ABSTRACT

CHU, QIAO. The Moderation of Perceiver's Mood and Emotional Valence of Face Stimuli on the Own-Age Bias in Attention and Memory . (Under the direction of Dr. Daniel Grühn.)

Research has found that faces of own-age group members tend to be detected earlier in attention and retained longer in memory than faces of other-age group members (referred to as the own-age bias). However, few studies have looked at the moderation of perceivers mood state and face emotions on the own-age bias in attention and memory. **Aim**: The present study was aimed at examining the own-age bias in attention and memory, as well as the moderation effect of perceivers mood and the emotional valence of the face images, with sufficient cognitive resources at the encoding phase (Study 1), and with insufficient cognitive resources at the encoding phase (Study 2). **Method**: College student participants were randomly assigned to three conditions to induce positive, anxious or neutral mood. Participants performed a face attention task, and encoded the faces with insufficient cognitive resources (Study 1) or with sufficient cognitive resources (Study 2). Participants were then surprised by a face recognition memory task. **Results**: In both studies, significant own-age biases were found in memory false-alarm rate and response tendency (C), but were not found in attention reaction time, memory hit rate, and memory discriminability (d'). In addition, there was an angry-potentiated effect for own-age bias in both Study 1 and Study 2, such that the own-age bias in false-alarm rate and response tendency of recognizing face emotion was more prominent for angry face emotion than happy and neutral face emotions. Finally, perceivers mood moderates the own-age bias in response tendency of recognizing face emotions: the own-age bias was only present under anxious mood but not present under positive or neutral mood. **Conclusion**: The own-age bias in memory and the angry-potentiated effect on the own-age bias were robust both when faces were encoded with sufficient cognitive resources and when faces were encoded with insufficient cognitive resources. The findings have important implications for future research on the own-age bias in cognitive processing of emotional faces, and intergenerational interactions in daily life.

The Moderation of Perceiver's Mood and Emotional Valence of Face Stimuli on the Own-Age Bias in Attention and Memory

by
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DEDICATION

To my parents.

BIOGRAPHY

Qiao Chu was born and raised in Dalian, Liaoning, China. With strong interests in both psychological and medical science, she attended Southern Medical University in Guangzhou, China, where she earned a Bachelor of Science in medical psychology in July 2011. To pursue deeper knowledge in psychology and a career as a researcher, Qiao entered the doctoral program in Lifespan Developmental Psychology at North Carolina State University under the direction of Dr. Daniel Grühn. Qiao received a master of science in May 2014 at North Carolina State University, and her master's research investigates the influence of social stereotypes on moral judgment. Qiao's doctoral dissertation investigates the own-age bias in attention and memory, as well as the moderation of perceiver's mood and the emotional valence of the face stimuli.

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Introduction

Face processing has important implications for people's daily social interactions. Better recognition of an acquaintance's face may make that acquaintance seem more familiar and emotionally close, which can impact subsequent social interactions. In addition, faster and longer attention to a stranger's face may influence impression formation and judgment, which can also impact the following interpersonal relationship. Numerous studies have revealed a bias in attention and memory toward the perceivers' own-age faces compared with other-age faces (referred to as the "own-age bias"; Anastasi & Rhodes, 2006; Ebner & Johnson, 2010; Wiese, Schweinberger, & Hansen, 2008). For example, young adults were found to spend longer time looking at young adult faces than old adult faces (Ebner, He, & Johnson, 2011), were slower in disengaging attention from young adult faces than old adult faces (Ebner & Johnson, 2010), and were faster to follow the gaze of their own-age faces compared to other-age faces (Bailey et al., 2014; Slessor, Laird, Phillips, Bull, & Filippou, 2010). Memory studies have also reliably found higher recognition memory accuracy (hit rates) and discriminability (d') for own-age faces than other-age faces (for a meta-analysis, see Rhodes & Anastasi, 2012).

There are two main theoretical accounts of the own-age bias. The experience-based account argues that the preference in processing own-age faces vs. other-age faces results from the more extensive social contact experience that people have with their same-age partners as opposed to other-age partners (Anastasi & Rhodes, 2006; Mason, 1986). In particular, the extensive contact exposure may facilitate the use of configural processing for own-age faces (Gauthier & Tarr, 1997; Maurer, Le Grand, & Mondloch, 2002), which focuses on the relations among the features of a face, or the way different facial features are structured to compose the whole face. In contrast, limited contact experience with other-age partners may result in featural processing (i.e., individual features of a face) that is more difficult to diagnose at retrieval (Tanaka, Kiefer, & Bukach, 2004). Another theoretical account of the own-age bias is the social cognitive theory (Hugenberg, Young, Bernstein, & Sacco, 2010), which suggests that the preference of pressing own-age faces results from the greater social and motivational values associated with the own-age faces (Ebner & Johnson, 2009). Based on the social cognitive theory, the own-age faces represent ingroup, which contributes to individuating encoding of the faces that facilitates memory recognition. In contrast, other-age faces usually represent outgroup, and tend to be processed based on the features related with its outgroup categorization (i.e., the age category), rather than on the individuating features that differentiate between faces within the category. As a result, own-age faces tend to be better recognized than other-age faces. Despite the extensive evidence supporting the own-age bias in attention and memory, most of the existing studies used emotionally neutral faces, and tested people's attention and memory performance under neutral mood state. Thus, little is known about the social emotional moderators of the own-age bias, such as the valence of the facial expression and perceivers' mood state. For example, will the own-age bias in attention and memory of faces be more prominent for certain face emotion than other face emotions? In addition, will people with certain mood state display greater own-age bias than people with other mood states? Considering the extensive evidence of the impacts of the emotional valence of the stimuli and people's mood state on information processing (e.g., Friedman & Förster, 2010; Mather & Carstensen, 2005), it is likely that the emotional valence of the faces and perceivers' mood state will interact with the age of the faces in influencing attention and memory of faces.

