>9.20 (8.17)</td>
</tr>
<tr>
<td>Neutral</td>
<td>6.51 (5.77)</td>
<td>8.81 (11.45)</td>
</tr>
<tr>
<td>Angry task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angry</td>
<td>14.75 (10.10)</td>
<td>20.11 (15.39)</td>
</tr>
<tr>
<td>Neutral</td>
<td>14.75 (13.05)</td>
<td>6.90 (7.37)</td>
</tr>
</tbody>
</table>

*Note.* Values presented are the mean error percentage in each condition. Numbers in parentheses denote one standard deviation.
Chapter 6
General Discussion
The overall aim of this thesis was to extend our understanding of the top-down influence of higher order cognitive states on the interaction of facial cues and social categories in the face, specifically in the processing of emotion. The dynamic interactive theory of person construal (Freeman & Ambady, 2011) proposes that the way we recognize category information (sex, race, age, and emotion) in a face is interactive, partly due to overlapping structural information and partly due to the top-down influence of higher level cognitive states including activated associations relevant to social categories, as well as the person’s current goals. Until now, the literature identifying these top-down influences and describing their influence is sparse. This thesis describes a range of demonstrations of how explicitly and implicitly activated higher order states influence the interaction of multiple facial cues and categories. Explicit contexts were manipulated by instructing participants to focus on different categories available within the face. Implicit contexts were elicited by altering the other faces seen at the same time as the target face, altering the other faces seen on different trials within the same task, or altering the other faces seen in recently completed tasks.

Chapter 2 demonstrated that the nature of the task can influence the way cues like race, sex, age, and emotion interact. Contrary to some previous research which found preferential processing of race/sex/age over emotion (e.g. Atkinson, Tipples, Burt, & Young, 2005; Karnadewi & Lipp, 2011), the current results suggest that emotion cues rather than group membership cues are preferentially processed in evaluation tasks. This chapter also demonstrated that explicit task goals can alter the way that faces are implicitly evaluated. Focusing on the race/sex/age/emotion enhanced the strength of evaluations along that dimension. Both of these conclusions support the notion that person construals are flexible and dependent on the type of task used to investigate the processing of multiple cues as well as explicit task goals.

Chapter 3 demonstrated that the nature of the background faces in a visual search task alters which expressions are more quickly detected. These findings provide evidence to suggest that other concurrently present faces can impose a top-down influence on the integration of multiple emotion relevant facial cues. This may be because changing the faces in the background changes the nature of the task and leads to participants using different strategies and prioritizing different facial cue level information. Similar to Chapter 2, these findings demonstrate the top-down influence of task goals on the processing of cue level information in the face, but this time the different contexts were elicited implicitly by the other task irrelevant faces on each trial.

In Chapter 4, it was shown that the way facial cues of race influence the categorization of happy and angry emotional expressions depends on the presentation duration, stimulus type and importantly the number of different faces presented within a task. Subsequently, the perceptual load account proposed as a potential explanation of the results observed in Chapter 4.1, was evaluated in
Chapter 4.2 and found to be unlikely to account for the different patterns of results observed at small and large set sizes. The findings of Chapter 4.2 suggest that completing a task using a large rather than a small number of different own and other race faces may trigger different higher order cognitive states which change the way that race cues influence emotion categorization. For example, it was suggested that seeing a large range of own and other race faces implicitly increased perceptions of outgroup heterogeneity, a manipulation which has previously been found to reduce negative evaluations of out groups (Brauer & Er-rafiy, 2011). These findings again support the idea that the processing of multiple facial cues is flexible and shaped by a range of different top-down influences arising implicitly due to the nature of the task and the stimulus faces used.

