Context Influence in Emotion Perception across the Lifespan: Interaction of Perceiver- and Target- Associated Factors

by Nhi Ngo

B.A. in Psychology, Oberlin College
M.A. in Psychology, Northeastern University

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Derek M. Isaacowitz
Professor of Psychology
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Abstract of Dissertation

Emotion perception of facial expressions is an essential tool to navigate the social world. Facial expressions are not stand-alone entities but are embedded in environments rich with cues that contextualize the emotion expressed on the face. Investigating how context is utilized as a function of perceiver- and target-associated cues will help us understand the mechanism through which context is incorporated into emotion perception. In this dissertation, I considered age, top-down control, and stereotyping as perceiver-associated contexts that can interact with target-associated contexts such as cue relevance and target’s race to produce individual differences in context utilization in emotion perception.

Study 1 investigated whether context can be attended spontaneously if the relevance of the contextual cue was manipulated, and whether older adults (n = 40), due to their inhibition decline, would be more influenced by context than younger adults (n = 43) even when the context was not relevant to the target. Younger and older adults were either instructed that the background scene was relevant or irrelevant to the embedded facial expression. Regardless of instruction about context relevance, participants were influenced by context. However, this contextual effect was much more pronounced in the relevant context than the irrelevant context condition. These results supported the hypothesis that attention to context is not fully spontaneous, and that a perceiver is capable of inhibiting their attention to context when they consider the context irrelevant to the target facial expressions.

Study 2 examined whether context effects would be attenuated if the target belonged to a social outgroup and expressed an emotion that was stereotypically believed to be representative of that group. In this study, White younger (n = 51) and older adults (n = 50) judged facial expressions of White and Black individuals embedded in emotionally congruent and incongruent
context. Older adults were expected to exhibit more prejudice and stereotyping behaviors, and consequently would be less influenced by context when the target was Black than when the target was White. Results revealed that context effects were evident for both Black and White targets. Despite the stereotypical association between Black and angry, both younger and older adults were more influenced by context when the target was Black, regardless of the target’s emotion. Participants appeared to have both low prejudice and sufficient motivation to correct for possible stereotypical association between Black and anger by using the “disgusted” label for Black angry faces. Executive functioning predicted how influenced by context younger adults were when the target was Black and angry, but did not predict the same for White angry targets. Better executive functioning, which includes better inhibition abilities, might have facilitated inhibition of stereotypes for perceivers with the best executive functioning abilities. No difference was found within older adults.

This dissertation demonstrated the importance of integrating different types of contextual cues from both the perceiver and the target, as they can interact to modulate the pattern of context effects on emotion perception. The emotion and the race of the target, the presumed relevance of the context, as well as the perceiver’s inhibition abilities all play a role in determining the magnitude of context effects. The current studies also highlight the role of aging in contextualized emotion perception. While the scientific process requires isolating variables so their effects are not confounded, and despite the definite benefits of studying facial expressions in isolation, emotion perception in real life never functions without context. Context effects, as have been shown in this dissertation, vary with different perceiver- and target- associated factors. Studying context can only further our understanding of the complex phenomenon of emotion perception, and how it can help us efficiently navigate the busy, multi-cue social world.
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Chapter 1: Introduction

Target- and Perceiver-Associated Contexts in Emotion Perception

Facial emotion perception is crucial to navigating the physical and social world. Being able to tell if someone is angry allows you to avoid confrontations that might damage a relationship, or in some cases, bring about physical danger. Noticing that someone is disgusted alerts you to the source of disgust, which is useful in preventing potential harm (e.g., moldy bread that could lead to food poisoning), or in facilitating a relationship through similar tastes (e.g., bonding over an unusual disgust for Macaroni and cheese). While early work established the importance of context on emotion perception (Goodenough & Tinker, 1931; Landis, 1924; Munn, 1940), for a large part of the last century, Ekman’s theory of discrete emotion categories in facial emotion perception (Ekman, 1992) dominated research in the field. In this view, facial expressions contain all the physical, configurational details needed to decipher emotional signals, and context only influences perception of facial expressions when the facial expression is ambiguous.

In contrast, other more recent theoretical models such as the circumplex model (Russell, 1980), the conceptual act model (Barrett, 2013; Barrett, 2006; Lindquist, 2013), and the emotion seed model (Aviezer et al., 2008), have argued for the importance of context, despite their different approaches in how these models illustrate emotions and emotion perception. The consensus is that while facial expressions convey certain levels of emotional meaning (valence and arousal in the circumplex and constructionist models, or shared physical features that convey affective signals in the emotional seeds model), categorizing facial expressions without context can be challenging (due to lack of specific emotion categorical information on the face) (Russell, 1980, Barrett, 2006), or completely inaccurate (due to certain facial configurations
being similar to each other). Furthermore, context is needed to determine the intended emotion by the sender (of the emotional signals on the face), or the target of the emotion perception process (Aviezer et al., 2008). Empirical evidence has also supported the importance of context in emotion perception. Even when facial expressions are unambiguous, contextual cues can still influence perception of emotional intensity (Ko, Lee, Yoon, Kwon, & Mather, 2011; Masuda et al., 2008), or even shift the categorization of emotion (Aviezer et al., 2008; Aviezer, Bentin, Dudarev, & Hassin, 2011).

Context in emotion perception research has usually been broadly defined and can refer to many things, such as description of emotion triggers (Carroll & Russell, 1996), body postures associated with the face (Aviezer et al., 2008; Meeren, & de Gelder, 2005; Van den Stock, Righart, & de Gelder, 2007), the scene surrounding the face (Righart & de Gelder, 2006, 2008a, 2008b) and other faces (Masuda et al., 2008; Neta, Davis, & Whalen, 2011; Russell & Fehr, 1987). These types of context are directly associated with the target (Barrett, Mesquita, & Gendron, 2011), and include within-target cues (e.g., body posture) and cues from the target’s environment (e.g., background scenes, other faces, situation description) (Wieser & Brosch, 2012). Individual differences among perceivers, termed perceiver-associated context or within-perceiver context, such as implicit race bias and personality traits have also been found to influence implicit response to facial expressions (Barrett et al., 2011; Wieser & Brosch, 2012).

Most research so far has investigated target-associated context and perceiver-associated context separately. This approach, while scientifically sound, is not yet ecologically valid. In daily life, multiple sources of context are available to the perceiver, and might interact to produce unique patterns of contextual effects. Contextual influence thus might not be constant but can be facilitated or impeded depending on which contextual factors are present. How do
individual differences in the utilization of context interact with the different types of context that may be available in emotion perception? Only a select few studies have looked at how perceiver-associated contextual factors, such as approach/avoidance motivation (Lee, Choi, & Cho, 2012), aggression (Kret & de Gelder, 2013), culture (Ko et al., 2011), and age (Noh & Isaacowitz, 2013), can modulate how much scene or body cues can shift the categorization of facial expressions. Investigating how context is utilized as a function of perceiver- and target-associated contexts within the same paradigm will help us understand at which level of cue complexity contextual influence occurs, and whether context complexity or individual differences in perceivers’ attentional bias, or a combination of both, determines the extent to which context is incorporated into emotion perception. Below, I will consider age, top-down control, and stereotyping as perceiver-associated contexts that can interact with target-associated contexts such as cue relevance and target’s race to produce individual differences in context utilization. I will then outline the research of this dissertation, which uses a lifespan approach to study the interaction of these contexts and its effects on emotion perception.

Aging and Context in Emotion Perception

Aging and emotion perception. Most studies used as supporting evidence for different theories on emotion perception (with or without context) contain mainly samples of college-aged young adults, and occasionally school-aged children (Widen & Russell, 2003). Research on emotion perception in later adulthood has yet to be incorporated in mainstream discussions of the emotion perception process. In recent years, researchers have paid more attention to the development of emotion perception in late adulthood, as studies have consistently found that emotion perception ability actually changes with age (see meta-analytic review by Ruffman, Henry, Livingstone, & Phillips, 2008). Older adults are less accurate than younger adults in
identifying angry, disgusted, happy, and fearful facial expressions even after controlling for emotion-specific bias (Isaacowitz et al., 2007). This age difference remains for some of the facial expressions even after differences in cognitive measures (Murphy & Isaacowitz, 2010; Suzuki & Akiyama, 2013) and looking patterns (Murphy & Isaacowitz, 2010) are accounted for. Although possible neuropsychological explanations concerning structural and functional changes in the brain have been proposed (Ruffman et al., 2008), no study has explicitly linked older adults’ difficulty in identifying facial expressions to neural responses (Isaacowitz & Stanley, 2011). Therefore, despite the consistently found age differences in emotion perception, the causes behind this age-associated deficit are still unclear.

Stanley and Isaacowitz (2011) proposed that research investigating this topic would benefit from a more ecologically valid approach. Most studies in the basic emotion approach have used isolated, non-contextualized facial expressions as stimuli (Ekman, 1972). Cognitive aging research has shown that older adults tend to rely on environmental support in cognitive tasks (Lindenberger & Mayr, 2014). This might extend to emotion processing, thus adding context to images of faces might shed light on whether older adults’ emotion perception difficulty lies in the absence of context.

**Aging and context processing.** One important change in older age is a shift from self-initiated processing towards reliance on environmental support in a number of cognitive processes such as memory, learning, perception, and action management (Lindenberger & Mayr, 2014). Craik and colleagues (1983) hypothesized that as self-initiated processing requires attentional resources, which decline with old age, older adults would perform worse at tasks that require more self-initiated activity. This hypothesis is supported by a meta-analysis that found the largest age differences for free recall and the smallest for procedural learning, two processes
that differ in how much self-initiated activity is required (La Voie & Light, 1994). Environmental support therefore acts as a variety of external cues to help older adults in tasks that require self-initiated processing. Older adults benefit more from semantically related target sentences and paired pictorial cues than from unrelated pairs (Smith, Park, Earles, Shaw, & Whiting, 1998), and they refer more to task-relevant but external cues more than younger adults (Spieler, Mayr, & LaGrone, 2006). Nevertheless, reliance on environmental support is not always beneficial. Overreliance on contextual cues can cost older adults accuracy or time. For example, older adults identify novel objects as old if they are placed in a previously seen background (Gutchess et al., 2007). Older adults also choose the time-consuming strategy of scanning a look-up table instead of retrieving information from memory, which for younger adults is the faster method (Rogers, Hertzog, & Fisk, 2000). This pattern of context-reliance in late adulthood might extend to the realm of emotion perception. If, as context-oriented theories have argued, facial expressions do not contain emotional information that can be readily interpreted, and context provides necessary cues to aid the emotion perception process, the traditional emotion perception task with non-contextualized, isolated faces may be especially challenging for this age group. Older adults, more so than younger adults, might need to rely on context to make accurate judgment of facial expressions.

**Aging and emotion perception in context.** The few findings on age differences in emotion perception of contextualized faces have been mixed. Using a paradigm that demonstrated contextual effect in younger adults’ emotion perception in a previous study (Aviezer et al., 2008), Noh and Isaacowitz (2013) investigated how context influences older adults’ perception of faces paired with body gestures. Disgusted expressions were shown to be the most perceptually similar to angry expressions, followed by sad and fearful expressions
(Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). Thus, the disgusted face was more likely to be categorized as angry than fearful if paired with an angry-looking body posture. Similarly, angry faces were perceived as disgusted when paired with a body posed with disgust. Older adults showed a greater bias than younger adults, and benefited more from viewing emotionally congruent face-body pairs than younger adults (Noh & Isaacowitz, 2013).

This finding that older adults show greater context effects in their emotion perception contrasts that of a study by Ko and colleagues (2011). Participants were presented with fearful and happy faces placed on negative and positive scenes. There was no age difference between younger and older American participants in their emotion intensity ratings of the target faces. Surprisingly, Korean younger adults were more influenced by context scenes in their ratings than Korean older adults and both younger and older Americans. The authors suggested that because older adults suffer from failure in context-target binding, both Korean and American older adults were not influenced by contextual information in emotion perception. However, if older adults’ contextual binding failure was the cause for the age difference in the Korean sample, it should have also led to a difference, albeit smaller, in contextual influence among the two American age groups, as has been demonstrated in previous studies with only American younger and older adults (Goh et al., 2007; Gutchess et al., 2007). It is therefore still unclear why there was no age difference in contextual effects among younger and older Americans in Ko and colleagues’ study.

There are a few possible reasons for the conflicting findings of Ko et al. and Noh & Isaacowitz. First, in Ko and colleagues’ (2011) study, the faces differed in valence (i.e., fearful faces are negative and happy faces are positive) and participants were only required to rate the intensity on a valence scale. In contrast, participants categorized targets into specific emotions
in Noh & Isaacowitz’s 2013 study. Valence perception does not rely on context as much as specific emotion categorization does. According to the conceptual-act model (Barrett, 2006), facial expressions carry only simple affective valence information. Emotion categorization needs access to conceptual knowledge in the form of emotion words, which influence perception of stimuli in a top-down manner. When emotion words are needed to label faces, attention will be directed to the context in which the facial expression is placed to facilitate access to the appropriate emotion concept (Barrett & Kensinger, 2010). Another reason for the difference in findings is the type of context stimulus used in each study. Body posture, which was used as a contextual cue in Noh and Isaacowitz’s study, is processed holistically with facial expressions (Aviezer, Trope, & Todorov, 2012), and could have produced a stronger contextual effect for older adults than background scenes used in Ko et al.’s study.

These mixed findings on older adults’ use of context in emotion perception thus reflect interesting conceptual issues about the effect of context as a function of the mode of response and the type of contextual stimuli. This dissertation, therefore, resolved these conflicting findings by combining emotion categorization and background scenes in one paradigm. The current research also contributed novel findings by exploring the boundary conditions of contextual influence on emotion perception across the lifespan. Under what circumstances do younger and older adults attend to contextual cues in emotion perception? In this dissertation, I looked into the role of cue relevance and stereotype in moderating the influence of context on the perception of facial expressions.

This dissertation also answered the question of whether adding context would eliminate age differences in emotion perception of static faces. Other studies have argued for using dynamic faces as a more context-rich, ecologically valid approach to study emotion perception
across the lifespan. Using video clips of people expressing emotions or interacting with others does seem to help older adults close the gap in performance levels with younger adults (Krendl & Ambady, 2010; Murphy, Lehrfeld, & Isaacowitz, 2010; Sze, Goodkind, Gyurak, & Levenson, 2012). However, these studies have also used valence categorization, which is not as challenging as specific emotion categorization, the response method of choice for most studies that used static faces. Furthermore, it is important to first investigate whether older adults can close the gap in their performance when still images of facial expression have situational information to contextualize them. Only when this question is answered can we proceed to investigating the more complex form of stimuli, in which a temporal dimension is added to facial expressions.

Chapter 2: Aging, Top-Down Attentional Control & Cue Relevance

Aging and Top-down Attentional Control in Context Processing

Besides answering questions about age-related emotion perception changes, exploring the role of the perceiver’s age in context processing in emotion perception would also provide insights into the general mechanism of context processing, in particular whether context is attended to spontaneously or not. In younger adults, contextual influence occurs even when the perceiver is instructed to ignore the context (Righart & de Gelder, 2008b) or told that the context is irrelevant (Aviezer, Bentin, Dudarev, & Hassin, 2011). However, to be able to conclude that context is spontaneously integrated with facial expression perception, we need to explore the same effect in older adults, who differ from younger adults in a number of domains that might alter their top-down allocation of attention to context. Aging has often been associated with attentional inhibition failure (Hasher & Zacks, 1988). When passively viewing

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objects, older adults showed no adaptation effect in neural signals for previously seen objects placed in novel backgrounds; however, older adults exhibited adaptation effects when instructed to attend to the object, suggesting that when passively viewing objects, they were spontaneously processing context instead of the target object (Chee et al., 2006). Older adults also encode both meaningful (Gutchess et al., 2007) and non-meaningful irrelevant context more than younger adults (Campbell, Hasher, & Thomas, 2010; Campbell, Zimerman, Healey, Lee, & Hasher, 2012), indicating that older adults’ stimulus-driven attention to the environment is a result of inhibition failure and thus spontaneous.

If older adults’ attention to context in emotion perception shares the same mechanism as their attention to context in object processing, it is possible that older adults will encode context spontaneously to the same or greater extent than younger adults. In contrast, it is also possible that older adults are capable of using top-down control to regulate their attention to context better than younger adults. Several studies have shown that older adults are not entirely incapable of suppressing their attention to co-varying distractors; this ability is only delayed (Cashdollar et al., 2013; Gazzaley et al., 2008; Jost, Bryck, Vogel, & Mayr, 2011). More importantly, older adults also have more social knowledge and life experience that allows them to make more complex social judgment (Hess & Auman, 2001; Hess, Osowski, & Leclerc, 2005), thus they may be able to disregard context if they deem it as irrelevant to their judgment of facial expressions. Investigating the effect of aging on contextual influence in emotion perception will shed light on the general mechanism of contextual bias in old age, and the extent to which contextual bias in emotion perception in particular is involuntary.

**Top-down Attentional Control, Cue Relevance and Context Processing in Emotion Perception**
Context is incorporated with information from the target facial expression in emotion perception, but research is still inconclusive concerning how exactly this process occurs (Wieser & Brosch, 2012). Evidence has shown that context can be encoded spontaneously, without top-down influence from the perceiver’s knowledge, expectation, or motivation. Event-related potentials (ERPs) findings show that the face-specific component N170 is modulated by the presence of scene context (Righart & de Gelder, 2006) and by context-facial expression emotional congruence (Righart & de Gelder, 2008a), indicating possible concurrent encoding of contextual scenes and target facial expressions. Righart and de Gelder (2008b) found contextual effects even when participants were asked to ignore context, although this study was not designed to investigate top-down control and therefore did not include a comparison group.

In a study that was designed to investigate the automaticity of contextual influence, with appropriate comparison groups, Aviezer and colleagues (2011) demonstrated that, despite instructions to ignore context or to consider the context to be irrelevant, participants were still influenced by incongruent context. However, unlike the studies discussed above (Righart & de Gelder, 2006, 2008a, 2008b) which used scene context, Aviezer and colleagues’ study utilized body postures as context. Bodily expression is a particular case of contextual cue. It is the only cue that is visually inseparable from facial expressions in real life. Misaligned faces and bodies reduce the influence of body postures on facial expression perception, suggesting that body and face are processed holistically (Aviezer et al., 2012). Bodily expressions also have similar brain activation patterns with facial expressions (de Gelder & van de Stock, 2011). It might be this particular advantage of body postures that allows them to affect emotion perception even when they are presented as irrelevant cues (Aviezer et al., 2011). Context processing may not be
entirely spontaneous when contextual cues are external to the target facial expression, as this would limit automatic, holistic processing.