Despite the numerous studies that demonstrate own-age bias in memory when face stimuli are encoded with sufficient cognitive resources, no studies thus far have tested whether the own-age bias is present in memory when participants' cognitive resources were highly occupied by another task, with insufficient attentional resources left to encode the face images. Previous studies (Lavie, 1995; Lavie, Hirst, de Fockert, & Viding; 2004) suggest that high perceptual load of the primary attention task reduces the interference of the distractors, resulting in insufficient processing of the distractors. Thus, it is likely that the own-age bias would be less prominent in memory when faces are encoded with insufficient cognitive resources rather than when face are encoded with sufficient cognitive resources.

Moderation of Face Emotion on the Own-Age Bias

Emotional stimuli usually carry social and motivational values and have been found to influence people's cognitive processing. Threatening information, such as angry faces, tend to be detected faster and more accurately (e.g., Fox et al., 2001; Ohman, Lundqvist, & Esteves, 2001), and are better recalled (Jackson, Linden, & Raymond, 2014) than happy or neutral faces among young adults. Given the priority of angry face emotion in attentional and memory processes, it may compete with the own-age faces for cognitive resources, resulting in various observation of the own-age bias across different face emotions. However, very limited studies have investigated the moderation of face emotion on the own-age bias, which yielded inconsistent findings. In Ebner and Johnson (2010; Study 2)'s study, participants responded rapidly to digits while inhibiting the interference of the distracting face images in the background. Young adults had longer reaction time when young adult faces rather than old adult faces appeared in the background, indicating an own-age bias in attention. However, this own-age bias was only present for angry but not happy or neutral faces, suggesting a potentiated own-age bias for angry face emotion. In contrast, in Ebner and colleagues (2013)'s study, participants viewed and identified the face emotions of young and old adult faces, while their brain activities were being monitored. The authors found that the brain activities associated with the own-age bias were only present for happy and neutral face emotions, but not for angry face emotion, suggesting a reduced own-age bias for angry face emotion. A possible explanation for these inconsistent findings, as Ebner et al. (2013) posited, is that the moderation of face emotion on the own-age bias may depend on the availability of individual's cognitive resources. Specifically, in the Ebner & Johnson (2010; Study 2) study that tested selective attention, participants' attentional resources were highly occupied by the demanding digit task, with insufficient resources left to process the faces. In this case, the age categorization and the emotional valence of the faces may not be encoded separately, but are more likely to be encoded as a whole. Thus, young adults' preference in deploying attention to angry faces over happy and neutral faces (Carstensen & Mikels, 2005; Mather & Carstensen, 2005) may result in the own-age bias being more likely observed for angry faces over happy and neutral faces, and thus display the "angry-potentiated effect". In contrast, in Ebner et al. (2013) study, participants watched and identified the faces with fully available cognitive resources. In this case, the age categorization and the emotional valence of the face stimuli may compete with each other in drawing attention. In this case, younger adults' preference in attention to angry faces may result in the age categorization of the faces receiving less attentional resources when presented for the angry faces rather than when presented for the happy or neutral faces. As a result, the own-age bias would be smaller for angry faces than happy or neutral faces. It calls for more empirical evidence to test Ebner et al. (2013)'s argumentation that the "angry-potentiated effect of the own-age bias" is only present in the condition of insufficient instead of sufficient cognitive resources. Furthermore, because both the Ebner & Johnson (2010; Study 2) study and the Ebner et al. (2013) study tested visual attention but not memory, it remains a question whether the above argumentation applies to people's face recognition memory. So far there is only one study (Ebner & Johnson, 2009) that investigated the own-age bias in memory using emotional faces. Participants firstly viewed and identified the facial expression of happy, neutral and angry face images of young adults and old adults, and then performed the recognition memory task, in which they responded "new face" or "old face" to the presented faces and unpresented distractors. Participants' memory performance was computed by subtracting the false alarm rates from the hit rates. There was no significant own-age bias or moderation of face emotion in memory performance, though the authors did not report results regarding to the hit rates and false alarm rates. The present study is intended to contribute to the literature about the own-age bias in memory of emotional faces.

Moderation of Perceiver's Mood State on the Own-Age Bias

Research has indicated that individual's mood state influences information processing. For example, positive mood signals a safe and benign environment, and thus widens perceptual span and promotes flexibility and globality in information processing (Fredrickson, 1998; 2000). In contrast, negative mood, especially anxiety, triggers attentional vigilance, and tends to narrow attention to potential threats in the environment (e.g., Friedman & Förster, 2010; Kuhbandner, Lichtenfeld, & Pekrun, 2011). Consistent with these theories, participants with positive mood had poorer inhibition of irrelevant distractors while performing an attention task compared to participants with neutral or sad mood (Rowe, Hirsh, & Anderson, 2007), suggesting a wider attentional scope of participants with positive mood in comparison to participants with neutral or sad mood. In addition, positive mood, in relative to negative or neutral mood, reduces attentional blink (defined as the impaired ability to identify the second of two targets presented in close succession, suggesting cognitive limitation) in the RSVP task , suggesting a broadening effect of positive mood (Jefferies, Smilek, Eich, & Enns, 2008; Olivers & Nieuwenhuis, 2006). Participants with positive mood also had a larger capacity of iconic memory than participants with negative or neutral mood (Kuhbandner, Lichtenfeld, & Pekrun, 2011). In contrast, participants with anxious mood tend to narrow their processing scope, and focus their cognitive resources on threatening information, such as angry facial expressions, threat-related words and dangerous animal pictures (for a meta-analysis, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). For example, highly anxious people fixated longer at threatening images (Ford et al., 2010; Hermans, Vansteenwegen, & Eelen, 1999) and were more vigilant toward threatening stimuli (Bradley, Mogg, & Millar, 2000; Tamir & Robinson, 2007) compared with people with happy or neutral mood.