Finally, Chapter 5 demonstrated that the way facial sex cues influence emotion perception can be affected not only by the other faces present within a task as Chapter 4 describes, but also by other recently completed tasks. Typically, in tasks where both male and female happy and angry expressions are present, happy expressions are categorized faster than angry expressions when posed by a female, but not when posed by a male. Presenting the male and female faces in separate tasks produced a statistically different pattern of results. This was because, there was no difference in categorization speed for male expressions of happiness and anger when participants completed the male task first, but participants were faster to categorize male expressions of happiness than anger, when they completed the task containing female faces first. It was hypothesized that presenting male and female faces separately rather than together influences the salience of the dimension of gender resulting in different influences of gender on emotion perception. Again, these findings can be interpreted within a model that predicts that the interaction of multiple social categories such as sex and emotion can be influenced by top-down higher order cognitive states which can shift from moment to moment (Freeman & Ambady, 2011).

Together these findings demonstrate that explicitly as well as implicitly activated higher order cognitive states elicited by the task, the task instructions or by other spatially and temporally proximal faces do indeed influence the way in which other category information in a face such as race, sex, and age, can alter the processing of emotional expression. This is not the first time that the influence of top-down higher order cognitive states has been observed to influence the interaction of multiple facial cues. For example, in studies investigating the nature of the interaction between two categories, participants complete two tasks of the same nature using the same faces where one category is task relevant in the first task, and the other is task relevant in the second (e.g. Aguado, García-Gutierrez, Serrano-Pedraza, 2009; Atkinson et al., 2005, Le Gal & Bruce, 2002, Lipp, Craig, Frost, Terry, & Smith, 2014, Karnadewi & Lipp, 2011; Kubota & Ito, 2007). The way the two categories interact is often found to vary across tasks and depends on the nature of the task. This investigation, however, is the first to explicitly recognize implicit contexts or higher order states
that arise due to the nature of the task, the faces observed recently within the task and the faces observed recently in a different task. The fact that these implicit contexts seem to arise due to the particular nature of the task or tasks that are completed has important practical and theoretical implications.

**Implications for Practice in Research on Person Construal**

The findings of this thesis have important implications for the way that research is conducted in the areas of face processing and person perception. Currently, the majority of studies investigating the perception of emotion, race, sex, etc. use multiple trials of a particular condition type. They also expose participants to multiple conditions (e.g. Atkinson et al., 2005; Aguado et al., 2009; Le Gal & Bruce, 2002; Lipp et al., 2014; Kubota & Ito, 2007). It is also not uncommon to have the same participants complete a number of tasks within one testing session (e.g. Karnadewi & Lipp, 2011). Through averaging, these designs have the benefit of producing a stable estimate of whatever the dependent variable is – be it response times, accuracy rates, physiological responses or self-report measures. Repeated measures designs are also typically statistically more powerful for detecting differences between different conditions as additional participant variance can be removed from the error variance (Howell, 2012). However, the often overlooked consequence of these designs in the face processing literature is that response patterns to a face are relative to the particular constrained context of the task, and may not generalize to other contexts. This is not necessarily problematic as it shows us the flexible nature of person construal; however, it limits our ability to generalize our findings beyond the particular task at hand and makes it difficult to predict exactly what is occurring in more natural face-to-face interactions and to develop theories that allow us to make predictions about what will occur during these interactions.

To address this, researchers should avoid testing multiple tasks within a testing session unless theoretically relevant or important for the ecological validity of the study. This can most easily be avoided when testing multiple ‘unrelated’ tasks with the same sample in the same testing session. If the order of these unrelated tasks is held constant, it may be impossible to determine whether a previously completed task has had an influence on performance on the task of interest. Where it is desirable to have the same participants complete multiple tasks, counterbalancing the order of unrelated tasks and statistical analysis of task order effects is recommended (e.g. see Chapter 5). As these order effects may be small, a larger sample may be required to have enough power to detect these effects and ensure that the patterns observed are not, in part, due to the influence of previous tasks. With smaller sample sizes, the completion of the same tasks in different orders for different participants may push responses in opposite directions making it harder to detect an effect. It may also have the result of producing an averaged pattern of results that may not necessarily represent the pattern of responding for any particular sub group.
The influence of presenting participants with multiple conditions is harder to address as many paradigms, especially a number of commonly used methods, cannot be successfully run without some kind of categorization or discrimination and thus at least two stimulus categories. As such, response patterns from any task of this nature may be relative to the other stimulus category or categories present in the task. This is, in some ways, no different from our natural interactions, as each face we see is processed relative to the accumulation of our past experiences. However, when we limit the categories that will be observed (for example, by only presenting happy and angry faces and giving only two response options) the outcomes we observe are likely to be constrained to this situation and the strategies participants use to perform our task will not necessarily reflect processes engaged on a daily basis in natural interactions. Also, varying a particular cue (like race) within a task in proportions that are not naturally encountered, may heighten the salience and thus the influence of this cue on the processing of other features in a way that does not happen in our incidental exposure to unfamiliar faces.