If context processing of non-body context is not entirely spontaneous, it might be modulated by top-down control. Carroll and Russell (1996) argued that inferences not drawn from direct observation can be combined with information from context and the target facial expressions to help the perceiver decode how their social partner feels. A similar idea was also discussed in the conceptual act model (Barrett, 2006, Kensinger & Barrett, 2010), in which categories of emotion are not inherent in the stimuli, but are constructed from conceptual knowledge of the perceiver, as the perceiver samples information from both their own bodily sensations, actions, and their or the target’s situation(s). In these views, the categorization of specific emotion to some extent can be modulated by top-down attentional control, in which knowledge, expectation, and previous experience can serve as selection goals and shape perception of facial expressions.

It is possible that context is indeed incorporated into facial expression perception in an early, mandatory manner as previous ERPs results have demonstrated. However, in daily life, there are numerous cues that may co-vary with a target, but not all of these cues will be useful in decoding the target’s facial expressions. If given enough processing time and explicit indications that the context is not meaningfully related to the target facial expression, the perceiver might still be able to update their judgment to disregard the irrelevant contextual cues. For example, imagine someone (the target) who walks into a room full of people she knows, with a particular emotional expression on her face. In this case, the room and the other people in it are the immediate visual context for the target’s facial expression. However, as the target has not been part of the social environment of the room, cues from this context (conversation
content, facial expressions of other individuals in the room, etc.) are unlikely to explain the emotion on the target’s face in any meaningful way. Visual context that co-varies with a target is thus not always meaningfully related to the target’s emotion, even if that context is visually connected to the target, or conveys emotional signal. Another example is a target standing with his back to a movie screen showing an emotional scene. The target himself is neither part of the scene semantically, nor is he reacting to the scene. Therefore, while the scene has emotional signals, it may not provide relevant contextual information to decode the target’s emotion. In such cases, the perceiver’s top-down control may modulate initial spontaneous perception of face-context integration to take into account the relevance of the context. Surprisingly, considering the potential role of top-down attentional control in context processing in emotion perception, no previous study has investigated this question with non-body context, especially with a lifespan sample, considering older adults differ from younger adults in how they process context in a number of cognitive tasks.

In order to fill this gap of the literature, I conducted a study to examine whether perceivers of different age groups still encode context spontaneously in emotion perception when contextual cues are, unlike body postures, somewhat independent from the target facial expression (Study 1, Ngo & Isaacowitz, 2015). The study was designed similarly to Aviezer et al. (2008) and Noh and Isaacowitz (2013), but with scene contexts, and participants were instructed to ignore the context. Context effects were replicated: categorization of facial expressions is shifted when they are paired with incongruent context. As expected, older adults were more influenced by context than younger adults. As context influenced perception even when participants were instructed to ignore context, context processing in emotion perception thus appears to be spontaneous, especially for older adults. However, because the task
instruction framed the surrounding cues as “context”, this may have indirectly suggested to participants that the set of cues could help clarify the meaning of a target. Participants might have thus perceived the surrounding cues as helpful and thus may have attended to context voluntarily, even when asked to ignore these cues. In other words, it is unclear whether participants’ contextual influence was spontaneous, or due to their top-down attentional control toward stimuli perceived specifically as meaningful to their judgment of the targets.

Overview of Study 1

Study 1 of this dissertation was conducted to address the key limitation of the study discussed above (and was thus Study 2 in Ngo & Isaacowitz, 2015). The study also aims to disentangle the effects of stimulus relevance and top-down control on contextual influence. In previous studies, the task-relevance of stimuli are mostly arbitrarily decided by the experimenter, either through task instructions (ignore X and attend to Y, e.g.Zanto et al., 2010) or pre-designed co-variation of contextual stimuli with the target (e.g.Campbell et al., 2012). Only one study so far (Aviezer et al., 2011) has looked into stimulus relevance as determined by a meaningful relationship between the context and the target. This study however only used body posture, which as discussed above is a special type of context. In Study 1, we selected scenes that were emotionally meaningful and evocative, and paired them with specific faces expressing congruent or incongruent emotions. The contextual role of the scene here is more content-based than regularity-based. We manipulated how participants perceived this relationship between the contextual scene and the target facial expression by telling them that the stimuli were either randomly or purposely matched, regardless of the emotional congruence of the target face and the contextual scene.
One group of older and younger adult participants was instructed specifically that context was irrelevant to the target facial expression and therefore should be ignored. Another group, in contrast, was told that context was relevant to the target, and therefore should be attended to. If contextual influence from scenes was modulated by perception of its relevance, it might not be as uniformly spontaneous as previously thought. In addition, if older adults were more biased towards context processing, they would be more influenced by context regardless of the relevance of the context. In other words, the difference in contextual influence between the two instruction conditions should be smaller for older than younger adults. Across conditions, older adults would be more influenced by context than younger adults.

Method

Participants. 48 younger adults (30 female, aged 18-26) and 44 older adults (28 female, aged 60-89) were recruited from Northeastern University and the Metro Boston area. Participants received either course credit or a monetary stipend. Participants were 67.4% Caucasian, 2.2% African, 16.3% Asian, 5.6% Hispanic, and 7.9% mixed race. The highest-completed levels of education were college or some college (younger adults: 100%, older adults: 19.4%), and graduate school (older adults: 52.8%), and high school (older adults: 27.8%).

Stimuli. 56 identities from the FACES database (Ebner, Riediger, & Lindenberger, 2010) were used as target and context faces. The FACES database consists of high-quality color photographs of young, middle-age, and older adults. We chose middle-aged faces to avoid a possible own-age bias effect that has been found in other studies (Ebner, 2008; Noh & Isaacowitz, 2011). The identities of target and context faces were randomized across participants. Physical context stimuli consisted of scenes from the IAPS database (Lang, Bradley, & Cuthbert, 1999) and from the internet (see Appendix for sample stimuli). These
pictures were first rated by 10 research assistants in our lab on how likely they were to elicit anger, disgust, fear or no emotion (neutral) in another person on a scale of 1-5, with 5 being “Very Likely.” Pictures were placed in a certain category (anger, disgust, fear, neutral) if they had a rating higher than or equal to 3.5 in that category, and lower than 3.5 in the other two categories. The rated pictures were then narrowed down and rated again in the same manner by 10 younger and 10 older adults. Facial expressions were graphically manipulated with Adobe Photoshop CS6 (Adobe Systems, Inc., San Jose, CA) to appear embedded within their contextual scenes. The targets were placed on the left, right, and in the middle of the scene to ensure the target did not always occlude important parts of the scenes. The location of the targets was counterbalanced within and across participants.

All scenes were also rated for visual complexity to ensure that the contextual stimuli included a wide range of complexity. Both isolated faces and faces placed on neutral context were used as baseline. Angry, disgusted and neutral targets were paired with anger, disgust, fearful, and neutral scene contexts, creating congruent and incongruent trials. There were 24 baseline isolated trials, and 96 context trials. The presentation order as well as pairing of target-context pictures was randomized and counterbalanced across participants.

Procedure. Participants provided informed consent and completed visual acuity tests, followed by the main experimental task. At the end of the experiment, participants completed several standard cognitive measures regularly used in aging studies (e.g. Noh & Isaacowitz, 2013) to ensure a sample of participants with normal cognitive functioning.

The stimuli were presented with Matlab (Mathworks, Inc., Natick, MA) on a 19-inch monitor with a pixel resolution of 1440 x 900 and a gray background (see Appendix for sample stimuli). The viewing distance was 20-24 inches. Stimuli were centered on the screen and
subtended at a visual angle of 16 degrees horizontally and 11 degrees vertically. Stimuli were presented for 3000 ms, after which they were replaced by a screen listing the answer choices. As processing speed bears important implications for the differential effects of types of context, we maintained a consistent stimulus presentation time for both age groups despite the known age-associated decline in reaction times, as has been done in previous studies (Krendl & Ambady, 2010; Ruffman, Ng, & Jenkin, 2009). We also chose 3000 ms as a viewing time that was not too long for younger adults or too short for older adults, judging from pilot data as well as from previous studies (Krendl & Ambady, 2010; Ruffman et al., 2009). Participants took a 3-minute break between blocks. Block order was randomized.

Participants could choose between angry, disgusted, fearful, and neutral as labels for the target facial expressions. Older and younger adults were randomly assigned to either the relevant context, or irrelevant context condition. The instruction for the relevant context condition was “the facial expression portrays how someone would react if they were in the situation portrayed by the scene. The face and the scene were purposely matched.” For the irrelevant context condition, participants were told that “the facial expression portrays how someone would react if they were in a certain situation, which is not portrayed by the scene. The face and the scene were randomly matched.” Participants read the instruction on the screen, which was then read aloud to them by the researcher, and repeated after six practice trials. We also had a manipulation check at the end of the experiment, asking if participants remembered which instruction they were given at the beginning of the experiment. Both participants viewed the same set of stimuli, but in individually randomized orders. The pairings of faces and scenes were counterbalanced for gender, face location, and face identity-specific scene combinations.
The study had a mixed design, with two between-subject factors (age group, instruction of relevance) and two within-subject factors (target emotion and context emotion).

**Results**

Data from 1 older and 1 younger adult were not recorded due to technical difficulty. 3 older adults (2 in the “irrelevant” condition) and 6 younger adults (3 in the “irrelevant” condition) who did not remember the instruction were removed from data analysis. The final sample consisted of 81 participants, with 20 older adults and 19 younger adults in the relevant context condition, and 20 older adults and 22 younger adults in the irrelevant context condition. Whenever sphericity was not assumed, the Greenhouse-Geisser estimate was used. All pairwise comparisons were Bonferroni corrected.

**Cognitive measures.** There was no age difference found for WAIS Digit Span Forward and Backward scores, or MMSE Score. Older adults scored higher than younger adults on the Shipley Vocabulary test, \( t(79) = 2.05, p = .04 \).

**Baseline trials.** Analysis of the baseline trials with a 3 (target emotions: anger, disgust, neutral) x 2 (age: old, young) mixed ANOVA revealed a main effect of emotion, \( F(2,158) = 6.69, p = .002, \eta_p^2 = .08 \). Accuracy for angry faces (\( M = 69.20, SE = 2.47 \)) was significantly lower than accuracy for neutral faces (\( M = 79.77, SE = 1.66 \)) and disgusted faces (\( M = 77.25, SE = 2.25 \)), \( p_s < .007 \). There was no difference between accuracy for neutral and disgusted faces, \( p = .40 \). The main effect of age was significant, \( F(1,79) = 14.28, p < .001, \eta_p^2 = .15 \). Younger adults (\( M = 80.18, SE = 1.78 \)) were more accurate in labelling isolated facial expressions than older adults (\( M = 70.63, SE = 1.80 \)).

**Accuracy.** Accuracy percentage was calculated by dividing correct responses by 8, which is the number of trials for each target-context combination. A 3 (target emotion: angry,
mixed ANOVA was conducted on accuracy, with context relevance instruction and age as between-subject factors.

**Age differences in accuracy.** The main effect of *age* was significant, \( F(1, 77) = 18.31, p < .001, \eta^2_p = .19 \): older adults \((M = 64.47, SE = 1.86)\) had lower accuracy than younger adults \((M = 75.67, SE = 1.84)\). This main effect was qualified by a *target x age* interaction, \( F(2, 80) = 7.94, p = .001, \eta^2_p = .09 \). Older adults had lower accuracy than younger adults for angry \((M_{\text{young}} = 71.75, SE_{\text{young}} = 2.87, M_{\text{old}} = 52.81, SE_{\text{old}} = 2.90, p < .001\), and disgusted targets \((M_{\text{young}} = 77.51, SE_{\text{young}} = 2.41, M_{\text{old}} = 65.00, SE_{\text{old}} = 2.43, p < .001\), but no significant age difference was found for neutral targets \((M_{\text{young}} = 77.74, SE_{\text{young}} = 2.26, M_{\text{old}} = 75.63, SE_{\text{old}} = 2.28, p = .70\). No significant age differences across instruction condition were found, \( p = .76, \eta^2_p = .001 \).

**Effects of target and context emotions.** The main effect of *target emotion* was significant, \( F(2, 154) = 23.32, p < .001, \eta^2_p = .23 \). Pairwise comparisons revealed that accuracy for neutral targets was higher than accuracy for angry and disgusted faces, \( ps \leq .001 \) (Table 1). There was also a main effect of *context emotion*, \( F(3, 232) = 20.81, p < .001, \eta^2_p = .21 \). Participants identified targets on fear context less accurately than anger, disgust and neutral contexts, all \( ps < .001 \) (Table 1), most likely because unlike the other three context emotions, fear context had no corresponding congruent target emotion. These main effects were qualified by a *target x context* interaction, \( F(6, 462) = 23.32, p < .001, \eta^2_p = .25 \). For angry and disgusted targets, participants had significantly higher accuracy in congruent trials than all incongruent trials, all \( ps < .01 \). No difference between congruent and incongruent contexts was found for neutral targets (Table 1).
Effects of relevance instruction. The main effect of relevance instruction was significant, $F(1, 77) = 8.28, p = .005, \eta^2_p = .10$. Participants had lower accuracy when they thought context was relevant ($M = 66.31, SE = 1.88$) to the target than when they thought it was irrelevant ($M = 73.84, SE = 1.82$). This main effect was qualified by a context x relevance instruction interaction, $F(3, 231) = 8.17, p < .001, \eta^2_p = .10$. The difference in accuracy between relevance instructions was only significant for disgust, fear and neutral contexts ($ps \leq .05$), but not anger context ($p = .27$). This interaction was further clarified by the significant target x context x relevance instruction interaction, $F(6, 462) = 11.26, p < .001, \eta^2_p = .13$. For the relevant context condition, accuracy for angry targets was higher in congruent context than incongruent context, $ps < .001$, although the difference between congruent and neutral contexts was not significant, $p = .66$. Similarly, disgusted faces that were placed in congruent disgust scenes were identified more accurately than those placed in incongruent and neutral scenes, $ps < .001$. For the irrelevant context condition, no significant differences in accuracy for angry targets in different context emotions were found. Disgusted targets placed in incongruent anger and fear contexts were identified less accurately than those in congruent disgust context ($ps < .01$). No difference between context emotions was found for neutral targets in either instruction condition.

Pairwise comparisons between instruction conditions for each target-context emotion pairing also revealed that accuracy in the relevant context condition was significantly lower than accuracy in the irrelevant context condition only when the target and context were incongruent ($ps < .02$), as opposed to congruent or neutral context (Figure 1).

Context-dependent errors. Context-dependent error percentage is the percentage of times participants identified the target emotion with the context emotion, when the target and context are emotionally incongruent (e.g. identifying an angry target as disgusted when it is
placed on a disgust context, (Ngo & Isaacowitz, 2015)). The percentage of context-dependent error was calculated based on all the incongruent context trials for angry, disgusted targets, and neutral targets. A 2 (relevance instruction) x 2 (age) x 3 (target emotion) x 3 (incongruent context emotion) Repeated Measures analysis was conducted for each of the target emotion: angry, disgusted, and neutral.

**Age differences in contextual influence.** For angry targets, the main effect of age was significant, $F(1, 77) = 4.83, p = .031, \eta_p^2 = .06$. Older adults ($M = 21.98, SE = 1.98$) were more influenced by context than younger adults ($M = 15.85, SE = 1.96$) when identifying angry targets. Similarly, for disgusted targets, older adults ($M = 18.02, SE = 1.66$) were significantly more influenced by context than younger adults ($M = 12.71, SE = 1.64$) when targets were disgusted, $F(1, 77) = 5.18, p = .026, \eta_p^2 = .06$. No age differences in contextual influence were found for neutral targets, $p = .84$.

**Effects of specific contextual emotions.** For angry targets, there was a significant main effects of context, $F(2, 154) = 36.11, p < .001, \eta_p^2 = .32$. Pairwise comparisons revealed that participants were most influenced by disgust context ($M = 28.42, SE = 2.38$), followed by fear context ($M = 19.20, SE = 1.97$), and neutral context ($M = 9.13, SE = 1.21$), all $ps < .001$. For disgusted targets, the main effect for context was also significant, $F(2, 154) = 45.36, p < .001, \eta_p^2 = .37$. Participants were most influenced by fear context ($M = 26.02, SE = 2.25$), followed by anger context ($M = 15.99, SE = 1.86$) and neutral context ($M = 4.10, SE = .97$). For neutral targets, the significant main effect for context, $F(2, 154) = 67.29, p < .001, \eta_p^2 = .47$, revealed that fear context ($M = 22.04, SE = 1.83$) influenced perception of neutral targets more than anger context ($M = 4.179, SE = .88$) and disgust context ($M = 8.09, SE = 1.55$).
Effects of relevance instruction. For angry targets, the main effect of relevance instruction was significant. Participants who received the relevant context instruction ($M = 26.83$, $SE = 1.98$) were more influenced by context than those who received the irrelevant context instruction, ($M = 10.14$, $SE = 1.96$), $F(1, 77) = 39.59$, $p<.001$, $\eta^2_p = .34$. The context x relevance instruction interaction was also significant, $p<.001$. However, pairwise comparisons revealed that consistent with the significant relevance instruction main effect, in all context emotions participants were more influenced by context when they thought context was relevant. For disgusted targets, presumed relevant context ($M = 20.76$, $SE = 1.63$) influenced perception more than presumed irrelevant context ($M = 9.65$, $SE = 1.60$), $F(1,77) = 24.07$, $p<.001$, $\eta^2_p = .24$. Even for neutral targets, participants were more influenced by context when they thought it was relevant ($M = 15.36$, $SE = 1.61$, compared to irrelevant context, $M = 6.95$, $SE = 1.59$), $F(1,77) = 15.54$, $p<.001$, $\eta^2_p = .17$. No age differences across instruction conditions were found.