Despite the abundant research on the effects of mood on cognitive processing, no studies to date have examined the moderation of mood state on the own-age bias in attention and memory of faces. Based on the existing findings discussed above that positive mood increases processing flexibility and reduced processing bias whereas anxious mood narrows processing span to local details that are more relevant to participants, it is likely that, the own-age bias, as a kind of processing bias and narrowed processing effect, will be reduced under positive mood and enhanced under anxious mood.

Own-Age Bias in False Alarm Rate and Response Tendency

To date most studies of own-age bias in memory have focused on memory hit rate (i.e., the percentage of correctly recognizing the presented faces), and discriminability (d'; the sensitivity of discriminating presented faces from unpresented distractors), or the accuracy in distinguishing between presented faces vs. unpresented distractors. However, very limited studies directed attention to false-alarm rate (i.e., the percentage of falsely recognizing an unpresented face) and response tendency (a tendency to report having seen or not having seen a face in the past). The small amount of studies that did report own-age bias in false alarm rate and response tendency yielded inconsistent findings. For memory false alarm rate, some studies found no significant own-age bias in false alarm rate (e.g., Bryce & Dodson, 2013) while others found higher false alarm rates for other-age faces than own-age faces (Rhodes & Antaski, 2012). For response tendency, there tend to be no significant own-age bias (Rhodes & Antaski, 2012). Nevertheless, the majority of the existing studies used neutral faces rather than emotional faces. As face emotion has been found to influence the own-age bias in face processing (Ebner & Johnson, 2009; Noh

& Isaacowitz, 2011), it is likely that the own-age bias in memory, including false-alarm rate and response tendency, will vary across facial expressions.

So far most of the existing studies that reported the findings of the own-age bias in false alarm and response tendency seem to interpret false alarm, or false memory of unpresented faces as a deviance in memory accuracy, rather than treating memory false alarm as a unique cognitive process. Several theories of false memory have been proposed (e.g., Roediger, Balota, & Watson, 2001; Whittlesea, 2002), which suggest that the occurrence of false memory undergoes unique cognitive processes, rather than simply a cognitive limitation. Among these theories, Jacoby's attributional theory (Jacoby, Kelley, & Dywan, 1989) may shed some light on the potential own-age bias in false-alarm rate and response tendency. According to this theory, individual's decision about whether he/she has ever seen an item is based on the individual's perception of his/her current fluency in processing that item. If a person perceives that he/she is better at processing item A than item B, he/she will have a greater tendency to report having seen A rather than B in the past, even if neither A nor B was presented. Thus, artificially enhancing individual's perception of processing fluency may elicit illusory familiarity of an unpresented item. For example, when a word was primed by flashing briefly prior to being tested in recognition memory, participants had higher false-alarm rate of this word, as the priming increased perceived processing fluency of this word (Jacoby & Whitehouse, 1989). Based on the attributional theory, as young adults tend to employ the more efficient configural processing of own-age faces and adopt the less efficient detailed processing of other-age faces, it is likely that the relative fluency in processing own-age vs. other age faces will elicit an illusory familiarity of own-age faces, resulting in higher false-alarm rate for unpresented own-age faces than unpresented other-age faces. Such illusory familiarity of own-age faces vs. other-age faces may also result in a response tendency to more frequently report having seen own-age faces than other-age faces.

The Present Study

The overarching goal of the present study is to further our understanding about the own-age bias by examining the emotional moderators of the own-age bias. There were two major research questions that are aimed at filling the gaps in the literature of own-age bias. First, I intended to investigate whether the own-age bias will be present in memory when faces are encoded with insufficient cognitive resources; that is, when individual's cognitive resources are highly occupied by a demanding task. In particular, I am not only interested in examining the own-age bias in memory hit rate and discriminability, but also interested in investigating the own-age bias in people's false-alarm rate and response tendency. Although a limited number of research examined the own-age bias in memory and response tendency (Rhodes & Anastasi, 2012), they used exclusively neutral face images, and have yielded inconsistent findings. Thus, it remains a question about the presence and direction of the own-age bias in false-alarm rate and response tendency of processing emotional faces. Second, I aimed at investigating the moderations of face emotions and perceiver's mood on the own-age bias in memory in the situation when faces are encoded with either sufficient cognitive resources (Study 1) or insufficient cognitive resources (Study 2). To date only one study (Ebner & Johnson, 2009) has investigated the moderation of face emotion on the own-age bias in memory, but found no significant own-age bias or a moderation of face emotion. More studies are needed to investigate this question, and to further our understanding about whether the moderation of face emotion on the own-age bias in memory will remain robust even when faces are encoded insufficiently with limited cognitive resources.

Two studies were conducted to attain these research goals. Both studies assessed college-age student participants' selective attention and memory of happy, neutral, and angry faces of young, middle-aged, and old adults. The only difference between the studies was the availability of the cognitive resources at the face attention, or the face encoding task. I designed a selective attention task, in which participants must rapidly and accurately respond to a demanding digit task, with the distracting faces appearing in the background. In Study 1, the faces appeared 1000 ms before the digits were presented on top of the faces, allowing for sufficient cognitive resources to encode the faces before the digits appeared; whereas in Study 2 the faces and digits appeared simultaneously with faces presented in the background, which caused participants to focus their attention on the demanding digit task, with little resources left to encode the faces in the background. In addition, participants were randomly assigned to three mood conditions that aimed at inducing positive, neutral and anxious mood.

Hypotheses

Hypothesis 1 The own-age bias in attention

College-age student participants will display longer attention reaction time to the digit task in the attention phase when young adult faces rather than middle-aged or old adult faces appear in the background as distractors; and the own-age bias will be present in attention with either sufficient or insufficient cognitive resources.