This is not to say that the patterns observed in tasks aiming to investigate the interaction of multiple cues are meaningless. It is likely that they reflect on overlaps between shared facial features (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007; Hess, Adams, Grammer, & Kleck; Sacco & Hugenberg, 2009) and the influence of evaluations, associations (Hugenberg, 2005; Hugenberg & Sczesny, 2006) or stereotypes held about the particular social categories (Bijlstra, Holland, & Wigboldus, 2010; Bijlstra, Holland, Dotsch, Hugenberg, & Wigboldus, 2014). However, the boundary conditions for these influences and the extent to which these influences occur in natural face-to-face interactions remain in question.

To address these questions, further research is necessary. For example, it may also be useful to run studies in which multiple social categories are varied, for example a task where race, age and sex are all varied within the same task, to decrease the salience of any one particular category. It may also be interesting to present different category members in the proportions that they are typically encountered to see how emotions are processed under these conditions. This may provide a better indication of whether and how these cues interact when one particular category is not made salient by the task. Researchers must also actively consider what kinds of implicit contexts may be elicited by the task at hand and how they may influence results. Questions that should be considered include: Which categories are explicitly important in this task? Which categories and associations may be implicitly activated by the task at hand? Which mental states, moods, associations etc. may have been activated by recently completed tasks? Have particular categories now been made more salient by presenting these tasks in this order? Results for any study should then be interpreted and discussed through this lens.
This approach may also be beneficial for making meaning of the growing number of studies investigating the interaction of multiple facial cues that are producing inconsistent results such as the influence of race on emotion categorization (Hugenberg, 2005; Kubota & Ito, 2007), or the influence of sex on emotion categorization (Becker et al., 2007; Aguado et al., 2009; Atkinson et al., 2005; Karnadewi & Lipp, 2011; Le Gal & Bruce, 2002). Considering the contexts elicited by a particular task or tasks may help researchers make more specific predictions about how multiple cues will interact. Looking at the nature of the interaction across multiple types of tasks as well as across multiple different category contexts will help us to find the most common patterns of interaction and the boundary conditions for these interactions (e.g. Chapters 4 and 5). We will then be able to identify different conditions that can alter or eliminate typical interactions. Doing so will also allow us to extend theory and produce models of person construal that can more accurately predict behaviour.

Implications for Theory on Person Construal

Although further research is required before we can fully appreciate the complexities of person construal, the findings reported in this thesis already extend existing theory. The dynamic interactive theory of person construal (Freeman & Ambady, 2011) describes how the multiple sources of information in a face are interpreted as social categories. This model proposes that the interpretation of social categories from faces is a result of the interaction of both lower level facial cues like eye shape, skin color, jaw line and the top-down influence of largely non-specified higher order cognitive states. Importantly, this model proposes that social categorization is a process that shifts across time and that categorization of a face along any social dimension can be altered by recent experiences and relevant associations. This means that the way the same face is categorized when seen on the first trial in a task, may be very different to how it is categorized when seen on the last trial or within a different task. The results of this thesis support the proposal that the interaction of social categories is flexible and dependent on higher order cognitive states that can change across time. The fact that the very same faces are categorized differently depending on the other faces seen within the task or other recently completed tasks demonstrates that accounts describing how multiple cues interact that only focus on mechanisms occurring on a single trial (e.g. Hugenberg, 2005; Hugenberg & Sczesny, 2006; Becker et al., 2007) overlook the important influence of broader situational factors. This thesis goes some way to providing concrete examples of the influence of a few higher order cognitive states and demonstrates that these can arise implicitly from a task or combination of tasks.