Response frequency analysis. A 3 (target emotion) x 2(age) x 2 (relevance instruction) repeated measures mixed ANOVA was conducted on response frequencies using a particular label when the stimuli did not have any emotion signal that matched that label. There were significant main effects of emotion ($F(2,154) = 8.25$, $p<.001$) and age ($F(2,154) = 13.70$, $p<.001$), but these were qualified by a significant emotion x age interaction ($F(2,154) = 5.15$, $p=.007$). There was no age difference in the frequency of using the “angry” label for non-angry targets or targets in non-anger context, $p = .72$. However, older adults ($M = 5.28$, $SD = 3.90$) responded “disgusted” to non-disgusted targets or targets in non-disgust context more frequently than younger adults ($M = 2.51$, $SD = 2.22$), $t (61.45) = 3.91$ (equal variances not assumed), $p<.001^2$. Older adults ($M = 3.28$, $SD = 3.82$) also responded “neutral” to non-neutral targets more frequently than younger adults ($M = 1.75$, $SD = 1.90$), $t (61.45) = 3.91$ (equal variances not assumed), $p<.001^2$. This result replicates unpublished analysis for Study 1 in Ngo & Isaacowitz (2015), in which older adults ($M = 17.53$, $SD = 12.29$) also responded “disgust” to non-disgusted targets in non-disgust context more frequently than
targets or targets in non-neutral context more frequently than younger adults ($M = 1.68, SD = 2.15), t (79) = 2.55, p = .01.

Discussion

Context is crucial to emotion perception, and has been shown to be integrated spontaneously with facial expression perception. Previous research has shown that context can alter not only intensity ratings of a facial expression, but also shift its category (Aviezer et al., 2008). In my previous research (Study 1, Ngo & Isaacowitz, 2015), similar to previous findings (Aviezer et al., 2011; Righart & de Gelder, 2008b), participants were still influenced by context despite being asked to ignore the context, although the role of contextual cue relevance was not specified in that study. In the current study, when cue relevance was specified, our results suggest that attention to context may not be entirely spontaneous. The current study investigated whether context, in particular scene context, can be attended spontaneously if the relevance of the contextual cue was manipulated. In addition, the study explored whether older adults, due to their inhibition decline, would be more influenced by context than younger adults even when the context was not relevant to the target. Regardless of instruction about context relevance, participants had lower accuracy when the context was incongruent with the target than when it was congruent or neutral. This effect was only found for angry and disgusted expressions, but not neutral expressions. Most importantly, this contextual effect was more pronounced in the relevant than the irrelevant context condition: in other words, participants were more influenced by incongruent context when they thought the context was relevant than irrelevant. Furthermore, participants had lower accuracy for incongruent trials when they thought the context was relevant than when they thought the context was irrelevant. This difference was not significant

younger adults, $M = 7.10, SD = 7.27, t (47.06) = 4, p < .001$. In contrast, there were no significant age differences in response biases to angry and fearful targets.
for congruent or neutral contexts. Together, these results supported the hypothesis that attention to context is not fully spontaneous, as context effects were reduced when the context was assumed to be irrelevant. It can be inferred that participants were able to inhibit their attention to context when they deemed the context irrelevant to the target facial expressions.

This study differs from that of Aviezer and colleagues (2011), which showed that body posture context is integrated automatically despite knowledge that context is irrelevant. While both scene and body posture contexts can influence emotion perception, body posture context might have an additional advantage over scenes in being processed holistically with faces (Aviezer et al., 2012). Thus when participants were told not simply to ignore context, but also that the context was irrelevant, the contextual influence of body posture was still present, whereas that of scene context was reduced. These results suggest that context processing in emotion perception with certain types of contextual cues is a combination of bottom-up and top-down attentional control - in this case, the knowledge of the relevance of the context. It is important to note that these results, while showing that contextual influence can be disregarded to some degree, do not argue for a face-only approach in understanding emotion perception. A face-only approach is equivalent to only looking at the rare occasions when the perceiver has the chance to decide advance that context is irrelevant, and only attends to the face. The perceiver usually has to decide for themselves, with what available information they have, whether to consider the context or not. More often than not the perceiver does not even have the chance to decide as context has been shown to be processed almost simultaneously with the target face (Righart & de Gelder, 2006). This study created an unusual, but not ecologically invalid, situation where participants could decide in advance, and thus use their top-down control to attend to or ignore contextual cues.
Replicating previous studies, older adults had significantly lower accuracy than younger adults for angry and disgusted targets, but not neutral targets, regardless of relevance instruction. The age difference in context-dependent errors was significant. This finding is in line with the hypothesis that older adults would be more biased towards context than younger adults, as has been found in Study 1 of Ngo & Isaacowitz (2015). However, one of the current study’s limitations is the inability to control for older adults’ preference for “disgusted” and “neutral” labels, as the main hypotheses rely on the ambiguity posed by angry and disgusted facial expressions when placed in incongruent disgust and anger context. Future studies might consider the use of other facial expressions that might still produce contextual effects while avoiding older adults’ specific emotion response biases.

Surprisingly, there was no evidence that older adults benefited from viewing targets on congruent context, as has been shown in Noh & Isaacowitz (2013), as there was no age x target emotion x context emotion interaction. If older adults benefited from the congruency of target and context emotions, there would have been a smaller difference in accuracy between two age groups in the congruent trials compared to the incongruent trials. Scene context, compared to body posture context in Noh & Isaacowitz (2013), might be more visually complex and thus negates any benefit emotion congruency might have provided. In addition, scene context is more independent from facial expressions than body posture, thus contextual benefit could also have been weakened, compared to body posture context.

There was also a lack of effect of relevance instruction differed by age group. A possible explanation is that by telling participants that the context was irrelevant to the target, the instructions may have suggested that the context and the target were not actually randomly paired. In other words, participants might infer that the emotion from the scene context was not
that the same as the emotion on the target facial expression. This may have led participants to eliminate the contextual emotion from the potential list of target emotions, thereby making the task easier for both younger and older adults, thus eliminating potential variance in age-related top-down control abilities in inhibiting attention to context. Even with this limitation, proactive evaluation of different possibilities of target emotions in light of the context emotion is likely to have taken place. This still suggests that top-down control has a role in emotion perception of contextualized facial expressions, although its effect may not vary by age as much as initially hypothesized.

**Chapter 3: Aging, Stereotyping & Emotion Perception**

The issue of aging and inhibition was addressed in Study 1, with the instruction about the relevance or lack of relevance of the stimuli aiming to test participants’ inhibition of attention to context when the stimuli were not relevant. Nonetheless, inhibition abilities were not directly measured. Study 2 aimed to address inhibition directly, while also exploring a new area in which contextual attention could be modulated. Study 2 not only aims to continue exploring contextual effects in emotion perception across the lifespan, but also examines this question from the lens of social cognition. The targets used in Study 1 were White, and so were 79.1% of our older adult participants (compared to 56.5% for younger adults). For groups who live in the same country, perceivers of a majority group appear to have less difficulty labelling facial expressions of ingroup targets than those of a minority outgroup (meta-analysis, Elfenbein & Ambady, 2002, review, Elfenbein, 2013). However, an updated meta-analysis with a different computation method shows that results are more mixed with regards to studies that used posed facial photos similar to those in this dissertation (Kang & Lau, 2013). It is unclear, however, whether older adults will show the same pattern of performance.
Older adults have been shown to exhibit more stereotype and prejudice due to their declining inhibitory abilities (von Hippel, 2007), and as a consequence might rely more on stereotype rather than the actual emotions displayed by the target, or additional information provided by the context. In other words, older adults may be less influenced by context when the target is a member of a stereotyped outgroup because of stereotype. Conversely, older adults might rely on context more due to the targets being an outgroup member because of unfamiliarity with outgroup emotion displays. The competing hypotheses pose interesting theoretical questions not just in the realm of aging and inhibition, but also in the area of contextual effects on emotion perception: for which target does context matter more?

**Aging and Stereotyping**

In addition to context processing, older adults’ decline in cognitive functioning has also been implicated in age-differences in social cognition, in particular stereotyping and prejudice. Older adults have been found to adopt more conservative values (Danigelis & Cutler, 1991) and to be more racially prejudiced against minorities (Firebaugh & Davis, 1988; Wilson, 1996) than their younger cohorts. These age differences were credited to a cohort effect rather than a developmental change, due to significant historical changes in the last 60 years. However, other researchers have also proposed that the age difference in racial prejudice is due to older adults’ changes in executive function, which results in a failure of inhibiting stereotypical biases (von Hippel, 2007).

The decline in executive function in aging has been associated with a reduction in volume across different brain regions, with the frontal lobes showing the steepest rate of atrophy (Dennis & Cabeza, 2008). The magnitude of atrophy predicts the degree of deficit in executive functioning (Dempster, 1992; Gunning-Dixon & Raz, 2003). Executive function
includes a group of interrelated mental processes that include planning and monitoring goal-oriented behaviors, activating goal-relevant information and inhibiting automatic responses or external irrelevant information that interferes with goals (Baddeley, 1996; Norman & Shallice, 1986). Poor executive control in older adults thus leads to decline in the ability to inhibit unwanted thoughts or attention to irrelevant sensory stimuli (Dempster, 1992; Hasher, Zacks, & May, 1999). In the context of stereotype and prejudice, these unwanted thoughts could be familiar stereotypes or automatic biases about the person’s social group. If such stereotypical thoughts are not inhibited, they could be expressed in perception of the person, or could lead to prejudice and discriminatory behaviors.

In recent models on stereotype and prejudice, executive function, especially inhibition, is an important component of stereotype regulation (Devine, 1989; Russell H Fazio, 1990; T. D. Wilson, Lindsey, & Schooler, 2000). Devine (1989) argued that due to the prevalence of racial stereotypes, such stereotypes are activated automatically in most individuals when encountering relevant stimuli. For low-prejudice individuals, these stereotypes conflict with their personal egalitarian beliefs and are inhibited through controlled processes (Devine, Monteith, Zuwerink, & Elliot, 1991; Devine, Plant, Amodio, Harmon-Jones, & Vance, 2002). Even in studies that did not find that stereotype is always automatically activated (e.g. Fazio, Jackson, Dunton, & Williams, 1995; Son Hing, Chung-Yan, Hamilton, & Zanna, 2008), for those whose stereotype is activated, whether such stereotype affects behaviors still depends on their executive functioning. In other words, any response is likely to result from both automatically occurred stereotypes and efforts to control such biased associations. Variations in the influence each process in tasks that measure implicit bias can be assessed using quantitative methods such as the Process Dissociation method (Jacoby, 1991; Payne, 2005), and the Quad model (Batchelder
& Riefer, 1999; Sherman et al., 2008). The Process Dissociation method has been able to identify controlled and automatic components as two distinct processes that correlate weakly with each other, and estimates of each process cohere well across different implicit measures (Payne, 2005). The controlled component also correlates with the antisaccade and Stroop tasks (Govorun & Payne, 2006; Payne, 2005), which measures inhibitory ability, a part of executive function.

As inhibitory ability plays an important role in regulating stereotyping behaviors, it would follow that the age differences in stereotyping behaviors could be explained by the age differences in inhibition. Older adults’ declined inhibition has been shown to affect their encoding (Radvansky, Copeland, & Hippel, 2010), response monitoring (von Hippel, Silver, & Lynch, 2000), and regulating prejudiced associations (Gonsalkorale, Sherman, & Klauer, 2009; B. A. Nosek, Banaji, & Greenwald, 2002; Stewart, von Hippel, & Radvansky, 2009) in tasks that measure explicit and implicit stereotyping behaviors. In the first study that linked inhibition with stereotyping in older adults, von Hippel, Silver and Lynch (2000) showed that older adults have poorer inhibition, stereotype more, and have more prejudice than younger adults. Specifically, stereotyping was measured with a task in which participants had to evaluate the intelligence of two targets with racially stereotypical names and descriptions. Prejudice was measured separately with questionnaires assessing race-related explicit attitude. Inhibition ability, but not prejudice, mediated the relationship between age and stereotyping behaviors, and between age and prejudice. Although older adults were more concerned with impression management and more motivated to control their prejudice than younger adults, these measures were not related to inhibition, stereotyping behaviors, and prejudice. While differences in executive control can be due to ability or motivation (Payne, 2005), this finding shows that for
older adults, ability to suppress stereotypes is responsible for their more pronounced stereotyping behaviors compared to younger adults.

Although von Hippel, Silver, & Lynch (2000) showed that motivation was not related to older adults’ stereotyping and prejudice, their explicit attitude task cannot answer fully whether older adults stereotype more than younger adults due to historical cohort differences, or solely due to their inhibitory ability. If older adults are more biased against a certain racial group because they possess a different value system from their socialization, their automatic biased associations as assessed by Process Dissociation or the Quad model in implicit bias tasks should be stronger than younger adults. Evidence points to the opposite. Older adults do not have stronger automatic associations about race than younger adults, but have more difficulty controlling their bias (Gonsalokorale et al., 2009; Stewart et al., 2009). The Quad model (Batchelder & Riefer, 1999) divides the controlled component further into Detection and Overcoming Bias, and in Gonsalokorale, Sherman, & Klauer’s study, Detection (of bias) increased with age, whereas Overcoming Bias had the opposite trajectory. This finding shows that age differences in stereotyping and prejudice do not arise from older adults’ inability to engage in the task and detect their bias, but rather from their inability to suppress their bias.

Stereotype and Emotion Perception

If older adults have difficulty inhibiting stereotypes about outgroup targets, they might rely on stereotypes as a judgmental heuristic when decoding facial expressions of outgroup members. Research with younger adults has most often investigated the association between the angry facial expression and a racial outgroup that is often stereotyped to be hostile (e.g. African American in the U.S., Moroccan in the Netherlands). In the U.S., African Americans are stereotyped to be more hostile than European Americans (Devine, 1989), and this association is
strong enough that racially predicted perceivers would categorize racially ambiguous angry faces as Black rather than White (Hugenberg & Bodenhausen, 2004; Hutchings & Haddock, 2008). The happy face advantage in which perceivers are quicker to accurately categorize a (White) face as happy reverses when the target is Black, such that angry and sad Black faces are identified more quickly than happy Black faces (Hugenberg, 2005). Although Hugenberg (2005) argued that the response latency advantage of both angry and sad Black faces indicates that negative prejudice against a racial outgroup results in sensitivity to all negative faces of the outgroup, Bijlstra and colleagues (2010, 2014) proposed that specific emotion stereotypes, as opposed to general negative prejudice, are what influences emotion perception of outgroup faces. In Hugenberg’s paradigm, faces of different valence (positive/negative) were presented together (happy-angry and happy-sad), which facilitates an evaluative context. When faces of the same valence are presented together (angry-sad), response latency advantage favors the emotion that is more often associated with the target outgroup (Bijlstra, Holland, Dotsch, Hugenberg, & Wigboldus, 2014; Bijlstra, Holland, & Wigboldus, 2010). Specifically, anger was detected faster on outgroup (Moroccan) than on ingroup (Dutch) faces. Compared to sadness, anger was detected faster on Moroccan faces, but slower on White faces (Bijlstra et al., 2014). Furthermore, the strength of participants’ emotion-specific implicit biased association predicted the magnitude of the response latency effect in the emotion perception task (Bijlstra et al., 2014). These findings indicate that emotion-specific stereotype about a social outgroup can facilitate perception of facial expressions in a stereotype-confirming manner.

While not directly assessing facial expression categorization, other studies have used an expression-change paradigm, in which participants have to detect the change from one facial expression to another in stereotyped and control targets. Highly prejudiced White participants
see angry expressions as appearing earlier and disappearing later than less prejudiced participants when a Black target changes expressions (Hugenberg & Bodenhausen, 2003). In the only study so far using this paradigm with older adults, Kang and colleagues (2014) showed that older adults displayed bias in emotion detection against stereotyped targets (young Black targets and old White targets, presumably more stereotyped than young White and old Black targets). Interestingly, these effects were either similar or weaker than those in younger adult perceivers. However, in this study, the facial expression transition always involves two separate valences, and the results of older adults could have been complicated by the well-known preference for positive over negative cues in late adulthood (Mather & Carstensen, 2005). Older adults might have detected happy expressions in targets of both races earlier due to the positive valence of the happy expressions, and this positivity effect could have reduced the effect of stereotype compared to younger adults. More research that utilizes a single-valence paradigm similar to Biljstra et al. 2010 and 2014 is needed to avoid the influence of the positivity effect on stereotyping behaviors.

**Stereotype and Emotion Perception of Contextualized Faces**

The research discussed above has all been conducted with isolated faces. No study has explored the effect of the target’s race and the perceiver’s stereotyping on emotion perception of contextualized faces, but inferences can be drawn from studies that investigated differences in causal attribution as a function of stereotype (e.g. Erber & Fiske, 1984; Jackson, Sullivan, & Hodge, 1993; Wilder, Simon, & Faith, 1996). These studies generally provide evidence for a phenomenon termed the ultimate attribution error (Pettigrew, 1979), which is the tendency to underestimate situational factors and overestimate personal factors when attributing causes of behaviors from prejudiced or stereotyped outgroups (see Hewstone, 1990 for a review). When
evaluating performance of outgroup targets, people tend to attribute the success of a prejudiced outgroup, which is stereotype-inconsistent, more to external cause than the success of an ingroup. In contrast, failure is attributed more to ability, an internal cause, when it occurs to a member of the outgroup rather than the ingroup (Jackson et al., 1993). In person perception, perceivers display more spontaneous situational inference when the target’s behavior is inconsistent with the prevalent stereotype about his/her social group. In contrast, more spontaneous trait inference is associated with stereotype-consistent behaviors (Ramos, Garcia-Marques, Hamilton, Ferreira, & Van Acker, 2012). Prejudice levels also specifically predict causal attribution of outgroup behaviors. High prejudice individuals make more external attribution when a member of a stereotyped group behaves differently from their stereotype (Sherman, Stroessner, Conrey, & Azam, 2005). External attribution serves as a means to explain away the stereotyped target’s behavior so that the high prejudice individuals can maintain their prejudiced view of the target’s social group.