Based on the previous studies that found own-age faces attract individual's attention faster and hold attention longer than other-age faces (Bailey et al., 2014; Ebner, He, & Johnson, 2011), as well as the finding that the own-age bias is present in attention even when participants' cognitive resources are limited (Ebner & Johnson, 2010 Study 2), I expected that the own-age bias in attention will be robust in both the situation of sufficient cognitive resources and the situation of insufficient cognitive resources.

Hypothesis 2 The own-age bias in memory

H2a. (Memory hit rate) College-age student participants will have a higher percentage of correctly recognizing the presented young adult faces than middle-aged and old adult faces.

Previous studies found that young adults are more likely to focus on configural facial information but are more likely to employ the less efficient featural processing, for the other-age faces (Maurer, Le Grand, & Mondloch, 2002; Tanaka, Kiefer, & Bukach, 2004). Thus, I expected these differences in processing efficiency would contribute to higher percentage of correct recognition of presented own-age compared with other-age faces.

H2b. (false-alarm rate) College-age student participants will have a higher percentage of falsely reporting having seen unpresented young adult faces than unpresented middle-aged and old adult faces.

H2c. (Response tendency -C) College-age student participants will have a higher tendency to report having seen young adult faces than middle-aged and old adult faces

Based on Jacoby's attributional theory (Jacoby, Kelley, & Dywan, 1989), people are more likely to report having seen an object in the past if they have optimal current fluency of processing that object. Because college age young adults generally have more daily contact experience with own-age partners than other-age partners (Ebner & Johnson, 2009; Wolff, Wiese, & Schweinberger, 2012), I expected that young adults would be more likely to report having seen own-age faces than other-age faces because of their relatively more experience in processing own-age vs. other-age faces.

Exploratory question: Will there be an own-age bias in general memory discriminability (d')?

Although previous studies using neutral faces found higher d' for own-age faces than other-age faces, it is likely that using emotional faces will yield different findings, as face emotions have been found to influence information processing (Ebner & Johnson, 2009; Noh & Isaacowitz, 2011). In addition, given my hypotheses for the higher hit rates and false-alarm rates for own-age faces than other-age faces, and the formula of computing d' (subtracting the z transformation of the false-alarm rate from the z transformation of the hit rate), the own-age bias in memory d' remains an open question.

Hypothesis 3 - The moderation of perceiver's mood state on the own-age bias in attention and memory

The own-age bias in attention (reaction time) and memory performance (hit rate, false-alarm rate, discriminability and response tendency) would be more prominent among individuals with anxious mood than individuals with happy or neutral mood; and this moderation of mood state will be hold both in the situation of sufficient cognitive resources, and in the situation of insufficient cognitive resources.

Positive mood has been found to broaden processing scope and reduce processing bias (e.g., Friedman & Förster, 2010), whereas anxious mood has been found to narrow attention and memory to relevant local parts (Ford et al., 2010). Given that the own-age bias in memory is also a kind of processing bias and narrowing effect, I expected that the own-age bias will be stronger under anxious mood than positive and neutral mood.

Hypothesis 4 - The moderation of face emotion on the own-age bias in attention and memory

When there are sufficient cognitive resources at the encoding phase, the own-age bias in attention and memory performance will be more prominent for happy and neutral faces than angry faces. In contrast, when there are insufficient cognitive resources at the encoding phase, the own-age bias in attention and memory performance will be more prominent for angry faces than happy and neutral faces, displaying an "angry-potentiated effect" on the own-age bias.

I based this hypothesis on Ebner and colleagues (2013)'s argumentation. When there are sufficient cognitive resources, the age categorization and the emotional valence of the face stimuli tend to compete with each other in drawing individual's attention. Thus, individual's preference in attending to the angry face emotions over happy and neutral face emotions may lead to less attention being directed to the age categorization of the angry faces than happy and neutral faces, resulting in weaker own-age bias for angry face emotion than happy and neutral face emotions. In contrast, when the cognitive resources are highly restricted and the age and emotional information of the faces tend to be processed as a whole, people's preference in angry face emotion may result in the own-age bias being more likely observed in angry faces than in happy or neutral faces. Thus, I expected the own-age bias to be stronger for angry faces compared with happy and neutral faces under situation of insufficient cognitive resources.

Study 1

The aim of Study 1 was to investigate the own-age bias and the moderation of face emotions and perceiver's mood in attention and memory when faces were encoded with sufficient cognitive resources.

Method

Participants

One hundred and nine college students were originally recruited, who participated to fulfill course requirement for their enrollment in a psychology introductory course. Four participants' data were excluded before analyses: Two participants reported being dyslexic; one participant reported having a small case of prosopagnosia; and one participant did not follow the instruction for the attention study. The Final sample included 105 college students aged 18-29 years old (M = 18.72, SD = 1.67, 49.5% female). The majority of participants were European American (73.3%). Other ethnicities included Asian (12.4%), African Americans (10.5%), Hispanic origin (7.6%) and Native Hawaiian (1%).

Materials

Depressive symptoms. As depressive symptoms can co-occur with anxiety (Kircanski, Joormann, & Gotlib, 2015; Wright, Hallquist, Swartz, Frank, & Cyranowski, 2014), and can impact cognitive performance. Thus, I measured participants' depressive symptoms as a control variable, using the Center for Epidemiological Studies Depression scale (CES-D; Radloff, 1977). The CES-D has 20 items. Participants rated how often they had felt this way during the past week on a 4-point scale ranging from *Rarely or none of the time (less than 1 day) (1) to Most or all of the time (4).* A higher mean score indicated more depressive symptoms in the past week. Study 1 indicated a high internal consistency reliability (α= .89).