These findings also provide a potential explanation for inconsistencies observed across the literature. Different studies investigating the interaction of the same facial features (for example race and emotion) have come to different conclusions about the nature of these interactions. For
example using categorization paradigms, researchers have concluded that cues of race are processed preferentially to cues of emotion such that varying the race of faces within a task influences emotion categorization but varying the emotions on a faces does not influence race categorization (e.g. Karnadewi & Lipp, 2011). On the other hand, other studies have drawn the opposite conclusion. Both visual search (Lipp et al., 2014) and affective priming tasks (Chapter 2) have revealed an influence of emotion cues on the detection or evaluation of race in the absence of a comparable influence of race on the detection or evaluation of emotional expression. It is likely that the nature of the interaction between cues like race and emotion depends on the task goals. Some tasks may lead to the prioritization of emotion information, making emotion categories more salient and prioritizing the processing of emotion relevant cues whereas others may prioritize other cues like race. As such, attempts to ascertain the order of processing or importance of different face cues using only a single task type overlook the broader influence of higher-order cognitive states that result from the demands of a given task, and the relative importance of different cues in different situations.

There is a need for further research in this area using a range of different paradigms as well as using already tested paradigms in slightly different contexts (such as with different race, emotion and age categories) in order to more fully understand how multiple cues are processed in concert. This will help us to understand how and when particular categories and cues are prioritized.

Considering the higher order cognitive states that may be elicited within these tasks will also allow the proposal of more accurate hypotheses in future investigations.

These studies, along with the existing literature demonstrate that the processing of social categories like race, age, and sex is highly flexible, as is their influence on the processing of emotional expressions. This is inconsistent with earlier theories of person perception that assumed that social categorization was an early and obligatory aspect of person perception that could only be subverted after the fact with conscious control (Brewer, 1988; Fiske & Neuberg, 1990). Consistent with more recent proposals (Bodenhausen & Macrae, 1998), our results suggest that early categorization processes may not always occur in the same way and might not always be detected in behaviour. Rather it seems that the degree to which a social stimulus like a face is categorized on any particular dimension depends on the specific context in which the face is viewed and which categories are implicitly or explicitly relevant to the observer’s goals and mental states.

It is likely that the processing of emotional expression is also not obligatory (Hansen & Hansen, 1988; Tracy & Robins, 2008) but flexible and whether or not it is processed depends on the task at hand or whether it is relevant to the given situation (e.g. van Dillen, Lakens, Kees, & van den Bos, 2011). This idea is also consistent with the finding of no influence of varying emotion cues on the processing of other facial information such as race and age (Karnadewi & Lipp, 2011).
as well as with studies in our lab which have failed to find interference effects for task irrelevant emotional faces in visual search. It is likely that the processing of all social categories depends on the salience or relevance of that dimension in the given situation – for example the way that an old Japanese man is categorized may differ depending on where he is seen. He might be categorized as old when seen with his grandchildren but not with his golf friends, as Asian when on holidays in Europe, but not at home, or as a Male if he accidentally finds himself in the ladies’ bathrooms. Thus the way in which facial social category information influences the perception of his expressions may be somewhat fixed, driven by overlapping facial cues, but also somewhat variable depending on the social categories relevant in that moment and their related associations.