For emotion-related behaviors, available research is more scant. A few studies have looked into how emotion attribution of targets of different genders is affected by the stereotype of women being more emotional – in other words, female emotionality being a stable internal characteristic, not usually caused by the situation. After reading a vignette of a target expressing emotion in an emotion-eliciting situation, perceivers attributed the target’s emotion more to the situation if the target was male, and to the disposition if the target was female (Shields & Crowley, 1996). A similar pattern was found with videos of targets expressing anger during a job interview: female targets’ angry expression was also attributed to disposition while male targets’ angry expression was attributed to the situation, although this gender-based correspondence bias was eliminated when a situational cause was provided for the target’s
behavior (Brescoll & Uhlmann, 2008). However, in another study where situational cause was paired with pictures of negative facial expressions, both female and male participants still made more dispositional attribution for female targets’ emotion compared to that of male targets (study 1), and more for feminine faces, regardless of true gender, compared to masculine faces (study 2) (Lisa Feldman Barrett & Bliss-Moreau, 2009). Additional memory tests of situational details paired with each target and original emotional intensity of each target indicated no difference between female and male targets. These results suggest that differences in emotional attribution of male and female are not likely to be caused by differences in processing complexity, but a more internalized stereotypic belief that women are inherently more emotional than men (Barrett & Bliss-Moreau, 2009).

**Overview of Study 2**

Stereotype and causal attribution findings thus suggest that perceivers might rely more on stereotype about internal characteristics of stereotyped groups, and make more stereotype-congruent dispositional attribution to explain the behaviors of these groups. These studies, however, only show how stereotypes influence the causal attribution of emotional expressions, but not the perception of the intensity or categorization of facial expressions themselves. Study 2 of this dissertation was designed to explore the effect of stereotype and age on the perception of stereotyped targets’ facial expressions with and without context, using only negative facial expressions to avoid possible interference on the positivity effect in older adults.

In emotion perception, context provides situational information for the target facial expression. Categorization of facial expressions has been shown to depend more on visual context than the intended emotion of the target (Aviezer et al., 2008; Aviezer et al., 2012) for both younger and older adults (Noh & Isaacowitz, 2013; Ngo & Isaacowitz, 2015) when
emotion signals from the context and the target are incongruent. This pattern might reverse if the target is a member of a stereotyped group. If the target expresses an emotion that is often associated with his/her group, whereas the context portrays a situation that would normally elicit a different emotion, the perceiver’s stereotype might inhibit the influence of context. Consequently, context effect is less evident for the stereotyped-group targets compared to control group targets, when both express the stereotypic emotion. This effect should be even stronger for older adults, who might have more difficulty than younger adults inhibiting their stereotyping. Exploring this phenomenon in older adults is particularly interesting due to their bias towards context in processing visual stimuli. Older adults have been shown to be more influenced by context when identifying contextualized facial expressions (Noh & Isaacowitz, 2013, Ngo & Isaacowitz, 2015), but it is unclear whether their failure to inhibit stereotype would also lead to attenuated attention to context. Furthermore, it has been established that older adults tend to make more dispositional attribution than situational attribution (Blanchard-Fields & Beatty, 2005; Blanchard-Fields, 1994; Chen & Blanchard-Fields, 1997; Horhota & Blanchard–Fields, 2006). Older adults, therefore, might be even more prone to making dispositional attribution for stereotyped targets’ emotional behaviors, which in an emotion perception paradigm can result in neglect of visual context when categorizing stereotyped targets’ facial expressions.

Due to the strong stereotypical association between anger and African American in American society (Hugenberg, 2005; Hutchings & Haddock, 2008), study 2 will focus on this stereotyped group. Both younger and older adults are expected to rely more on stereotypes when perceiving facial expressions of Black targets, which in turn will inhibit the influence of context when context and stereotype diverge. This effect is hypothesized to be stronger for older
adults. However, there is also a competing hypothesis that older adults, due to their most likely less diverse social environment and socialization, will have less familiarity with and thus more difficulty categorizing Black targets’ facial expressions. This difficulty might lead older adults to rely on context more than younger adults when the target is Black.

While most research so far in both younger and older adults have focused almost exclusively on inhibition as a key process in moderating activated stereotype and expressed behaviors, other researchers have argued for a more comprehensive approach by looking beyond inhibition towards executive functioning as whole (Ito et al., 2015). Executive function, in this model (Ito et al., 2015; Miyake & Friedman, 2012) involves more than just response inhibition; it also involves working memory updating and task switching. These different processes show strong correlations with one another, but do not completely overlap. Together they make up the unified yet diverse aspects of executive function. Studies on stereotype, prejudice and inhibition so far have used inhibition and executive function interchangeably, but in light of findings from Ito et al. (2015), distinction is necessary. Ito and colleagues (2015) demonstrated that the three most commonly used inhibition tasks showed non-significant loadings on an Inhibition-specific factor, and their residuals also did not correlate. Their model, replicating previous work, found a common Executive Function factor, an Updating-specific factor, and a Shifting-specific factor across 9 well-validated, often used tasks that measure inhibition, updating, and shifting. Individual differences in these factors predicted implicit bias in three separate tasks (including the IAT), indicating that cognitive control in implicit bias requires more than inhibition. This finding is especially important within the aging context, as it is executive function as a whole and not just inhibition that is in decline in late adulthood. In fact, individual and age differences in inhibition did not correlate with measures of stereotyping
in one study (Radvansky et al., 2010). On the other hand, executive function measures have been associated with stereotyping-related behaviors and neural patterns in older adults, such as regulating negative reactions towards stigmatized individuals (Krendl, Heatherton, & Kensinger, 2009), peer-rated social inappropriateness (Henry, von Hippel, & Baynes, 2009), and perception of stigma controllability (Krendl & Wolford, 2013). The current study, therefore, will include different measures of inhibition and executive function as potential predictors for the magnitude of contextual effects in emotion perception of stereotyped targets.

In summary, the hypotheses were as follows:

1. Both younger and older adults would be more influenced by incongruent context regardless of the target’s emotion or race, as would be shown by the difference in accuracy between congruent and incongruent trials.

2. Both younger and older adults would be more influenced by context when the target was angry and White than when the target was angry and Black, as would be shown by the difference in context-dependent errors, as well as the difference in magnitude of the accuracy difference between congruent and incongruent trials for each race.

3. Regarding age differences in the use of stereotype in contextualized facial expressions perception:
   a. The difference between contextual influence for White angry faces and Black angry faces would be larger for younger than older adults, due to older adults relying more on stereotypes than younger adults when perceiving Black facial expressions, thus reducing the influence of context on Black angry targets in older adults.
b. Alternatively, the competing hypothesis is that the pattern of results would be reverse: if older participants have more difficulty categorizing outgroup (Black) targets’ facial expressions than ingroup (White) faces, and more so than younger adults, they would rely more on context when identifying Black than White faces. This would apply to all emotions and not just angry faces.

(4) Executive functioning, implicit and explicit prejudice would moderate how much younger and older adults are influenced by context when perceiving Black and White angry targets. How much the perceiver relies on context when perceiving angry targets would depend on the target’s race, the perceiver’s age, and the perceiver’s levels of prejudice and executive functioning. In other words, when perceiving angry targets, participants would rely less on context when the target was Black than when the target was White, and this effect would be stronger for those with lower executive functioning, higher prejudice, and older age.

Method

Participants. A priori power analysis (with effect size partial eta squared = .10 estimated from Study 1, in which effect sizes for a between subject x within subject interaction with a similar number of measures ranges from .08 -.25) indicated a sample size of 108 was required to achieve a power of .90 (more power is needed for a small effect). As the study focused on stereotypes about African American that are more common among White European Americans, only White European Americans who were born in the US or have lived in the US for more than 90% of their lives were included in the final sample of the study. Recruitment advertisements did not include this eligibility criterion, and only asked for native English speakers from the U.S., so as to not alert participants of the focus on stereotype of the study. A
total sample of 136 younger and older adults was recruited in the same manner as in Study 1, with 24 younger adults and 10 older adults not meeting the ethnicity criterion.

The final sample included 51 younger adults (31 female, aged 18-26) and 51 older adults (21 female, aged 60-80). The highest-completed levels of education were graduate school (younger adults: 0%, older adults: 39.2%), college (younger adults: 3.9%, older adults: 31.4%), and high school (younger adults: 96.1%, older adults: 29.4%). Most of the younger adults (92.2%) reported overall good health as well as the older adults (98%).

**Stimuli and procedure.** The study contained images of facial expressions of anger, disgust, and neutral expressions from different individuals. Facial expressions were taken from the NimStim database (Tottenham et al., 2009). These images were embedded within emotion-eliciting background scenes (the same stimuli as Study 1). The emotion of the facial expression could be congruent or incongruent with the emotion of the scene. Participants were asked to identify (as fast and as accurately as possible) the emotion of the displayed facial expressions. This paradigm created a 2 age groups (young, old) x 2 target race (Black, White) x 3 target emotions (angry, disgusted, neutral) x 2 context emotion (anger, disgust) mixed design. There were 8 trials for each unique combination of target race x target emotion x scene context (4 Black faces and 4 White faces), creating 96 experimental trials for each participant. To increase the variety of facial expressions that participants viewed to map onto the range of response choices that they had, 16 filler trials with happy, surprised, sad, and fearful faces on neutral scenes were added, making it a total of 112 trials. The order of all trials was randomized for each participant. The filler trials were not included in the analysis. The stimuli were presented with Matlab (Mathworks, Inc., Natick, MA) on a 19-inch monitor with a pixel resolution of 1440 x 900 and a gray background. The viewing distance was 20-24 inches. Stimuli were
centered on the screen and subtended at a visual angle of 28.5 degrees horizontally and 19.4 degrees vertically.

After the main experiment task, participants were asked to complete a fast emotion categorization task, adapted from Bijlstra et al., 2010. The task was programmed with Matlab, and administered on the same computer as the main experimental task. The goal of this task was to evaluate participants’ ability to identify facial expressions without context (with accuracy as the dependent variable) and also to examine younger and older adults’ strength of association between certain specific emotions with specific races (using reaction times.) Participants were asked to categorize Black and White facial expressions of anger, disgust and sadness as quickly and accurately as possible. There were 3 blocks of trials with expressions from 2 emotions at a time: anger vs. disgust, disgust vs. sadness, and sadness vs. anger. As the original Bijlstra et al. study only compared anger and sadness, this comparison was included in an attempt to replicate the original study. In addition, the main experimental task in the current study contained disgusted expressions, necessitating the comparison between anger and disgust. Thus, all three comparisons were included to make sure participants saw all stimuli the same number of times. Each trial consisted of a fixation cross, presented for 1,000 ms, followed by a facial expression displayed for 200 ms. Participants responded by pressing one of two keys (“Q” or “P”), corresponding to either of the two emotions. The key mapping was counter-balanced across blocks, and the block order was randomized across participants. Each block included 20 practice trials using 2 identities (1 Black, 1 White) from a different database (Tracy, Robins, & Schriber, 2009). Each experimental block had all 24 pictures (6 identities for each race, selected from the Nimstim database) displayed one time in random order.
Participants then completed the emotion Implicit Association Test (eIAT) adapted from Bijlstra et al., 2014. In Bijlstra et al. 2014, participants categorized typical Moroccan and Dutch names, and sadness and anger related words with the same set of two keys on the keyboard. However, since in the current study, older and younger adults might have differed in what types of Black/White names they were familiar with, the current eIAT used neutral expressions from the Chicago face database (Ma, Correll, & Wittenbrink, 2015). Faces, as opposed to names, have also been more often used in the general racial attitude IAT (Nosek et al., 2007).

Participants completed two eIATs: one examined the strength of association between Black faces and anger (compared to White faces and disgust), the other one following more closely the original eIAT and examined the association between Black faces and anger, and White faces and sadness. The order of the eIATs was counterbalanced across participants.

Each eIAT consisted of 5 blocks. First participants completed two 20-trial practice blocks to familiarize themselves with the response mapping. In the first practice block, Black and White American faces appeared in the middle of the screen one at a time, and participants had to categorize them using two keys (“E” and “I”), with one key corresponding to one category, on the computer keyboard. Participants received feedback if they responded incorrectly. In the next practice block, participants categorized words that are associated with anger (seethe, infuriating, mad, rage, fist) and disgust (nauseate, gross, revolted, distaste, vomit), or anger and sadness (weep, depressing, sorrowful, grief, tears). These words were selected among more than 20 other candidate words after piloting sessions with research assistants and participants on Amazon Mechanical Turk, and were matched in terms of type of word (verb, noun, adjectives).
After the 2 practice blocks, participants completed a 40 trials test block in which they categorized both faces and words (one at a time), with one category from the target concept (race) sharing a response key with one category from the attribute concept (emotion). In the first test block, participants categorized anger words and Black faces with one key and disgust/sadness words and White faces with the other key (stereotype-congruent). Participants then completed a third practice block with 40 trial block in which the response mapping for the target concept (race) was reversed. In the last test block, participants completed 40 trials categorizing all four categories, with the target concept (race) key mapping reversed as practiced in the third practice block, and the attribute concept (emotion) response mapping unchanged. This last test block was the stereotype-incongruent block, such that anger words and White faces shared one response key, and disgust words and Black faces shared the other. Faster reaction times in the congruent block compared to the incongruent block indicated stronger automatic associations between anger with Black Americans. To minimize between-participant differences in IAT scores due to order effects, the order of blocks was presented in a fixed manner, although the order of stimuli was randomized.

Additional measures include: A) Measures of explicit prejudice: Black and White feeling thermometers in which people were asked to rate how warmly they felt toward Blacks and Whites, on a 0 (cold) to 100 (warm) scale; and the Internal and External Motivation to be Non-Prejudiced Scales (Plant & Devine, 1998), B) Executive functioning measure: FAS phonemic fluency test in which participants were given 1 minute to generate as many words as they can that start with the letter A; Wisconsin Card Sorting Task, and Digit Scan Backward from the Wechsler Memory Scale— Revised. C) Inhibition measure: Stroop task (Stroop, 1935),
and D) Speeded Pattern Comparison Task. The Card Sorting Task, the Stroop task, and the Speeded Pattern Comparison Task were administered via PEBL (Mueller & Piper, 2014).

Results

**Hypothesis 1: Contextual influence across target’s emotions and races.**

**Main experimental task**

*Accuracy percentage.* Accuracy percentage is the percentage of times, out of 8 possible times for each target emotion x context emotion x target race category, that participants identified the intended emotion expressed by the targets. A 2 (perceiver’s age: old, young) x 2 (target race: White, Black) x 3 (target emotions: anger, disgust, neutral) x 2 (context scene: anger, disgust) mixed repeated measures ANOVA was conducted on accuracy percentage. For within-subject tests, whenever Sphericity was not assumed, Greenhouse-Geisser correction for degrees of freedom was used. Complete data for this analysis are available for 50 older adults (OA) and 51 younger adults (YA)\(^3\).

*Age differences in emotion perception accuracy.* The main effect of age for accuracy was significant, with older adults \((M = 68.31, SE = 1.71)\) performing worse than younger adults \((M = 76.49, SE = 1.70)\), \(F(1,99) = 11.54, p = .001, \) partial \(\eta^2 = .10\). This result replicates the well-established emotion perception deficit in aging.

*Target’s emotion effects on accuracy.* The main effect of the target’s facial emotions \((F(1.80,178.33) = 171.89, p < .001, \) partial \(\eta^2 = .64)\) was significant. Pairwise comparisons revealed accuracy was highest for neutral faces \((M = 90.96, SE = 1.64)\), followed by accuracy

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\(^3\) One OA was was unable to complete all cognitive tasks except for Stroop, Pattern Comparison, and Card Sorting Task; their scores for congruent, incongruent, and neutral items for the Stroop task, reaction time for the Pattern Comparison task, and perseverance errors for the Card Sorting task were all extreme outliers. This OA was thus excluded from all analyses. Results did not change after exclusion of this OA.
for disgusted faces ($M = 69.59, SE = 1.47$), and last was accuracy for angry faces ($M = 56.65, SE = 1.73$) (all $ps < .001$).

*Target’s race effects on accuracy.* Accuracy for White targets ($M = 71.29, SE = 1.22$) was significantly lower than that for Black targets ($M = 73.52, SE = 1.33$), ($F(1,99) = 6.66, p = .011$, partial $\eta^2 = .06$). This main effect appears to be mainly driven by high accuracy for disgusted Black faces, as evident in the target’s emotion $\times$ target’s race interaction, ($F(1.81,179.02) = 43.85, p < .001$, partial $\eta^2 = .31$). Accuracy for angry Black faces ($M = 54.05, SE = 2.12$) was significantly lower than accuracy for angry White faces ($M = 59.25, SE = 1.77$), $p = .005$, and the difference between Black and White neutral faces was not significant ($M_B = 90.56, SE = 1.74; M_w = 91.36, SE = 1.66, p = .39$). However, accuracy for disgusted Black faces was higher than that for disgusted White faces ($M_B = 75.93, SE = 1.77; M_w = 63.25, SE = 1.49, p < .001$).

*Contextual effects on accuracy.* The target emotion $\times$ context emotion interaction was significant, $F(1.52,150.66) = 80.01, p < .001$, partial $\eta^2 = .45$. Participants were more accurate in identifying angry and disgusted faces when they were in congruent context than when they were in incongruent context ($ps < .001$). No significant difference was found between accuracies for neutral targets on anger and disgust context ($p = .46$). The significant target’s emotion $\times$ context emotion $\times$ target’s race interaction ($F(2,198) = 10.12, p < .001$, partial $\eta^2 = .09$) did not qualify this effect, as contrasts based on context emotion showed that for both races of targets, accuracy for congruent target-context was significantly higher than incongruent target-context accuracy ($ps < .001$). These results replicated previous work showing lowered accuracy for

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4 There was a significant interaction between context emotion and target race, $p = .04$, but this effect was calculated with accuracies collapsed across congruent and incongruent trials, and was therefore harder to interpret. It was also qualified by the target emotion $\times$ context emotion $\times$ race.
incongruent target-context trials, compared to congruent trials, indicating that context emotion influenced how participants identified the targets (Figure 2).

**Summary.** To summarize, the hypothesis that both younger and older adults would be influenced by context regardless of the target’s emotion or race was supported.