Measures of cognitive functioning. As general cognitive functioning is closely related to attention and memory of faces, participants' fluid and crystallized intelligence were assessed. Participants completed the Digit Symbol Substitution and letter-number-sequence tasks (Wechsler, 1981) as indicators of fluid intelligence, and the Shipley Vocabulary Test (Zachary, 1986) as an indicator of crystallized intelligence. Score of Digit Symbol Substitution equaled the number of correct symbols that a participant finished. Score of letter-number sequence task equaled the number of correct sequences a participant completed. Score of the Shipley Vocabulary Test equaled the number of questions a participant answered correctly.

Pre- and post- mood induction measures of mood state. Participants' moods were assessed using the same measures prior to and after the mood induction procedure, to examine the effectiveness of the mood induction. Positive mood was assessed by five discrete emotions: happy, cheerful, pleased, delighted, and excited. Anxious mood was assessed by five discrete emotions: anxious, nervous, worried, afraid and tense. Five additional discrete emotions, including depressed, angry, sad, calm and annoyed, were also included in the measure to eliminate the potential priming effects of the above happy and anxious emotional words. All discrete emotions were rated on seven-point unipolar scales from 0 (No such feeling) to 6 (Very much). Participants' baseline or post-induction positive and anxious mood scores were calculated by averaging the ratings of all the corresponding discrete emotions. The appendix presents the measure of mood state. Study 1 indicated high internal consistency reliabilities for baseline positive mood ($\alpha = .92$), baseline anxious mood ($\alpha = .85$), post-induction positive mood ($\alpha = .90$), and post-induction anxious mood ($\alpha = .92$).

Procedure

Participants came to the laboratory to complete all assessments. After signing the consent form, participants firstly completed a collection of paper-based questionnaires, including a basic demographic questionnaire, the Center-for-Epidemiological-Studies-Depression-Scale (CES-D), the Digit Symbol Substitution Task and the letter-number sequencing task. Participants then completed the pre-induction mood state measure, which assessed their baseline mood state. They then completed the mood induction procedure. Participants were randomly assigned to one of the three mood conditions: positive, anxiety, or neutral. The mood induction procedure consisted of two parts: a) journal writing/speech preparation, and b) watching emotional film clips. In the journal writing/speech preparation part, participants in the positive emotion condition were asked to identify an occasion in which they experienced a high level of happiness, to think about the occasion for 3 minutes by concentrating on how it made them feel, and then to write down at least 3 words that most appropriately describe their emotional states. The positive emotion induction lasted about 5 minutes. Participants in the neutral mood condition were asked to think about what their bedroom looked like, and write down the names and colors of the furniture. The neutral mood condition lasted about 5 minutes. To induce anxiety mood, I used a manipulation procedure modified from the procedure used by Phillips) and Giancola (2008). Participants in the anxiety mood condition were asked to prepare and deliver a short speech in front of a video camera, which were used to assess their thinking style. Specifically, the experimenter read the following script to the participants:

> *You will be taking part in a portion of the study that deals with testing your thinking style. We are interested in your ability to think quickly with limited time for preparation. Research has shown that these skills are related to your reaction time in the following number identification task. For this task, you must quickly prepare and then deliver a short speech about what you like and dislike about your body while standing directly in front of this video camera that will record your speech. You will have 5 minutes to prepare a 3-minute speech. This will take place immediately after you complete the following number identification task. It is very important that you think about the speech you are about to give. This has been shown to improve performance on the number identification task. This clock will now give you a 5-minute countdown. You will have this time to prepare your speech in your mind. When the 5 minutes are up, you will begin the number identification task.*

In fact, participants in the anxiety condition did not have to deliver the speech. The procedure was simply used to induce anxious emotional states. Previous research found this manipulation procedure effectively induced state anxiety (Phillips) & Giancola, 2008). To reinforce the mood induced by the journal writing/speech preparation task, participants then wore a headphone and watched emotional film clips). Participants in the positive mood condition watched a 235-second long live talk show given by the comedian Aziz Ansari. Participants in the anxiety mood condition watched an 80-second long film clip from the horror film "The Shining". Participants in the neutral mood condition watched a 40-second long film clip from the movie "Blue". After the mood induction procedure, participants completed the mood state measure again for the manipulation check.

Participants then performed the face attention task (number identification task). Figure 1 presents the face attention task trials in Study 1. The stimuli were presented using Psychophysics Toolbox Version 3 (PTB-3). Each trial started with presenting a face image for 1000 ms, followed by the appearance of three digits in random locations on top of the face image. The three digits varied in value, ranging from 0 to 9. Participants were asked to identify the digit with the medium value of the three by pressing the corresponding button on the keyboard, and to do so as fast and rapidly as possible. Participants received no instructions about the face images. There was an interval of 1000 ms between trials, when participants were asked to focus attention on a cross in the center of the screen.

The face images used in the present study were selected from the FACES database (Ebner, Riediger, & Lindenberger, 2010). The stimuli contained 72 faces that were performed by 72 different actors. The 72 faces consisted of 24 happy expressions, 24 neutral expressions and 24 angry expressions. The 24 faces in each emotional expression were equated across age (young vs. middle-aged vs. old) and gender groups (male vs. female). In addition, I created three balancing conditions of the facial stimuli, in order to balance out the attractiveness and distinctiveness of the facial expressions. For example, face ID 004 was presented in happy expression in Balancing 1 condition, but was presented in angry or neutral expression in Balancing 2 or 3 condition. By assigning participants randomly to one of the three balancing conditions, every face had equal chance to be presented in all three expressions. Each face was presented twice, resulting in a total of 72 x 2 = 144 attention trials.