It is possible that flexibility in social categorization is one example of a more domain general cognitive flexibility – that is being able to classify an object across various dimensions and readily shift these classifications in response to the environment (Scott, 1962). Tests of cognitive flexibility assess how quickly a person can shift from categorizing something along one dimension to another (e.g. Wisconsin Card Sort Test; Grant & Berg, 1948). Parallels have been drawn between being able to categorize an entity flexibly along multiple dimensions such as being able to see the duck or the rabbit (see Figure 1) and the ability to create and be innovative (e.g. Murray, Sujan, Hirt, & Sujan, 1990). It is possible that this ability also allows us to be flexible in social interactions and to extract meaning from a face that is particularly relevant to the current situation. The ability to shift from categorizing something from one dimension to another develops through childhood (Chelune & Baer, 1986) and is impaired with old age (Haaland, Vranes, Goodwin, & Garry, 1987; Rhodes, 2004). It may be interesting to investigate the flexibility of social categorization in children and in older adults as the processes involved and patterns observed may be different in these groups.

Figure 1. Is it a rabbit or is it a duck?
Future Directions

As we come closer to understanding the most common patterns of interaction and the boundary conditions for these patterns, further research will be required to identify what mechanisms underlie changes in responding as a function of observed intra- or inter-task effects. In Chapter 2, different patterns of evaluations were observed depending on the instructions given to participants. These different patterns could be attributed to differences in participants’ explicit goals and attentional focus. When the influence is due to the nature of the task itself, as observed in chapters 3 - 5, it is harder to pinpoint the underlying mechanism. To do so will require further research. In this research, if the same patterns can be replicated by manipulating the relevance of social categories with instruction rather than by just observing changes in behaviour due to other recently observed faces, it may be possible to identify the potential mediators of these effects.

To address the broader questions of how multiple facial cues are integrated, separating the role of higher order cognitive states and shared facial cues on the resulting interaction of social categories and emotion is necessary. One way to do this would be to present the two cues, such as the emotional expression and the race information separately on the screen, to see whether they still interact. For example, a line drawn schematic emotional faces could be presented alongside own and other race faces, or male and female faces to measure the contribution of evaluations, associations or stereotypes elicited by the categories separate from the influence of shared facial cues. Chapter 4.2, Experiment 2b demonstrates that this technique may be successful. In that task, an influence of race on emotion categorization was observed even though the race information was separate from the emotional expressions. Ultimately, teasing apart the role of top down and bottom up influences on person construal will allow for the development of a model that is able to generate specific predictions about the exact nature of the interaction between multiple cues in any given situation.

Beyond the influence of other faces, future research should also focus on fleshing out the broad range of top-down influences on the interaction of social category information and emotional expressions on the face, as current models of person construal are not specific on exactly what these are (see Freeman & Ambady, 2011). Understanding the role of various contexts in person construal will be useful in developing strategies to reduce automatic social categorization and activation of negative stereotypes or evaluations of particular groups. It is difficult to change the physiognomy of a face, but it is possible to change a person’s expressions and even easier, it seems, to change the degree to which social categories are extracted or influence the processing of other cues. Chapter 2 demonstrates that relatively negative evaluations of outgroup members, including Africans/African Americans, older adults, and males are not observed in implicit evaluations when emotional expression information is present. Having a strong understanding of the range of influences that can
alter how and when social categorization occurs can provide a basis for the development of both short term and longer term intervention strategies that can reduce stereotyping and discrimination.

For example, the results from Chapters 4 and 5 suggest that cues of race and gender do not moderate the speed of recognizing emotional expressions under some circumstances. Recent experiments in our lab have added to this, demonstrating that the moderating influence of age and race cues are eliminated when the emotion categorization task is preceded with an age or race categorization task. These preliminary results suggest that engaging in this kind of social categorization task may inhibit subsequent automatic social categorization or evaluation when another dimension of the face (such as emotion) is more relevant. If an underlying mechanism for this effect could be identified, this could potentially be harnessed as an intervention to reduce the influence of social category and resulting associations and stereotypes on social interactions.

Person construal is highly flexible and dependent on the situation. Studies investigating the interaction of multiple cues must more seriously consider the role of both explicit and implicit context, especially those elicited by other faces observed in the task at hand or in a recently completed task. Further research needs to determine which contexts matter, and get a better handle on the way in which these contexts result in different patterns of behaviour. This will allow the development of theory that can better predict how multiple facial cues interact in any given situation and ultimately shed light on how faces are processed in natural interactions.
References