**Hypothesis 2 & 3: Contextual influence difference between angry White and angry Black targets, and age differences in the magnitude of this effect**

**Main experimental task**

**Accuracy percentage.** As presented above, there was a significant target’s emotion x context emotion x target’s race interaction, and while this interaction did not show variation in contextual effects across races (in other words, participants were influenced by context when perceiving targets of both races), it did reveal differences in the magnitude of the context effects between Black and White targets within each facial expression emotion. Contrasts based on race for the three-way interaction revealed that when placed in incongruent context, angry White faces were better identified than angry Black faces, $p < .001$. In contrast, accuracy for disgusted White faces was lower than that for disgusted Black faces on both congruent disgust context and incongruent context, $ps < .001$. No significant difference between accuracy for angry White and Black faces in congruent context, or when Black and White faces were neutral or incongruent with their context (Figure 3).

It appears that when angry faces were placed in an incongruent context, participants identified ingroup better than outgroup faces. They appear to have had to rely on context more for outgroup faces. In contrast, congruent anger context might have helped boost accuracy for angry Black faces and eliminate accuracy difference between angry Black and White faces. However, disgusted Black faces were better identified than White faces regardless of the
congruency of the context, indicating an advantage of Black disgusted faces in emotion
perception. Alternatively, a response bias could exist for disgust to Black faces only, such that
the context effect (labelling disgusted faces as “angry” when in anger context) was reduced.
This could also partially explain the higher accuracy of Black angry faces compared to White
angry faces, though the response bias would not explain why accuracy was not significantly
different between Black and White for congruent angry faces.

Response frequency analysis. To explore possible response bias, such that participants
were responding “disgust” more to Black faces than White faces, a repeated measures mixed
ANOVA was conducted on the number of times participants responded “disgusted” to angry
faces in congruent context, and to neutral faces on anger context. In other words, these trials had
no disgust signal, and therefore should not bias participants towards responding with the
“disgusted” label, unless participants were already biased themselves. The main effect of
target’s race was significant, $F(1,99) = 7.09, p = .009, \text{partial } \eta^2 = .07$. Participants responded
“disgusted” more often to Black faces ($M = .87, SE = .08$) than White faces ($M = .66, SE = .07$).
The main effect of target’s emotion was also significant, $F(1,99) = 140.76, p < .001, \text{partial } \eta^2 = .59$.
Participants responded “disgusted” more often to angry faces on anger context ($M = 1.44, SE = .09$) than neutral faces on anger context ($M = 0.09, SE = .04$). These main effects were
qualified by the significant target’s race x target’s emotion, $F(1,99) = 10.08, p = .002, \text{partial } \eta^2 = .09$. No difference between “disgusted” response frequencies for Black and White neutral
faces was found, $p = .20$ ($M_B = .07, SE_B = .03, M_W = .11, SE_W = .05$). In contrast, participants
chose the “disgusted” label more frequently for Black angry faces than White angry faces in
congruent context, $p = .004$ ($M_B = 1.67, SE_B = .15, M_W = 1.22, SE_W = .12$). No age differences
were found. Full aggregated response frequencies across the entire sample for all trials are also
presented in Figure 5, showing the higher frequencies of “disgusted” label to Black faces compared to White faces. Notably, responses using other labels (specifically the “sad” label – not shown in graph) were more frequent toward White disgusted faces than Black disgusted faces. This could be due to ingroup perceivers viewing ingroup targets as more complex and expressing a wider range of emotions, even if that perception was inaccurate.

Accuracy percentage difference between congruent and incongruent trials. To further probe the three-way interaction between target’s race, target emotion and context emotion, secondary analysis was conducted on accuracy difference between congruent and incongruent trials. The accuracy percentage difference between congruent and incongruent trials was calculated for all possible target-context pairings for both target races, and the means were submitted to a 2 (age: old, young) 2 (target emotion: anger, disgust) x 2 (target’s race: Black, White) mixed repeated measures ANOVA.

The main effect of target’s emotion was significant, \(F(1,99) = 3.80, p = .054, \text{partial } \eta^2 = .04\). The accuracy difference between congruent and incongruent trials was bigger for disgusted targets (\(M =19.01, SE = 2.21\)) than for angry targets (\(M =14.85, SE = 1.64\)). The main effect of target’s race was significant, \(F(1,99) = 11.91, p = .001, \text{partial } \eta^2 = .11\). The accuracy difference between congruent and incongruent trials was bigger for Black (\(M =19.56, SE = 1.83\)) targets than White targets (\(M =14.31, SE = 1.76\)). There was no main effect of age, \(p = .59\).

These main effects were qualified by the significant target’s race x target’s emotion interaction, \(F(1,99) = 7.66, p = .007, \text{partial } \eta^2 = .07\). Accuracy difference was bigger for angry Black (\(M =18.45, SE = 2.50\)) than angry White targets (\(M =10.17, SE = 1.80\)), \(p < .001\), while no significant difference was found between disgusted Black and disgusted White faces, \(p = .60\) (\(M_B =19.58, SE = 2.40; M_w = 18.45, SE = 2.50\)). Compared to congruent trials, accuracy for
incongruent Black angry face trials decreased to a larger extent than the decrease of accuracy of incongruent angry White face trials.

The three-way target’s race x target’s emotion x age interaction approached significance, $F(1,99) = 3.65, p = .068$, partial $\eta^2 = .03$. A priori contrasts to test for hypothesis (3) revealed a bigger discrepancy between Black and White angry target accuracy differences for older adult perceivers, though this difference only approached significance, $p = .07$. For younger adults, accuracy difference was bigger for angry Black than angry White targets, $p < .001$. No difference was found for disgusted Black and White targets in both younger and older adults, $p > .3$ (Figure 5). In other words, for older adults, accuracy difference for Black targets was larger than that for White targets across target’s emotion. However, for younger adults, accuracy discrepancy between congruent and incongruent trials was noticeably larger for Black than White in angry targets, and was not different in disgusted targets.

Context-dependent errors. Hypothesis (2) posits that stereotype about Black Americans being angry can influence perceivers’ perception of angry Black faces, and thus reduce or eliminate contextual effects for Black targets, compared to White targets. The above-discussed three-way interaction of accuracy results between target’s emotion, context emotion, and race, when analyzed with contrasts based on context, showed contextual effects (accuracy for congruent trials was higher than accuracy for incongruent trials) for both Black and White targets that supported the two-way target’s emotion x context emotion interaction. Therefore, the contextual effects were not eliminated for Black targets, but stereotypes could still reduce contextual effects for Black compared to White targets. We thus examined the dependent variable of context-dependent errors to determine the magnitude of contextual effects.
Context-dependent error percentage, as was defined in Study 1, is the percentage of times participants identified the target emotion with the context emotion, when the target and context are emotionally incongruent (e.g. identifying an angry target as disgusted when it is placed on a disgust context, (Ngo & Isaacowitz, 2015)). For angry targets, the incongruent context is disgust, and for disgusted targets, it is anger context. Neutral targets did not have a congruent context, and were placed in two incongruent contexts - anger and disgust. The context-dependent errors (CDE) for neutral targets were averaged across both incongruent contexts. CDE data were analyzed using a 2 (age: old, young) x 3 (target emotions: anger, disgust, neutral) x 2 (race: White, Black) mixed repeated measures ANOVA. When Sphericity was not assumed, Greenhouse-Geisser correction for degrees of freedom was used. Complete data for this analysis are available for 51 older adults (OA) and 50 younger adults (YA).

Age differences in context-dependent errors. The main effect of age was significant, $F(1,100) = 8.52, p = .004, \text{partial } \eta^2 = .08$. Older adults ($M = 15.42, SE = 1.12$) were more influenced by context than younger adults ($M = 10.78, SE = 1.12$).

Target’s emotion, target’s race and perceiver’s age effects on context-dependent errors. The main effect of the target’s emotions was significant, $F(1.66,164.75) = 150.63, p < .001, \text{partial } \eta^2 = .60$. Participants made more CDE when the target was angry ($M = 33.67, SE = 1.75$) than when the target was disgusted ($M = 12.86, SE = 1.56$), and both more than neutral targets ($M = 2.89, SE = .87$), with CDE for angry targets also being significantly higher than that for disgusted targets, all $ps < .001$. The main effect of race was significant, $F(1,99) = 45.05, p < .001, \text{partial } \eta^2 = .31$. Participants were more influenced by context when the faces were Black ($M = 19.66, SE = 1.17$) than White ($M = 13.29, SE = 1.03$).
These main effects were qualified by significant target’s emotion x target’s race 
\((F(1.56,154.20) = 25.35, p < .001, \text{partial } \eta^2 = .20)\) and target’s emotion x perceiver’s age 
\((F(2,198) = 3.38, p = .04, \text{partial } \eta^2 = .03)\) interactions. Participants were more influenced by 
context when the faces were angry and disgusted Black than White faces \((ps < .02)\), though no 
difference between races was found for neutral faces, \(p = .88\). Older and younger adults did not 
differ in CDE when identifying angry and neutral targets \((ps > .3)\), but older adults labelled 
disgusted faces in anger context as angry more often than younger adults, \(p = .002\) (Table 3).

While it is useful to understand the pattern of results based on raw context-dependent 
error percentage, it should be noted that participants could have made this type of error based on 
chance, and not because of influence from context. If all participants picked an emotion label 
out of 7 possible choices by chance, their average score over all 8 possible questions of each 
target emotion x context emotion x target race cell would be \((1/7)^*8\), thus making their average 
percentage score 14.29%. Accuracy percentage, with the lowest average being that for older 
adults’ accuracy for Black incongruent angry face trials \((M = 41.5\%)\), was well above chance. 
Context-dependent errors, however, were generally lower, and were tested with one sample t-
tests in each target emotion x context emotion x target race category against chance (14.29\%) 
for each age group. CDE percentages for neutral targets of both races in anger and disgust 
contexts were significantly below chance, \(ps \leq .002\). Younger adults’ CDE percentages for 
disgusted faces on incongruent anger contexts were either not different from chance (Black 
faces, \(p = .15\)) or below chance (White faces, \(p < .001\)). Similarly, older adults’ CDE was at 
chance for both disgusted Black and White faces, \(ps > .10\). Both younger and older adults made 
significantly more CDE than chance when identifying angry faces of both races in an
incongruent disgust context, ps ≤ .001. That means older adults were more influenced by context when the target was angry on a disgust context, and this contextual influence was not by chance.

**Baseline: Fast emotion categorization task**

*Accuracy percentage.* Following Biljstra et al. (2010, 2014), responses with reaction time lower than 200ms and higher than 3000ms were excluded. Responses in each of the three trial blocks (comparing Anger-Disgust, Disgust-Sadness, and Anger-Sadness) were averaged to create accuracy data for angry, disgusted, and sad faces across all 3 blocks. A 2 (age group: older, younger) x 3 (target emotion: anger, disgust, sadness) x 2 (race: Black, White) mixed repeated measures ANOVA was conducted on accuracy percentage. All participants who were included in the context task were included in the analysis for this task, except for 1 YA who forgot instructions and had to stop the task halfway through, thus not having enough data compared to other participants.

*Age differences in emotion perception.* Older adults (M = 64.14, SE = 1.46) had lower accuracy than younger adults (M = 78.67, SE = 1.46), F(1,98) = 49.29, p < .001, partial \( \eta^2 = .34 \). No other effects with age were found.

*Target’s emotion effects on accuracy.* The main effect of emotion was significant, \( F(2,198) = 10.66, p < .001, \) partial \( \eta^2 = .10 \). Accuracy for sad targets (M = 75.35, SE = 1.49) was the highest, followed by disgusted targets (M = 71.46, SE = 1.30) and angry targets (M = 67.50, SE = 1.46), ps ≤ .029.

*Target’s race effects on accuracy.* The main effect of race was significant, \( F(1,98) = 6.24, p = .014, \) partial \( \eta^2 = .06 \). Accuracy for Black faces (M = 72.58, SE = 1.14) was higher than White faces (M = 70.22, SE = 1.14).
Target’s race and emotion effects on accuracy. The race and emotion main effects were qualified by a target’s emotion x target’s race interaction, \( F(2,198) = 9.64, p < .001, \text{partial } \eta^2 = .09 \). No significant difference between two target’s races were found for angry and sad targets (\( ps > .5 \)), but accuracy was higher for disgusted Black than disgusted White targets, \( p < .001 \) (Figure 5).

Reaction time (RT). Consistent with Biljstra et al. (2010, 2014), responses with reaction time lower than 200ms and higher than 3000ms were excluded (1.5% for anger-sadness block, 2.3% for anger-disgust block, and 2% for sadness-disgust block.) Because RT data are positively skewed, to avoid violation of normality in ANOVA, raw RT data were log-transformed, and then standardized (as was done in Biljstra et al. 2014) with z-scores. Z-scoring also helps control generalized age-related slowing that is not related to the main manipulation of interest (Costello et al., 2011). Unlike the analysis for accuracy data, which reflects overall identification ability, and was thus analyzed collapsed across blocks, RT data were analyzed within each comparison block as the type of comparison might affect reaction time (Biljstra et al., 2010, 2014). Raw RT means instead of z-scored log-transformed data are presented here for ease of interpreting. The same analysis with raw RT data yielded similar patterns of results (with some main effects approached significant with raw RT data but significant with log-transformed data.)

Anger-Disgust comparison. The main effect of target’s race was significant, \( F(1, 91) = 4.54; p = .036, \text{partial } \eta^2 = .048 \). Participants responded faster to White faces (\( M = .88, SE = .03 \)) than Black faces (\( M = .91, SE = .03 \)). The age x target’s emotion x target’s race interaction was also significant; \( F(1, 91) = 5.08; p = .027, \text{partial } \eta^2 = .053 \). Older adults responded faster to disgusted White than to disgusted Black faces, \( p = .02 \). Younger adults, on the other hand,
responded faster to angry White than to angry Black faces, \( p = .04 \) (Figure 7). No difference was found between two races for angry faces in older adults, and disgusted faces in younger adults, \( ps > .1 \).

*Anger-Sadness comparison.* The main effect of target’s emotion was significant, \( F(1, 92) = 6.64; p = .012, \text{partial } \eta^2 = .067 \). Participants responded faster to angry \((M = .84, SE = .02)\) than sad faces \((M = .88, SE = .03)\). No other effects were found.

*Disgust-Sadness comparison.* No difference was found for this comparison.

*Summary.* To summarize, hypothesis 2 and 3a were not supported, although hypothesis 3b was partially supported. Overall, participants were more influenced by context when the target was Black than when the target was White for angry and disgusted expressions, but not because they had a perceptual deficit for outgroup faces, as shown by the baseline task. Both younger and older adults displayed at once a response bias for disgust to Black faces regardless of the actual target’s facial expression, and a perception advantage for disgusted Black faces. Older adults were more influenced by context than younger adults, but mostly when the target was disgusted.

**Hypothesis 4: Executive functioning, implicit and explicit prejudice as moderators for the relationship between target’s race and contextual influence**

*Implicit and explicit prejudice measures.* All descriptive statistics for cognitive and prejudice measures can be found in Table 4.

*Feeling thermometers.* A mixed repeated measures ANOVA with race as a within-subject factor and age as a between-subject factor found no difference between feeling thermometers for Black and White across age groups. Older adults rated their feelings as less warm than younger adults for both Black and White, \( p = .001 \), \text{partial } \eta^2 = .12 \) (Table 4).
However, there was no age difference in the relative preference for White over Black, calculated as the rating difference between the White and Black thermometers, \( p = .34 \).

**Internal and external motivation to control prejudice.** A mixed repeated measures ANOVA with motivation type (external/internal) as a within-subject factor and age as a between-subject factor revealed a significant main effect of age, \( F(1,99) = 5.54, p = .02 \), partial \( \eta^2 = .053 \). Younger adults were both more externally and internally motivated to control their prejudice than older adults. The interaction effect was not significant. Since these two scores also did not significantly correlate \( (r = .06, p = .59) \), only the score for the Internal Motivation subscale was used for further analysis, as this score has been shown to correlate well with other behavioral measures (Plant & Devine, 1998). Furthermore, one-sample t-tests within each age group (against the value of 3, which indicated “neither agree nor disagree” on the 5-item Likert scale for both motivation measures) indicated that only the internal motivation scores were significantly higher than 3, \( ps < .001 \), for both age groups, whereas external motivation scores were not, \( ps > .11 \).

**Emotion Implicit Association Test.** Emotion IAT (eIAT) scores were calculated using the improved ratio formula, which calculates the difference in RT between two combined categorization test blocks, divided by an inclusive standard deviation from both blocks (Greenwald, Nosek, & Banaji, 2003). This approach to calculating IAT scores also avoids extraneous influences such as individual differences in average RT, which is a common problem in age group data. Due to a change in procedure\(^5\), eIAT scores were only available for 30 of the 51 included younger adults. Each eIAT score from each age group was subjected to a

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\(^{5}\) The first iteration of the eIATs used words from the anger and sadness category as in Biljstra et al., 2014; however, these words were translated from Dutch, and thus some of the words were not viewed as belonging to the appropriate categories by English speakers. A new version of these eIATs was thus created using ratings and categorization from English speakers (research assistants and Mturkers).
one-sample t-test against 0. Positive values indicate an implicit association of Black and anger, and White and disgust/sadness, while a value of 0 indicates no association. All eIAT scores from both eIATs for both age groups were positive, but only eIAT score from Sadness eIAT for younger adults was significantly different from 0 when subjected to a one sample t-test \((t(29) = 3.16, p = .004)\), indicating that younger adults showed an association between Black and anger, but only when this association was pitted against White and sadness.

**Executive functioning measures.** For the Stroop task, Stroop Interference score, often thought of as an index of inhibition (Bugg, 2014; Verhaeghen & De Meersman, 1998), was calculated as the differences in accuracy and RT between the incongruent trials and the neutral trials. Age difference was significant for Interference accuracy \((t(98) = 4.05, p < .001)\) and approached significance for Interference RT \((t(98) = 1.85, p = .068)\). Performance on the Trail Making Test was assessed with a difference score between RTs for Trail B and Trail A. Older adults had a larger RT difference than younger adults, \((t(99) = 4.98, p < .001)\).