Following the attention task, participants completed the Shipley vocabulary test as a filler task. They then were surprised with the face memory task (Figure 2). Each trial of the face memory task presented the happy, neutral, and angry emotional expressions of the same actor. Participants were asked whether they had seen the face actor in the face attention task; and if they had, they must indicate in which emotional expression the face was presented in. The materials included 72 faces that were presented in the face attention task, along with 72 new faces that were performed by 72 new actors. The face memory task was not timed and participants had as much as they needed to complete

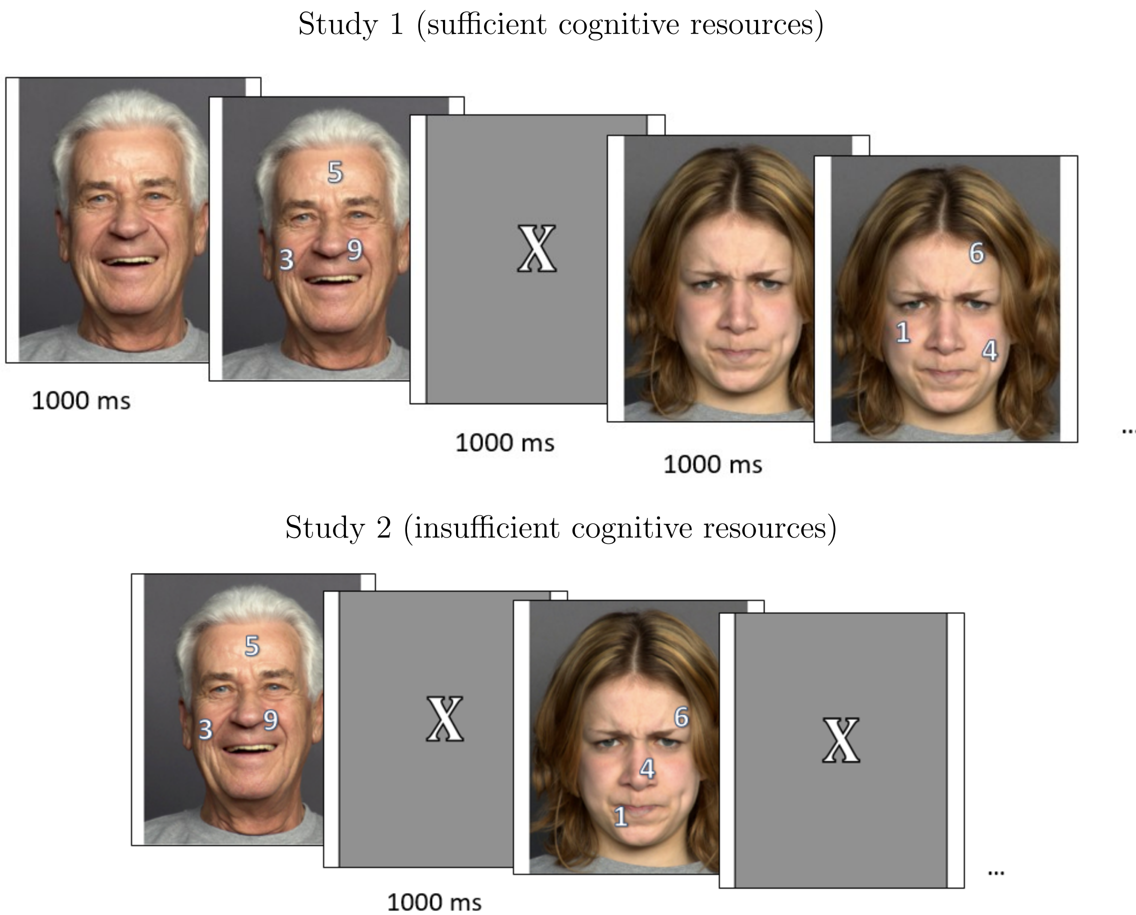


Figure 1: The face attention task (Number Identification Task) used in Study 1 and Study 2. In each trial of study 1, faces were presented 1000 ms prior to the appearance of digits; thus, participants were able to encode the faces with sufficient cognitive resources before the digits appeared. In each trial of Study 2, digits and faces were presented simultaneously; thus, participants' cognitive resources were highly occupied by the digit task, with insufficient resources left to encode the face images in the background

the task.

At the end of the experiment, participants completed a follow-up questionnaire, in which they were asked to rate the difficulty of face attention task and the face memory task on a five-point scale ranging from 1 (very hard) to 5 (very easy). They also left the comments and suggests. Afterwards, they were thanked, debriefed and credited for research participation.

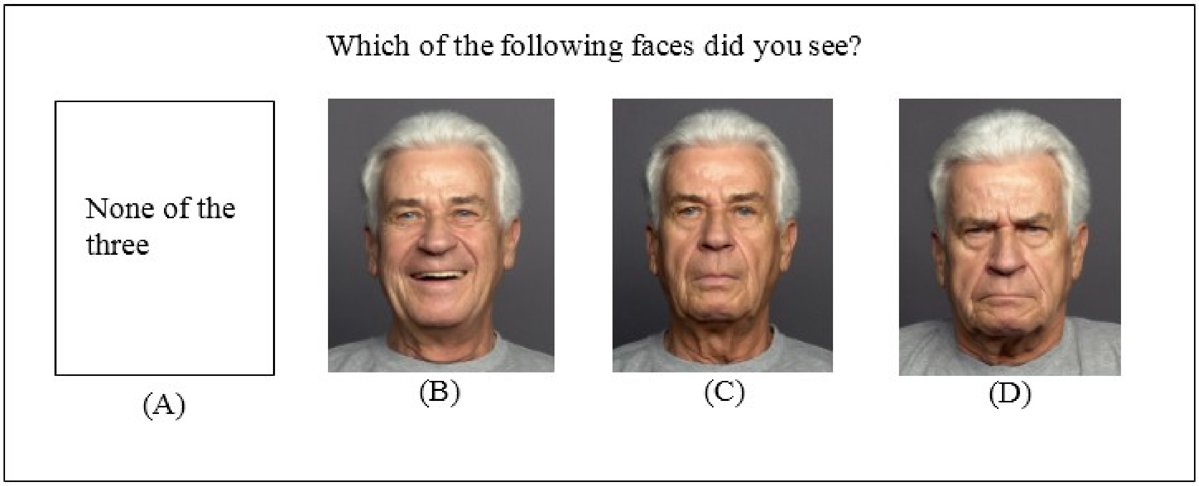


Figure 2: The face recognition memory task used in Study 1 and Study 2. In each trial, the three faces for choice were performed by a same actor, and represented happy, neutral and angry expressions, respectively.