As there are multiple executive functioning measures that correlated with one another, a principal component analysis (PCA) using correlation matrix of these measures was conducted to obtain an aggregate score that represents a general cognitive component. The correlation matrix (Table 5) was used to exclude variables that did not covary with others, leaving Stroop Interference Accuracy, WCST categories achieved, Trail B-A RT difference, and Pattern Comparison RT as the variables for the PCA. The first principal component (also the only component with eigenvalue > 1) accounted for 54.93% of the total variance. This first principal component positively correlates with RT measures (Trail B-A difference, \(r = .84\); Pattern Comparison RT, \(r = .82\)) and interference measure (Stroop Interference Accuracy, which is the difference in accuracy between the neutral trials and the incongruent trials; larger difference
indicates lower accuracy for incongruent trials and higher Stroop interference effect, $r = .72$). In contrast, the first component negatively correlates with the number of categories achieved for the card sorting task, $r = -.56$. The first principal component score thus represents the difficulty in avoiding interference effects in executive functioning, and will henceforth be called Interference score. A higher Interference score indicates worse executive functioning, and a lower score indicates better executive functioning. Older adults ($M = .66$, $SD = .97$) had a higher Interference than younger adults ($M = -.70$, $SD = .33$), mirroring results from the original cognitive variables in which they showed lower level of executive functioning ($t(60.39) = 4.98$, $p < .001$).

**Executive functioning and prejudice as moderators.** The roles of executive functioning and prejudice as moderators for the relationship between target’s race and contextual influence on angry targets, as indicated by context-dependent errors, and how these effects vary by age groups (moderated moderation), were tested using multilevel modelling (specifically hierarchical generalized linear model). Due to target’s race being a within-subject factor, and the fact that traditional multiple regression does not allow for testing of between and within subject factors interaction in the same model, multilevel modelling was selected as the most appropriate analysis approach. Analyses were conducted in SAS version 9.4 for Windows (SAS Institute, Cary NC) and web-based R code on quantpsy.org (Preacher, 2016).

**Executive functioning, explicit prejudice, stereotyping, and age as moderators.** Context-dependent error (CDE) for angry targets on incongruent (disgust) context was used as a binary outcome variable. Context-dependent errors variable was coded as 1 if the participant identified a target with the emotion of the scene context, and coded as 0 if the participant did not. This variable was then modeled as a function of target’s race (Level 1), age, Interference score (INT),
internal motivation (IM), feeling thermometer relative preference of White over Black (FT) (Level 2), stereotyping (ST), and all cross-level two-way and three-way interactions (see model below). Stereotyping was calculated as the difference in reaction time in the baseline fast emotion categorization task between White angry and Black angry faces. If participants responded faster to Black angry faces than White angry faces, their ST score would be higher, indicating more emotion-specific stereotyping. Internal motivation and feeling thermometer relative preference were not significantly correlated \( r = .14, p = .16 \), thus were entered as separate variables. Implicit prejudice measured with the eIAT was included in a separate model due to the missing cases that would have been deleted listwise\(^6\).

For target’s race and age, White and younger adults were the reference categories (dummy coded as 0). Executive functioning and internal motivation were grand-mean centered. A relative preference of 0 means no preference for either Black or White, and was therefore not mean centered. The test for moderation is the cross-level interaction, represented by the slopes of the two-way interactions between the two level 2 predictors in the equation for the slope of the level 1 equation, which predicted change in the relationship between target’s race and context-dependent error as a function of the age x INT, age x IM, and age x FT interactions.

\[
\log(\text{CDE}_\text{angry face incongruent}) = \beta_0 + \beta_1(\text{RACE})
\]

\[
\beta_0 = \gamma_{00} + \gamma_{01}(\text{AGE}) + \gamma_{02}(\text{FT}) + \gamma_{03}(\text{IM}) + \gamma_{04}(\text{ST}) + \gamma_{05}(\text{AGE} \times \text{INT}) + \gamma_{06}(\text{AGE} \times \text{FT}) + \gamma_{07}(\text{AGE} \times \text{IM}) + \gamma_{08}(\text{AGE} \times \text{ST}) + u_0
\]

\[
\beta_1 = \gamma_{10} + \gamma_{11}(\text{AGE}) + \gamma_{12}(\text{INT}) + \gamma_{13}(\text{FT}) + \gamma_{14}(\text{IM}) + \gamma_{15}(\text{ST}) + \gamma_{16}(\text{AGE} \times \text{INT}) + \gamma_{17}(\text{AGE} \times \text{FT}) + \gamma_{18}(\text{AGE} \times \text{IM}) + \gamma_{19}(\text{AGE} \times \text{ST})
\]

\(^6\) As there has been some evidence for the role of executive functioning in implicit and explicit prejudice (Ito et al., 2015; von Hippel et al., 2000), multiple regression analyses predicting eIAT disgust score and feeling thermometer relative preference were conducted, using age, executive functioning, and internal motivation to control prejudice as predictors. No significant relationship was found, \( p_s > .09 \).
There were 1616 observations across 101 participants (the same participants in the accuracy and context-dependent error ANOVAs) in the unconditional model. In subsequent models, 160 observations were excluded, as 4 participants with one or more missing cognitive tests did not have an INT score computed, 1 participant did not complete fast emotion categorization task (as stated in the results section for this task), and 5 separate participants who skipped or declined to complete the Feeling Thermometers. No data were missing for the Internal Motivation test. The log odds of making a context-dependent error for a typical subject was $\gamma_{00} = -2.35$, $SE = 0.16$. The intraclass correlation (calculated with the latent variable method as suggested by Snijders and Bosker (1999) revealed that 34.46% of the variability in CDE was between-subjects (variance component significant at $p < .01$). The variability of log odds of making a CDE was significant, $\tau_{00} = 1.73$; $z(101) = 5.04$, $p < .0001$. Results from the full model are reported in Table 6.

There was a significant cross-level interaction between target’s race and interference score, $p = .01$. Simple slope tests were conducted to examine the relationship between INT and CDE as a function of target’s race (race as a moderator). When the target was Black, participants with higher INT (worse executive functioning) were less likely to make CDE, $b = -2.44$, $SE = 0.99$, OR = 0.09, $t(1386) = -2.49$, $p = 0.013$. In contrast, INT did not predict the log odds of making CDE when the target was White, $b = -0.07$, $SE = 1$, OR = 0.93, $t(1386) = -0.07$, $p = 0.94$ (Figure 8).

This two-way interaction was qualified by a significant cross-level three-way interaction target’s race x INT x age, $p = .02$. Simple slope analysis showed that the two-way interaction

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Hierarchical generalized linear models with the same predictors and the same model building process, except leaving out the feeling thermometer relative preference variable (FT) and its interaction terms to see if the participants who were exclude affected the data. Results remained the same as those without FT with respect to the two-way and three-way interactions involving target’s race, age group, and executive functioning.
discussed above was present for younger adults, but not older adults (Table 8 and Figure 9, 10). Executive functioning did not predict how likely younger adults were to make CDE when the target was White (OR = 0.93); however, the higher the INT score (the worse executive functioning), the less likely younger adults were to make CDE for Black angry targets (OR = 0.09). This difference did not exist for older adults (OR_{White} = 1.14, OR_{Black} = 1.15).

*Implicit prejudice and age as moderators.* An eIAT score of 0 means no association between Black and anger, thus eIAT score was not centered. Since the main experimental task did not contain sad facial expressions, only the eIAT with anger and disgust concepts was used as a moderator in the model. Variables were dummy-coded in the same manner as in the previous model. Target’s race was the level 1 variable; age and eIAT were level 2 variables. EIAT was hypothesized to moderate how target’s race affected contextual influence on angry targets, and age was expected to moderate this moderation relationship.

\[
\log(\text{CDE}_{\text{angry face incongruent}}) = \beta_0 + \beta_1(\text{RACE})
\]

\[
\beta_0 = \gamma_{00} + \gamma_{01}(\text{AGE}) + \gamma_{02}(\text{eIAT}) + \gamma_{03}(\text{AGE}*\text{eIAT}) + u_0
\]

\[
\beta_1 = \gamma_{10} + \gamma_{11}(\text{AGE}) + \gamma_{12}(\text{eIAT}) + \gamma_{13}(\text{AGE}*\text{eIAT})
\]

There were 1264 observations across 79 subjects. In the null model, 33.8% of variance was between subjects. The full model is presented in Table 7. Older adults were more likely to make CDE for angry faces in incongruent context than younger adults, \(\gamma_{01} = 1.09, SE = 0.43, t(1181) = 2.56, p = .01, OR = 2.96, 95\% \text{ CI} [1.29, 6.81]\), controlling for other predictors in the model. Notably, this result differed from the contrast analysis from the mixed repeated measures ANOVA reported above under Hypothesis 2 and 3, in which older adults did not differ significantly from younger adults in angry incongruent face trials, despite having higher CDE overall than younger adults. Unlike the ANOVA, in this hierarchical generalized linear
model, variance from eIAT and its related effects, as well as within-person variance with non-aggregated data in responding to Black and White angry faces, were accounted for, and the trial-level analysis provided more power to detect differences. However, eIAT did not predict CDE or moderate the relationship between target’s race and CDE8.

Summary. In summary, hypothesis 4 was partially supported. Executive functioning, but not implicit or explicit prejudice, moderated how target’s race predicted context influence for angry incongruent target trials. Age did moderate this moderation, but not in the direction expected. Executive functioning moderated the relationship between target’s race and contextual influence for younger adults, but not for older adults. If the perceiver was a younger adult, the better the level of executive functioning, the more influenced by context the perceiver was when the target was Black, compared to when the target was White. If the perceiver was an older adult, neither the target’s race nor the perceiver’s levels of executive functioning significantly predicted contextual influence.

Discussion

The results of Study 2 showed that emotion perception, especially of contextualized facial expressions, varies as a function of age, target’s race, and executive functioning, though not in the direction predicted by the hypotheses. Contextual influence, in the same manner as in Study 1, was assessed with not only accuracy, but also specific context-dependent errors, to rule out other types of errors that could have led to accuracy discrepancy between congruent and incongruent trials. As expected and similar to Study 1, older adults performed worse than younger adults in both the speeded, isolated emotion perception task, and the contextualized face task. When identifying faces in context, older adults were more influenced by context than

8 As motivation to control prejudice has been shown to moderate the relationship between implicit prejudice and behavior judgment (Olson & Fazio, 2004), the same model but with Internal Motivation and all related two- and three-way interaction terms were included. Results did not differ from models without this variable.
younger adults. Angry targets, compared to disgusted and neutral targets, were more difficult to identify to both age groups, and led to more contextual influence. As hypothesized in hypothesis 1, the quite robust context effect was evident for both Black and White targets, replicating and extending previous research on contextual influence that has been almost exclusive conducted on ingroup targets. Context effects were found only in negative facial expressions, but not neutral expressions, indicating that the influence of context is more than simply priming of emotional signals from the context. When there is valenced information to be decoded, as in the case of non-neutral expressions, the perceiver is more likely to make use of the contextual cues presented with the target facial expressions.

Replicating Study 1 and in line with previously discussed contextual bias in visual perception in late adulthood, older adults were more influenced by context than younger adults. This main effect of age appears to be mainly driven by age differences in contextual influence on disgusted targets\(^9\), such that older adults were labelling disgusted faces in anger context as “angry” more often than younger adults. This disgust-specific result also replicated Study 1, although in Study 1, older adults were also more influenced by context for angry targets. Interestingly, unlike Study 1, older adults did not respond “disgust” to non-disgusted faces more frequently than younger adults, which indicated the context effect was not likely to be due to a response bias. Similar to Study 1, again older adults did not benefit in accuracy when the target emotion was congruent with the context emotion, even for ingroup targets. Scene context as a type of environmental support cue might not be the sole solution for older adults’ emotion perception deficit.

\(^9\) Although multi-level analysis with only angry targets, as discussed in results for hypothesis 4, revealed that older adults were also more influenced by context when the target was angry.
In contrast to what was hypothesized in hypothesis 2 and 3a about participants using stereotype instead of context when identifying Black angry faces on incongruent disgust context and boosting accuracy compared to White angry faces (on incongruent context), accuracy for Black angry faces on incongruent context was lower than accuracy for White angry faces. This finding supported the alternative hypothesis 3b, which posits that more contextual influence for Black targets across target’s emotions might indicate a perceptual deficit for outgroup faces, thus leading to more reliance on context. There has been evidence on how perceivers can identify ingroup facial expressions better than outgroup ones (Elfenbein & Ambady, 2002; Kang & Lau, 2013). A perceptual advantage for ingroup faces, if there was one, should have been demonstrated in the speeded emotion categorization task, in which stimuli were presented for only 200ms, presumably precluding the influences of non-perceptual biases. However, participants identified Black and White targets equally well when the facial expression was sad or angry, showing no advantage of White participants in identifying White faces. More interestingly, accuracy for Black disgusted targets was higher than White disgusted targets. Accuracy was also higher for Black disgusted targets on congruent and incongruent context compared to that for White disgusted targets in the contextualized face task. This perceptual advantage for Black disgusted faces could explain why contextual influence for Black angry faces was higher than that for Black disgusted faces. These results indicate that participants did not have an ingroup advantage or outgroup perception deficit in labelling White negative facial expressions, thus the increased contextual effects for Black faces – both angry and disgusted ones – might not be due to Black targets being more difficult to categorize.

A possible explanation for the increased context effect for angry incongruent Black faces on disgust context is a response bias for disgust to Black faces. Participants used the label
“disgusted” for angry and neutral faces on anger context more often when the target was Black than when the target was White, even though there was no “disgust” emotion signal in the stimuli. However, the pattern appears to be that while a perceptual advantage for Black disgusted faces exists, participants tend to use the “disgusted” label for Black angry faces more than for White angry faces, which could suggest an attempt to correct automatically activated bias towards labelling Black faces as angry.

More evidence for attempt to correct for biases was provided by results from the speeded emotion categorization task with isolated faces. In this task, younger adults were faster to respond to White angry faces than Black angry faces. This finding contrasted previous studies by Biljstra et al. (2010, 2014) in which participants responded faster to a stereotypical facial expression (angry) of an outgroup (Moroccan). Older adults, on the other hand, responded faster to White disgusted faces than Black disgusted. Older adults, however, have been found to have a slight advantage over younger adults in disgusted face perception (Ruffman et al., 2008), and as all these studies were conducted with White faces, it can be inferred that older adults might have responded faster to White disgusted faces than Black disgusted faces (whereas this difference did not exist for younger adults) because they found White disgusted faces easy, and especially easier than Black disgusted faces. This faster response did not translate to an accuracy advantage for older adults with White disgusted faces compared to younger adults or compared to their own accuracy for angry faces, however. In fact, both younger and older identified Black disgusted faces more accurately than White disgusted faces. In this task, participants only had two keys to indicate their answer, which means an error can be due to either a failure to identify an emotion, or a response bias for the other

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10 In analyses for each block (anger vs. disgust, anger vs. sadness, sadness vs. disgust) separately, accuracy for Black disgusted faces were also significantly higher than Black sad and angry faces, $ps < .05$. 
emotion. Older adults’ higher accuracy for Black disgusted faces might have been due to a response bias (as was found in the response frequency analysis for the context task), and not because they found Black disgusted faces easier (as they would have responded to Black disgusted faster if that was the case). Note that these effects for reaction time were not found when angry faces were pitted against sad faces. These results suggest that at least younger adults were attempting to correct for their bias to Black faces (and respond slower to the stereotyped emotion of anger for Black faces).

Correction can happen when an individual has enough motivation to control prejudice (Dasgupta, 2004), irrespective of whether the individual has positive or negative toward the target (Olson & Fazio, 2004). In fact, Olson and Fazio (2004) found that their White participants reported more positive trait inferences for Black than White targets. In this study, both younger and older adults appeared to have sufficient internal motivation to control prejudice, which could explain why they “bend over backwards” to label Black angry faces – and Black non-disgusted faces in general – as “disgusted” instead of angry. In addition, individuals from the current sample exhibited very little negative bias, both explicit and implicit, towards Blacks. A bootstrapping procedure with 1000 samples on the feeling thermometer relative preference of Black over White indicated the confidence intervals for the mean are [-2.91, 2.5], which are noticeably lower than means reported by previous studies ($M = 8.73$ from Greenwald et al. 1998’s study; $M = 10.46$ from Ito et al. 2015’s study).

Our sample thus appeared to be motivated to suppress their bias, and expressed very little explicit bias. With regards to implicit prejudice, evidence is more mixed, but still seems to indicate that the current sample, with individuals being from and residing in a more diverse and progressive area of the country, might be more egalitarian than an average sample. Younger
adults did show some association between anger and Black, although this association – while positive – was only significantly different from 0 (meaning no association) when anger was pitted against sadness, and not when anger was pitted against disgust. Older adults, surprisingly, did not show any implicit association between Black and anger. The current sample thus appears to at once hold weak to no stereotypical association between Black and anger, and have sufficient motivation to correct for their biases.

Considering the nature of the current sample, it was not surprising then that neither implicit nor explicit prejudice significantly predicted contextual influence on angry targets. There might not have been enough variability in prejudice (everyone was more egalitarian than prejudiced) to accurately predict behaviors. Contextual influence for angry targets was mainly predicted by the target’s race, the perceiver’s age, and the perceiver’s level of executive functioning. Controlling for implicit prejudice, older adults were more likely to make CDE than younger adults. In the model without implicit prejudice, controlling for explicit prejudice, odds ratios suggested that for each unit increase in Interference score, older adults were more likely than not to make context-dependent errors for both Black and White angry targets (ORs > 1). With each unit increase of Interference, older adults were 0.14 times (14%) more likely to make CDE when the target was White, and 0.15 times (15%) more likely to make CDE when the target was Black. In contrast, for each unit increase in Interference score, younger adults were less likely to make context-dependent errors than not (ORs <1). Specifically, with every unit increase of Interference, when the target was White, the odds of younger adults making CDE decreased by 1-0.93 = 0.07 times (7%). When the target was Black, with every unit increase of Interference, the odds of younger adults making CDE decreased by 1-0.09 = .91 times (91%). It is important to note that among the odds ratios for younger and older adults for Black and White
targets, only the odds ratio for younger adults, Black targets was statistically significant. In other words, within younger adults, higher levels of executive functioning led to higher probability of being influenced by context when the target was Black. More contextual influence could be interpreted as an attempt to avoid labelling the facial expression with its stereotypical, even if correct, label. The predictive power of executive functioning indicated that better executive functioning, which includes better inhibition abilities, might have facilitated inhibition of stereotypes for perceivers with the best executive functioning abilities (in this case, younger adults with higher executive functioning; older adults had significantly lower score on executive functioning than younger adults on average).

Chapter 4: General Discussion

The Robust Effect of Visual Context on Emotion Perception

The current dissertation explored context effects in facial emotion perception from a lifespan perspective and examined the different boundary conditions of context effects by integrating theories from cognitive aging and social cognition literatures. Findings support the robust context effects in facial emotion perception, specifically the effects of visual scene context. Extending previous studies in which scenes affect intensity ratings of the target facial expressions (Ko et al., 2011; Masuda et al., 2008), the current studies provide evidence that scene context can shift the categorization of a target facial expression. The categorization shift effect (context-dependent errors averaged around 10-20%) is larger than that of the few previous studies using scenes in which total error rates (not just context-dependent errors) were from 5-8% (Righart & de Gelder, 2008b). Furthermore, participants in the current studies had to choose between seven distinct labels (compared to two or three labels as in Lee et al., 2012; Righart & de Gelder, 2008a, 2008b, although these studies measured reaction times and thus
had to limit their response options), which created more room for non-context errors. Instead of
decreased intensity or morphed faces as in Lee et al. 2012 or Ko et al. 2011, the current studies
also utilized the traditional, more exaggerated facial expressions, which should have made it
more difficult for participants to be influenced by context, but they did not. The robust and
consistent context effects even as the two studies employed scenes across different emotions,
targets (from two different databases, one for each study), target’s races (Black and White),
instructions about context relevance, and so on, provide strong evidence for the role of context,
especially visual context, in facial emotion perception.

Finding of context effects from visual scene context is crucial to establishing evidence
for context effects in general. Within the type of context that is associated with but physically
external to the target, context effects have been demonstrated more often with verbal than visual
descriptions of emotion triggering situations (see Barrett et al., 2011; Wieser et al., 2014 for
reviews). Verbal descriptions – essentially written scripts constructed by the researcher – are
easily manipulated to portray precisely a situation that can elicit one major emotion. In contrast,
emotional scenes, which are curated from real unstaged pictures, are often interpreted to elicit
multiple emotions as was shown in stimuli norming data for the current dissertation. Scene
context, therefore, does not always convey a clean-cut, easily interpretable situation and
emotion as verbal context does. Moreover, while scenes are integral to target identification
processes (such as object recognition, (Davenport & Potter, 2004; Davenport, 2007; Oliva &
Torralba, 2007), and despite evidence that scenes are processed simultaneously with the target
faces (Righart & de Gelder, 2008a), scenes might not be processed in a holistic manner with
facial expressions as body posture context is (Aviezer et al., 2012). Evidence that scene context

11 In one of the multiple rating sessions with younger and older adults on Mechanical Turk, with pictures
preselected by research assistants, only 4 out of 55 pictures met the criterion of having one emotion rated higher
than 3.5 (out of a 5 point scale) and other emotions rated lower than 3.5.
can shift categorization of facial expressions, even though not as much as body posture does, supports the notion that emotion perception utilizes all available cues, even ones that are not physically connected to the target face, or are more semantically muddled.

**Age Differences in Emotion Perception and the Role of Context**

The current studies, while continuing the tradition of research on context in emotion perception, offer a novel perspective by incorporating research on aging. Most studies on emotion perception of contextualized faces using static images have been with younger, college-aged adults, with only a few exceptions (Ko et al., 2011; Noh & Isaacowitz, 2013), and results from these studies have been mixed with regards to how older adults differ from younger adults in contextual influence. Contextual effects, while robust, might change with age as a function of cognitive functioning and social-emotional perception abilities in late adulthood. The current studies explored such changes as well as contributed to the study of emotion perception in old age by using context as a possible explanation for the often-found age-related emotion perception deficit with non-contextualized faces (Isaacowitz & Stanley, 2011). Several studies have used dynamic stimuli (e.g. Richter, Dietzel, & Kunzmann, 2010; Sze et al., 2012) as a way to explain this age difference, but considering that the age difference was found with static images, it was important to see if adding more cues, even though static, would help boost accuracy in older adults.

Across the two studies, the age difference in emotion perception accuracy was consistent and robust, for both target-context incongruent and congruent trials. Contrary to what was hypothesized, older adults’ performance did not benefit from having congruent context. Accuracy for older adults’ congruent trials was comparable to baseline trials with no context or with neutral context. In addition, congruent trial accuracy for older adults was lower than that
for younger adults, indicating that the age-related emotion perception deficit exists even when contextual cues are provided. These findings suggest that older adults need more support than simply static contextual cues – especially with scene context, a more “difficult” type of context as discussed above. Older adults have been shown to be able make use of body posture context (Noh & Isaacowitz, 2013), dynamic changes of the expression itself (Grainger, Henry, Phillips, Vanman, & Allen, 2015; Krendl & Ambady, 2010; Richter et al., 2010), and accompanying vocal expression with the face (Lambrecht, Kreifelts, & Wildgruber, 2012) to various degree of success. These types of cues are all physically connected to the target face, which might explain their more powerful effect on boosting older adults’ accuracy. Future research can directly compare static scene images and dynamic scenes (videotaping a situation) to explore whether integrating a temporal dimension with more situational information into scene context will help older adults utilize the contextual cues better.

The reduced accuracy for incongruent trials in older adults, compared to younger adults, was mostly due to a relative increase in context effects. In both studies, older adults were more influenced by context than younger adults, but only when the target was angry or disgusted, and not when the target was neutral. Angry and disgusted faces are more physically similar compared to other negative facial expressions (Susskind et al., 2007), angry faces tend to be identified as disgusted faces, and vice versa (Calvo & Lundqvist, 2008). Consequently, when an angry face is placed in a disgust context, even angry expressions at 100% signal strength are often identified as disgusted; similarly, disgusted expressions on anger context are perceived as angry (Aviezer et al., 2008). It appears that older adults only rely on context more than younger adults when the target and context emotions are more easily confusable.
Accuracy for neutral targets was similarly high among age groups, which replicates past findings that while older adults consistently identify negative facial expressions worse than younger adults, the age difference was more often absent when it came to non-negative faces such as neutral and happy expressions (Ruffman et al., 2008). This could be due to the fact that among the stimuli presented, there is always a wider variety of negative faces than non-negative faces, and correspondingly, more negative emotion labels than non-negative ones. Since valence is more easily differentiated than specific emotion categories (Barrett, 2006), participants only need to identify the non-negative faces, and choose between two labels (happy or neutral) to identify those faces. With negative faces, there are more choices, which could lead to more errors - or in the case of the current studies, more context-dependent errors, as participants have to rely on context for supportive cues. Alternatively, due to a tendency to avoid negative stimuli in old age (Mather & Carstensen, 2005), older adults might avoid negative facial expressions in real life, and thus have less practice with identifying them. However, within the current two studies, there is not enough support for a positivity bias in older adults. Although in Study 1, older adults responded “neutral” to non-neutral targets more than younger adults, this difference was not found in Study 2 \( (p_s > .50^{12}) \). Therefore, older adults’ response pattern across the two studies can be explained more by contextual bias than by the positivity effect. This contextual bias in older adults was found even for targets of a stereotyped outgroup, showing that the contextual influence affects emotion perception more than stereotypes, with the caveat being that the older adult sample in Study 2 might not hold as much stereotypical beliefs about the outgroup as an average older adult sample.

\[^{12}\text{As there was no happy facial expression in either study, the frequency of the “happy” response was low, averaging for each target-context pairing around 0.00 – 0.12 (raw score), with no significant age differences, } p_s > .05.\]
The age-related attentional bias for context extends previous findings on similar patterns of older adults’ contextual bias in visual processing of objects (Chee et al., 2006) to show that contextual bias in aging also affects how older adults perceive contextualized facial expressions of emotion. This contextual bias, at least within emotion perception, has a boundary condition: if the contextual cue is explicitly indicated as irrelevant, older adults are capable of exercising top-down control to ignore these cues. In Study 1, older adults were more influenced by context when they were told that the context was relevant than when they were told it was not. Given that the context task was not timed, and the stimuli stayed on screen for 3000ms, older adults might have had enough time to inhibit their attention to the irrelevant context, as inhibition has been shown to not completely abolished, but only delayed in time among older adults (Gazzaley et al., 2008). This explanation also supports findings that older adults have intact reactive control (the ability to inhibit interference from irrelevant information after stimulus onset), even as proactive control (the ability to prepare according to a sustained goal and avoid interference in advance) is impaired in old age (Bugg, 2014). Nonetheless, there was still some evidence that even within the irrelevant context condition, older adults were still more influenced by context than younger adults, as evident by the main effects of age for angry and disgusted targets and the lack of age x relevance condition interaction in context-dependent errors.

**Emotion Perception as a Function of Target- and Perceiver-Associated Contexts**

Context effects, as discussed thus far, are demonstrated across different task conditions, and vary as a function of different factors associated with the target and the perceiver. The *perceiver’s age* has proved to be an important predictor of context effects, although how much context effects vary across age groups also depend on other target-associated cues.
The magnitude of context effects depends on the emotion of the target. Context effects were larger for angry targets than disgusted targets, and neutral target perception was very minimally influenced by context. Correspondingly, accuracy for baseline trials (isolated facial expressions, no context) was highest for neutral faces, followed by disgusted faces, and lowest for angry faces. It appears that the harder a target emotion is to identify, the more the perceiver relies on contextual cues. Interestingly, data from previous studies do not detect an accuracy advantage of disgust over anger, even for the two databases whose stimuli were used in the current studies (Calvo & Lundqvist, 2008; Calvo, Gutiérrez-García, Fernández-Martín, & Nummenmaa, 2014; Tottenham et al., 2009). Nonetheless, as the comparisons are within subjects, it can be established that for the current samples, how difficult they found each of the target emotion to be corresponded to how much they relied on context when identifying that emotion.

Given that almost all context studies so far have used ingroup targets, it was not yet known how contextual effects would vary when the target belonged to an outgroup, especially a stereotyped outgroup. Outgroup targets are harder to identify (Elfenbein & Ambady, 2002a), hence the perceiver might rely more on context for cues. However, stereotyped outgroup targets might elicit strong stereotypical beliefs about their group from the perceiver, and if that belief conflicts with the context, the perceiver might rely more on the stereotype heuristically and ignore the cues from the context. It is not surprising then that group membership, in this case, the race of the target, did have an effect on context effects. Participants were more influenced by context when the target was Black than when the target was White, suggesting an ingroup advantage in perception. However, for both congruent and incongruent trials, Black angry faces were not identified more accurately than White angry faces, even though there is a stereotypical
association between Black targets and anger. This finding could be attributed to a response bias for disgust when the target was Black and angry. Response frequency analysis on non-disgusted targets and context indicated that participants used “disgusted” label more for Black angry faces than White angry faces. This response bias was not present for neutral faces. Despite a perception advantage for Black disgusted faces, as shown by the higher isolated and contextualized disgusted targets accuracy for Black than White faces, at the same time there seems to be a top-down motivated bias to use the disgust label to avoid appearing prejudiced among the participants, who were White and exhibited low prejudicial beliefs.

How much participants were able to correct for their bias and suppress their stereotyping behaviors were predicted by levels of executive functioning. Executive functioning, which includes the ability to inhibit attention to irrelevant stimuli or unwanted thoughts, was shown in both studies to influence the magnitude of contextual influence. The perceiver can utilize their top-down control to inhibit attention to contextual cues if they know beforehand that the context is not relevant to the target facial expressions. Interestingly, as discussed above, this effect did not vary with age, even though older adults have declined inhibition abilities and executive functioning (Salthouse & Meinz, 1995). Contextual influence, under certain circumstances where top-down control can be utilized, is not as spontaneous as previously thought (Aviezer et al., 2011).

Executive functioning, in Study 2, modulates contextual influence indirectly through facilitating correction of bias for stereotyped targets. Younger adults utilized their inhibition so that the better their executive functioning, the more influenced by context they were when the target was Black and angry. In contrast, executive functioning did not predict contextual

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13 It is unclear whether the advantage for Black disgusted faces is unique to the NimStim database, as there is no available extant research on this topic, and also no available rating comparison from the NimStim norming publication (Tottenham et al., 2009).
influence for White angry targets in younger adults. It appears that when faced with the two most likely choices of label for angry targets (anger and disgust), a younger adult perceiver does not need to exercise top-down control to inhibit the more stereotypical choice (even if correct) of “angry” when the target is White. When the target is Black, only the perceiver with better executive functioning can inhibit the “angry” response to choose the other likely label, “disgusted”, based on both structural similarity and contextual cues. In contrast, older adults, who had lower executive functioning levels than younger adults, were influenced by context for both Black and White targets regardless of their executive functioning levels. This suggests that contextual bias is present even among older adults with better executive functioning than others among their cohort.

**Limitations and Future Directions**

As with most cross-sectional aging studies, the biggest limitation with these current studies is the inability to make causal claim about how aging leads to emotion perception deficit, decline in inhibition, and increase in contextual attention. Longitudinal studies in which emotion perception tests – preferably both with and without context – that have high test-retest reliability, and at the same time control for practice effects, will be an excellent way to look at how different social and biological changes affect emotion perception in old age.

In the current research, age differences in accuracy were still present for congruent target-context trials, indicating that having contextual cues as aids does not eliminate the often-found age-associated deficit in emotion perception (Ruffman et al., 2008). It is possible that older adults need contextual cues that are even richer in information than those used in the current research. Indeed, previous studies found no age differences in emotion perception accuracy when the stimuli were dynamic (Krendl & Ambady, 2010; Sze et al., 2012), although
these studies also only focused on target-specific contexts (dynamic targets with no or simplistic situational cues). Future studies can incorporate dynamic stimuli embedded within dynamic situations to investigate whether older adults’ accuracy will benefit from rich context.

The age differences in accuracy and contextual influence in emotion perception in the current studies also highlight the importance of using more diverse samples in non-clinical emotion perception research. Age is only one factor among many individual differences that can influence how context is integrated with facial information in emotion perception. Whether a perceiver has higher approach motivation or avoidance motivation predicts which contextual images, positive or negative, influence their perception of an ambiguous target (Lee et al., 2012). Violent offenders are more influenced by angry body context when identifying happy faces than controls, presumably due to their elevated aggression (Kret & de Gelder, 2013). East Asians, whose cultural beliefs lead them to be more context-sensitive, attend to background information more than European Americans in facial emotion perception (Ito, Masuda, Man, Li, & Man Wai Li, 2013; Masuda et al., 2008; Masuda, Wang, Ishii, & Ito, 2012). It is important, therefore, for future research to include diverse samples with varying perceiver-specific characteristics so as to investigate how such factors can modulate the effect of context on emotion perception.

Although this is not the first study to find a lack of significant statistical difference between age groups in how stereotypes influence social-emotional perception (see Kang, Chasteen, Cadieux, Cary, & Syeda, 2014), it is still surprising that prejudice did not predict emotion perception more in older adults than younger adults. Both younger and older adults in the current sample exhibited minimal explicit and implicit prejudice. Using more diverse samples, as suggested above, both in terms of geography and ideology could help researchers
more easily explore the potential differential effects of prejudice and stereotypical belief
strength on emotion perception.

Angry and disgusted targets were used in the current studies due to their similarity in
features, which lends itself well to the congruent/incongruent context paradigm (Aviezer et al.,
2008). However, a few problems with using disgust are the disgust bias found in older adults,
and the disgust perception advantage for Black targets. Future studies can experiment with other
emotions that might not pose a challenge in controlling for response biases, such as sadness (as
fearful faces are often identified as surprised).

As context effects have been shown as varying depending on the perceiver’s top-down
control, context research in general might benefit from using innovative paradigms from the
predictive processing perspective (Lupyan & Clark, 2015). Under this framework, top-down
processes (e.g., knowledge and expectation) can produce predictions that will interact with
bottom-up sensory signals to shape mental representations of perceptual and cognitive inputs. In
terms of emotion perception, it can be posited that the perceiver’s representation of different
contexts – most of which have already been learned throughout the socialization process – can
shape what the perceiver sees when they encounter facial expressions. Testing this hypothesis
will require the examination of prediction error when the target’s emotion does not match the
prediction derived from prior knowledge or expectation about the context. This promising
paradigm will allow the researcher to further understand how context is integrated and utilized
in emotion perception, particularly in a more proactive than reactive way.

**Conclusion**

This dissertation demonstrated the importance of integrating different types of
contextual cues from both the perceiver and the target, as they can interact to modulate the
nature and magnitude of context effects on emotion perception. The emotion and the race of the
target, the presumed relevance of the context, as well as the perceiver’s inhibition abilities all
play a role in determining the magnitude of context effects. The current studies also highlight
the role of aging in contextualized emotion perception, as there is an increase in contextual bias
in older age. While the scientific process requires isolating variables so their effects are not
confounded, and despite the definite benefits of studying facial expressions in isolation, emotion
perception in real life never functions without context. Context effects, as has been shown in
this dissertation, vary with different perceiver- and target- associated factors. Studying context
can only further our understanding of the complex phenomenon of emotion perception, and how
it can efficiently help us navigate the busy, multi-cue social world.
References


Temporary to Permanent Memory [and Discussion]. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 302(1110), 341–359. doi:10.1098/rstb.1983.0059


Govorun, O., & Payne, B. K. (2006). Ego—depletion and prejudice: separating automatic and


### Table 1. Means and standard errors for accuracy in labelling contextualized facial expressions in Study 1.

<table>
<thead>
<tr>
<th>Target Emotion</th>
<th>Context Emotion</th>
<th>Anger</th>
<th>Disgust</th>
<th>Fear</th>
<th>Neutral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anger</td>
<td>Anger</td>
<td>68.79 (2.38)</td>
<td>57.04 (2.55)</td>
<td>59.36 (2.31)</td>
<td>63.93 (2.38)</td>
<td>62.28 (2.04)</td>
</tr>
<tr>
<td>Disgust</td>
<td>Disgust</td>
<td>69.23 (2.38)</td>
<td>85.24 (1.82)</td>
<td>59.46 (2.45)</td>
<td>71.09 (1.99)</td>
<td>71.26 (1.71)</td>
</tr>
<tr>
<td>Neutral</td>
<td>Neutral</td>
<td>77.38 (1.85)</td>
<td>77.06 (2.09)</td>
<td>74.83 (1.89)</td>
<td>77.47 (1.76)</td>
<td>76.68 (1.60)</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
<td>71.80 (1.43)</td>
<td>73.11 (1.48)</td>
<td>64.55 (1.67)</td>
<td>70.83 (1.37)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. *Cognitive measures (Study 1).*

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Digit Span</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>40</td>
<td>7.15</td>
<td>1.331</td>
</tr>
<tr>
<td>Younger</td>
<td>41</td>
<td>7.27</td>
<td>1.205</td>
</tr>
<tr>
<td>Backward Digit Span</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>40</td>
<td>5.13</td>
<td>1.244</td>
</tr>
<tr>
<td>Younger</td>
<td>41</td>
<td>5.00</td>
<td>1.183</td>
</tr>
<tr>
<td>Mini Mental State Exam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>40</td>
<td>28.98</td>
<td>1.121</td>
</tr>
<tr>
<td>Younger</td>
<td>41</td>
<td>29.05</td>
<td>.893</td>
</tr>
<tr>
<td>Shipley Vocabulary Test*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>40</td>
<td>14.85</td>
<td>6.175</td>
</tr>
<tr>
<td>Younger</td>
<td>41</td>
<td>12.49</td>
<td>4.001</td>
</tr>
</tbody>
</table>

* *p* <.05
Table 3. Mean and standard errors of context-dependent error percentage for each target emotion as a function of target’s race and perceiver’s age (Study 2).