Results

Descriptive analyses

Table 1 presents the means and standard deviations, as well as F tests on the difference in test scores between participants in the three mood conditions. Results indicated that participants in the three mood conditions were comparable in terms of baseline negative mood, depressive symptoms, and cognitive test scores. However, participants in neutral mood condition ($M = 3.60$, $SD = 1.51$) had significantly higher baseline positive mood than participants in positive mood condition ($M = 2.47$, $SD = 1.43$); and no other between-condition differences were found ($p > .05$).

Manipulation check

The effectiveness of mood induction procedure. Firstly, I examined participants' mood change following the mood induction procedure. Two 2 (assessment: baseline vs. post-induction) × 3 (mood condition: positive vs. neutral vs. anxious) within-between ANOVAs were performed on positive mood score and anxious mood score, respectively. Results indicated a significant assessment × condition interaction for positive mood, $F(2, 102) = 27.86$, $p < .001$, $\eta_p^2 = .35$, and anxious mood, $F(2, 102) = 12.67$, $p < .001$,

η_p^2 = .20. Following mood induction procedure, participants in positive mood condition displayed an increase of positive mood (Mdifference = 0.58, $p < .001$) while participants in neutral (Mdifference = -0.61, $p < .001$) and angry conditions (Mdifference = -0.94, $p < .001$) displayed decreases of positive mood. In addition, there was no significant increase of anxious mood for participants in the anxious mood condition (Mdifference = 0.13, $p = .44$). Participants in positive mood condition (Mdifference = -1.06, $p < .001$) and neutral mood condition (Mdifference = -0.41, $p = .02$) displayed significant decrease of anxious mood. These findings suggest that the positive mood induction procedure effectively induced positive mood whereas anxious mood induction procedure did not effectively induce anxious mood.

Post-induction mood state between the three conditions. Because participants in neutral and positive mood conditions were not comparable in the baseline positive mood, I examined the differences in post-induction positive and anxious mood among the three mood conditions using univariate ANOVA. Results indicated a marginally significant between-condition difference in post-induction positive mood, $F(2, 102) = 2.81$, $p = .065$, $\eta_p^2 = .05$, and a significant between-condition difference in post-induction anxious mood, $F(2, 102) = 11.59$, $p < .001$, $\eta_p^2 = .19$. Pairwise comparisons indicated that there was no significant difference in positive mood between the positive mood condition ($M = 3.08$, $SD = 1.46$) and neutral mood condition ($M = 2.99$, $SD = 1.58$, $p = .96$). Participants in positive mood condition reported marginally higher positive mood than participants in anxious mood condition ($M = 2.33$, $SD = 1.29$, $p = .08$). In contrast, participants in anxious mood condition reported significantly higher anxious mood ($M = 1.99$, $SD = 1.61$) than participants in neutral ($M = 1.25$, $SD = 1.15$, $p = .036$) and positive mood conditions ($M = .59$, $SD = .79$, $p < .001$); and participants in neutral condition reported marginally higher anxious mood than participants in positive mood condition, $p = .08$.

Attention of faces

Table 2 presents participants' attention reaction time and correct rate in three mood conditions. As participants' correct rate in attention task was generally very high, analyses were only performed on reaction time. Data of participants' reaction time were cleaned in two ste*ps*: First, outliers in the sample distribution were identified and excluded; second, for every participant, the reaction time was excluded in the trials when participants made a wrong response in identifying numbers. A 3 (face age: young adult vs. middle-aged vs. old adult) $\times$ 3 (face emotion: happy vs. neutral vs. angry) $\times$ 3 (mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on the cleaned reaction time. Results indicated a significant main effect of mood condition, $F(2, 99) = 4.21$, $p = .018$, $\eta_p^2 = .08$. In particular, participants in positive mood condition ($M = 1.55$, $SD = .05$) had significantly shorter reaction time than participants in neutral ($M = 1.74$, $SD = .05$, $p = .048$) and anxious conditions ($M = 1.75$, $SD = .05$, $p = .029$). There were no other significant main or interaction effects, $Fs < 2.00$, $ps > .100$, $\eta_p^2 < .02$.

Memory of faces

I analyzed four indices of memory performance: a) the percentage of accurately recognizing a presented face (hit rate); b) the percentage of falsely recognizing an unpresented face (false-alarm rate); c) accuracy of differentiating between presented faces and unpresented distractors (d'); and d) the subjective tendency of reporting having seen a face image C. The discriminability d' was computed by subtracting the z transformation of false-alarm rate from the z transformation of hit rate. The response tendency C was computed by reversing the arithmetic mean of the z transformations of hit rate and false-alarm rate.

Because there were participants whose hit rate or false-alarm rate equaled zero or one for certain face ages or face emotions, the d' and C could not be computed using the above equations. The loglinear approach has been proposed to resolve this problem well (Hautus, 1995). In particular, all hit rates and false-alarm rates were adjusted by adding 0.5 to both the number of hit rates and the number of false-alarm rates, and adding 1 to both the number of signal trials and the number of noise trials. In the present study, d' and C were computed based on the adjusted hit rate and false-alarm rate.