<table>
<thead>
<tr>
<th></th>
<th>Younger Perceivers</th>
<th>Older Perceivers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
<td>Black</td>
<td>White</td>
</tr>
<tr>
<td>Angry Target</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>25.74 (2.72)</td>
<td>39.95 (3.11)</td>
<td>26.25 (2.76)</td>
</tr>
<tr>
<td>Black</td>
<td>42.75 (3.14)</td>
<td></td>
<td>25.99 (1.94)</td>
</tr>
<tr>
<td>Disgusted Target</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>4.90 (2.24)</td>
<td>11.03 (2.64)</td>
<td>17.00 (2.26)</td>
</tr>
<tr>
<td>Black</td>
<td>17.00 (2.26)</td>
<td></td>
<td>10.95 (1.59)</td>
</tr>
<tr>
<td>Neutral Target</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>2.21 (1.27)</td>
<td>1.96 (1.24)</td>
<td>3.63 (1.28)</td>
</tr>
<tr>
<td>Black</td>
<td>3.63 (1.28)</td>
<td></td>
<td>2.88 (0.89)</td>
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</table>
Table 4. Prejudice and Cognitive Test Results (Study 2).

<table>
<thead>
<tr>
<th></th>
<th>Younger</th>
<th></th>
<th>Older</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Prejudice measures</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Feeling thermometer-Black*</td>
<td>90.36</td>
<td>13.22</td>
<td>50</td>
<td>82.98</td>
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<tr>
<td>Feeling thermometer-White*</td>
<td>91.57</td>
<td>8.76</td>
<td>49</td>
<td>82.09</td>
</tr>
<tr>
<td>Preference White over Black</td>
<td>.39</td>
<td>11.84</td>
<td>49</td>
<td>-2.11</td>
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<tr>
<td>External Motivation</td>
<td>3.07</td>
<td>0.87</td>
<td>51</td>
<td>2.81</td>
</tr>
<tr>
<td>Internal Motivation*</td>
<td>3.70</td>
<td>0.38</td>
<td>51</td>
<td>3.51</td>
</tr>
<tr>
<td>eIAT Anger vs. Disgust</td>
<td>0.94</td>
<td>0.36</td>
<td>50</td>
<td>0.32</td>
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<tr>
<td>eIAT Anger vs. Sadness</td>
<td>0.23+</td>
<td>0.40</td>
<td>30</td>
<td>0.06</td>
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<tr>
<td>Executive Functioning measures</td>
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<tr>
<td>Backward Digit Span</td>
<td>4.02</td>
<td>1.26</td>
<td>51</td>
<td>4.48</td>
</tr>
<tr>
<td>FAS *</td>
<td>11.37</td>
<td>3.83</td>
<td>51</td>
<td>14.88</td>
</tr>
<tr>
<td>Trail A RT (s)*</td>
<td>21.57</td>
<td>6.48</td>
<td>51</td>
<td>39.72</td>
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<tr>
<td>Trail B RT (s)*</td>
<td>45.81</td>
<td>14.35</td>
<td>51</td>
<td>90.06</td>
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<tr>
<td>Pattern Comparison RT(ms)*</td>
<td>1066.65</td>
<td>168.0</td>
<td>48</td>
<td>2114.55</td>
</tr>
<tr>
<td>Stroop congruent accuracy*</td>
<td>47.6</td>
<td>3.37</td>
<td>50</td>
<td>42.90</td>
</tr>
<tr>
<td>Stroop incongruent accuracy *</td>
<td>45.34</td>
<td>4.00</td>
<td>50</td>
<td>36.52</td>
</tr>
<tr>
<td>Stroop neutral accuracy *</td>
<td>47.10</td>
<td>3.64</td>
<td>50</td>
<td>42.94</td>
</tr>
<tr>
<td>Stroop congruent RT (ms)*</td>
<td>699.73</td>
<td>95.75</td>
<td>50</td>
<td>1023.94</td>
</tr>
<tr>
<td>Stroop incongruent RT (ms)*</td>
<td>823.94</td>
<td>127.55</td>
<td>50</td>
<td>1209.20</td>
</tr>
<tr>
<td>Stroop neutral RT (ms)*</td>
<td>722.79</td>
<td>102.38</td>
<td>50</td>
<td>1078.67</td>
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<tr>
<td>WCST Categories</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Achieved*</td>
<td>2.86</td>
<td>0.50</td>
<td>50</td>
<td>1.76</td>
</tr>
<tr>
<td>WCST Perseverance error percent</td>
<td>12.41</td>
<td>5.91</td>
<td>50</td>
<td>12.94</td>
</tr>
</tbody>
</table>

Note. Means are given for all participants who completed the perception task. Asterisks denote significant age differences at $p < .05$. Plus sign denotes mean significantly different from 0 (for eIAT score, this indicates stronger association between Black and Anger.) Backward digit span is a subtest of the Wechsler Adult Intelligence Scale–Revised (Wechsler, 1981).
### Table 5. Correlations between executive function measures (Study 2).

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>Backward Digit Span</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAS RT</td>
<td>0.432**</td>
<td>-</td>
<td></td>
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<tr>
<td>Pattern Comparison RT</td>
<td>-0.094</td>
<td>0.164</td>
<td>-</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>WCST categories achieved</td>
<td>0.075</td>
<td>-0.148</td>
<td>-0.344</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>WCST perseverance error</td>
<td>-0.017</td>
<td>0.087</td>
<td>-0.046</td>
<td>0.329**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trail Making Difference</td>
<td>-0.097</td>
<td>0.027</td>
<td>0.573**</td>
<td>-0.311</td>
<td>-0.003</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroop Interference Accuracy</td>
<td>-0.254</td>
<td>-0.030</td>
<td>0.431**</td>
<td>-0.181</td>
<td>0.061</td>
<td>0.504**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference RT</td>
<td>-0.032</td>
<td>0.104</td>
<td>0.012</td>
<td>-0.196</td>
<td>0.088</td>
<td>-0.275</td>
<td>-0.092</td>
<td></td>
</tr>
</tbody>
</table>

**p < .01. * p < .05
Table 6. Results from multi-level modelling predicting context-dependent error for angry faces on disgust context (incongruent angry faces) from target’s race (within-subject), age, executive functioning (EF), feeling thermometer relative preference of White over Black (FT), and internal motivation to control prejudice (IM).

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>SE</th>
<th>df</th>
<th>t</th>
<th>p-value</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept $\gamma_{00}$</td>
<td>-3.52</td>
<td>0.79</td>
<td>82</td>
<td>-4.46</td>
<td>&lt;.0001</td>
<td>0.03</td>
<td>[0.006, 0.14]</td>
</tr>
<tr>
<td>Race $\gamma_{10}$</td>
<td>-0.86</td>
<td>0.79</td>
<td>1354</td>
<td>-1.09</td>
<td>0.27</td>
<td>0.42</td>
<td>[0.09, 1.98]</td>
</tr>
<tr>
<td>Age $\gamma_{01}$</td>
<td>1.35</td>
<td>0.85</td>
<td>1354</td>
<td>1.59</td>
<td>0.11</td>
<td>3.84</td>
<td>[0.73, 20.22]</td>
</tr>
<tr>
<td>INT $\gamma_{02}$</td>
<td>-0.15</td>
<td>1.00</td>
<td>1354</td>
<td>-0.15</td>
<td>0.88</td>
<td>0.86</td>
<td>[0.12, 6.15]</td>
</tr>
<tr>
<td>FT $\gamma_{03}$</td>
<td>0.05</td>
<td>0.06</td>
<td>1354</td>
<td>0.83</td>
<td>0.41</td>
<td>1.05</td>
<td>[0.94, 1.17]</td>
</tr>
<tr>
<td>IM $\gamma_{04}$</td>
<td>-0.33</td>
<td>0.85</td>
<td>1354</td>
<td>-0.39</td>
<td>0.70</td>
<td>0.72</td>
<td>[0.14, 3.79]</td>
</tr>
<tr>
<td>ST $\gamma_{05}$</td>
<td>-0.26</td>
<td>1.68</td>
<td>1354</td>
<td>-0.15</td>
<td>0.88</td>
<td>0.77</td>
<td>[0.03, 20.73]</td>
</tr>
<tr>
<td>Race * Age $\gamma_{11}$</td>
<td>0.97</td>
<td>0.82</td>
<td>1354</td>
<td>1.17</td>
<td>0.24</td>
<td>2.63</td>
<td>[0.52, 13.26]</td>
</tr>
<tr>
<td>Race * INT $\gamma_{12}$</td>
<td><strong>-2.38</strong></td>
<td><strong>0.97</strong></td>
<td><strong>1354</strong></td>
<td><strong>-2.44</strong></td>
<td><strong>0.01</strong></td>
<td><strong>0.09</strong></td>
<td><strong>[0.01, 0.63]</strong></td>
</tr>
<tr>
<td>Race * FT $\gamma_{13}$</td>
<td>0.53</td>
<td>0.74</td>
<td>1354</td>
<td>0.71</td>
<td>0.48</td>
<td>1.69</td>
<td>[0.40, 7.19]</td>
</tr>
<tr>
<td>Race * IM $\gamma_{14}$</td>
<td>0.00</td>
<td>0.06</td>
<td>1354</td>
<td>-0.05</td>
<td>0.96</td>
<td>1.00</td>
<td>[0.89, 1.11]</td>
</tr>
<tr>
<td>Race * ST $\gamma_{15}$</td>
<td>-0.25</td>
<td>1.59</td>
<td>1354</td>
<td>-0.16</td>
<td>0.88</td>
<td>0.78</td>
<td>[0.035, 17.49]</td>
</tr>
<tr>
<td>Age * INT $\gamma_{06}$</td>
<td>0.34</td>
<td>1.08</td>
<td>1354</td>
<td>0.31</td>
<td>0.75</td>
<td>1.40</td>
<td>[0.17, 11.67]</td>
</tr>
<tr>
<td>Age * FT $\gamma_{07}$</td>
<td>0.31</td>
<td>1.04</td>
<td>1354</td>
<td>0.3</td>
<td>0.76</td>
<td>1.37</td>
<td>[0.18, 10.44]</td>
</tr>
<tr>
<td>Age * IM $\gamma_{08}$</td>
<td>0.02</td>
<td>0.07</td>
<td>1354</td>
<td>0.28</td>
<td>0.78</td>
<td>1.02</td>
<td>[0.90, 1.16]</td>
</tr>
<tr>
<td>Age * ST $\gamma_{09}$</td>
<td>-2.05</td>
<td>2.01</td>
<td>1354</td>
<td>-1.02</td>
<td>0.31</td>
<td>0.13</td>
<td>[0.003, 6.57]</td>
</tr>
<tr>
<td>Race * Age * INT $\gamma_{16}$</td>
<td><strong>2.38</strong></td>
<td><strong>1.00</strong></td>
<td><strong>1354</strong></td>
<td><strong>2.39</strong></td>
<td><strong>0.02</strong></td>
<td><strong>10.82</strong></td>
<td><strong>[1.54, 76.40]</strong></td>
</tr>
<tr>
<td>Race *Age * FT $\gamma_{17}$</td>
<td>-0.05</td>
<td>0.06</td>
<td>1354</td>
<td>-0.81</td>
<td>0.42</td>
<td>0.95</td>
<td>[0.84, 1.08]</td>
</tr>
<tr>
<td>Race * Age * IM $\gamma_{18}$</td>
<td>-1.19</td>
<td>0.90</td>
<td>1354</td>
<td>-1.32</td>
<td>0.19</td>
<td>0.31</td>
<td>[0.05, 1.78]</td>
</tr>
<tr>
<td>Race * Age * ST $\gamma_{19}$</td>
<td>0.54</td>
<td>1.80</td>
<td>1354</td>
<td>0.3</td>
<td>0.76</td>
<td>1.72</td>
<td>[0.05, 58.14]</td>
</tr>
</tbody>
</table>
Table 7. Results from multi-level modelling predicting context-dependent error for angry faces on disgust context (incongruent angry faces) from target’s race (level 1), age, and implicit association between Black and anger (compared to White and disgust) (level 2).

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Coefficient</th>
<th>SE</th>
<th>df</th>
<th>t</th>
<th>p value</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept $\gamma_{00}$</td>
<td>-3.12</td>
<td>0.36</td>
<td>76</td>
<td>-8.74</td>
<td>&lt;.0001</td>
<td>0.04</td>
<td>[0.02,0.09]</td>
</tr>
<tr>
<td>Race $\gamma_{10}$</td>
<td>0.41</td>
<td>0.33</td>
<td>1181</td>
<td>1.25</td>
<td>0.21</td>
<td>1.51</td>
<td>[0.79,2.87]</td>
</tr>
<tr>
<td>Age $\gamma_{01}$</td>
<td><strong>1.09</strong></td>
<td>0.43</td>
<td><strong>1181</strong></td>
<td>2.56</td>
<td><strong>0.01</strong></td>
<td>2.96</td>
<td><strong>[1.29,6.81]</strong></td>
</tr>
<tr>
<td>Disgust eIAT $\gamma_{02}$</td>
<td>-0.21</td>
<td>0.50</td>
<td>1181</td>
<td>-0.43</td>
<td>0.67</td>
<td>0.81</td>
<td>[0.31,2.14]</td>
</tr>
<tr>
<td>Race*Age $\gamma_{11}$</td>
<td>-0.22</td>
<td>0.37</td>
<td>1181</td>
<td>-0.58</td>
<td>0.57</td>
<td>0.81</td>
<td>[0.39,1.68]</td>
</tr>
<tr>
<td>Race*Disgust eIAT $\gamma_{12}$</td>
<td>1.28</td>
<td>0.80</td>
<td>1181</td>
<td>1.61</td>
<td>0.11</td>
<td>3.60</td>
<td>[0.76,17.11]</td>
</tr>
<tr>
<td>Race<em>Age</em>Disgust eIAT $\gamma_{13}$</td>
<td>-1.26</td>
<td>0.86</td>
<td>1181</td>
<td>-1.46</td>
<td>0.14</td>
<td>0.29</td>
<td>[0.05,1.53]</td>
</tr>
</tbody>
</table>
Table 8. Results from simple slope analysis for the three-way interaction predicting context-dependent error for angry faces on disgust context (incongruent angry faces) from target’s race (level 1), age, and Interference (level 2). The slope and intercept statistics are for Interference score predicting log odds context-dependent errors at specific levels of age and target’s race.

<table>
<thead>
<tr>
<th>Age</th>
<th>Target’s race</th>
<th>Intercept</th>
<th>SE</th>
<th>t</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>YA</td>
<td>White</td>
<td>-3.5</td>
<td>0.78</td>
<td>-4.48</td>
<td>86</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>-0.07</td>
<td>-0.07</td>
<td>1386</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>-4.34</td>
<td>0.8</td>
<td>-5.43</td>
<td>86</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>-2.44</td>
<td>-2.49</td>
<td>1386</td>
<td>0.01</td>
</tr>
<tr>
<td>OA</td>
<td>White</td>
<td>-2.02</td>
<td>0.28</td>
<td>-7.14</td>
<td>86</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0.13</td>
<td>0.49</td>
<td>1386</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>-1.92</td>
<td>2.36</td>
<td>-7.26</td>
<td>86</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>0.14</td>
<td>0.63</td>
<td>1386</td>
<td>0.53</td>
</tr>
</tbody>
</table>
Figure 1. Emotion perception accuracy as a function of emotional context and instruction about context relevance (Study 1). Error bars represent standard errors of the means.
Figure 2. Accuracy for targets of different emotions as a function of which context they were embedded in (Study 2).
Figure 3. Accuracy for congruent, incongruent, and neutral trials across targets’ races (Study 2).
Figure 4. Younger and older adults’ response frequencies to angry and disgusted faces on congruent and incongruent contexts
Figure 5. Accuracy difference between congruent and incongruent trials (Study 2).
Figure 6. Accuracy as a function of target’s emotion and race for the fast emotion categorization task (Study 2).
Figure 7. Reaction time for younger and older adults in the fast emotion categorization task, Anger-Disgust comparison (Study 2).
Figure 8. Plot of simple slope analysis for the cross-level two-way interaction between target’s race and Interference (Study 2), with race as the moderator.
Figure 9. Plot of simple slope analysis for the cross-level three-way interaction between target’s race, age and executive functioning (EF). Plot shows simple slopes for younger adults (YA) (Study 2).
Figure 10. Plot of simple slope analysis for the cross-level three-way interaction between target’s race, age and executive functioning (EF). Plot shows simple slopes for older adults (OA) (Study 2).
Appendix

Picture 1. Disgust scene context with an angry target (in color, reproduced in black and white).