General memory performance. Firstly, I examined participants' own-age bias in face memory across all face emotions. Thus, general hit rate represents the percentage of recognizing presented faces, regardless of whether or not recognizing the presented face emotion; general false-alarm rate represents the percentage of falsely recognizing unpresented faces, regardless of whether or not recognizing the presented face emotion; general d' represents the accuracy in differentiating presented faces from unpresented faces, regardless of whether or not recognizing the presented face emotion; general C represents a subjective tendency to report having seen a face, regardless of the face emotion. Four 3 (face age: young adult vs. middle-aged vs. old adult) × 3 (mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on four dependent variables, respectively: general hit rate, general false-alarm rate, general d' and general C.

For general hit rate, there was a significant main effect of face age, $F(2, 98) = 23.02$, $p < .001$, $\eta_p^2 = .32$. Consistent with expectation, participants had a higher percentage of recognizing presented young adult faces ($M = .64$, $SE = .02$) than middle-aged faces ($M = .55$, $SE = .02$, $p < .001$) and old adult faces ($M = .58$, $SE = .02$, $p = .006$), indicating an own-age bias; and the general hit rate was not significantly different between middle-aged and old adult faces ($p = .191$). There was no significant main effect of mood condition, $F(2, 99) = 0.88$, $p = .416$, $\eta_p^2 = .02$, and no significant interaction between mood condition and face age, $F(4, 198) = 0.97$, $p = .427$, $\eta_p^2 = .02$.

For general false-alarm rate, there was a significant main effect of face age, $F(2, 98) = 14.57$, $p < .001$, $\eta_p^2 = .23$. Consistent with expectation, participants had a higher percentage of falsely recognizing unpresented young adult faces ($M = .52$, $SE = .02$) than middle-aged faces ($M = .45$, $SE = .02$, $p < .001$) and old adult faces ($M = .41$, $SE = .02$, $p < .001$), indicating an own-age bias; and the general false-alarm rate was significantly different between middle-aged and old adult faces ($p = .022$). There was no significant main effect of mood condition, $F(2, 99) = 0.04$, $p = .957$, $\eta_p^2 = .001$, and no significant interaction between mood condition and face age, $F(4, 198) = 0.68$, $p = .609$, $\eta_p^2 = .01$.

For general d', there was a significant main effect of face age, $F(2, 98) = 9.85$, $p < .001$ $\eta_p^2 = .17$. Participants' memory accuracy was significantly higher for old adult faces than middle-aged faces ($p < .001$). There were no differences in memory accuracy between young adult faces and middle-aged faces, or between young adult faces and old adult faces, although there was a trend that the memory accuracy for young faces was higher than middle-aged faces and old adult faces.

For general C, there was a significant main effect of face age, $F(2, 98) = 21.42$, $p < .001$, $\eta_p^2 = .30$. Consistent with my expectation, participants had a higher tendency to report having seen young adult faces ($M = -0.25$, $SE = 0.07$) than middle-aged faces ($M = -0.01$, $SE = 0.07$, $p < .001$) and old adult faces ($M = 0.01$, $SE = 0.07$, $p < .001$), indicating an own-age bias; the response tendency was not significantly different between middle-aged faces and old adult faces (p = 1.00). There was no significant main effect of mood condition, $F(2, 99) = 0.26$, $p = .77$, $\eta_p^2 = .01$ and no significant interaction between mood condition and face age, $F(4, 198) = 0.54$, $p = .705$, $\eta_p^2 = .01$).

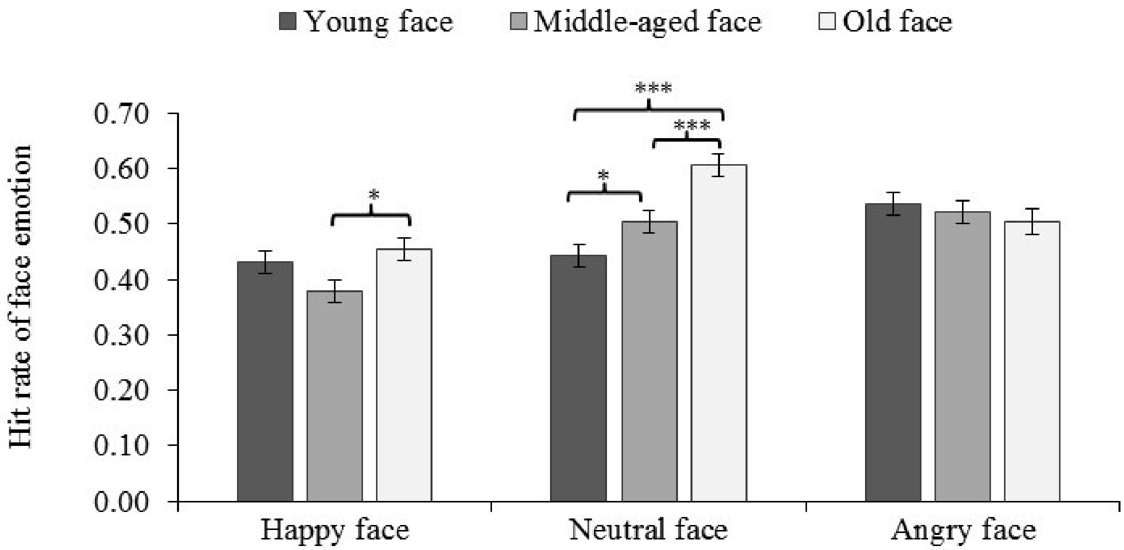
Memory of face emotion

In the next step, I investigated when participants correctly recognized presented faces, whether there was an own-age bias in recognizing presented vs. unpresented face emotions. Thus, the hit rate represents the percentage of correctly recognizing the presented face emotion; the false-alarm rate represents the percentage of falsely recognizing an unpresented face emotion; d' represents participants' sensitivity in differentiating between presented face emotion from unpresented face emotions; and C represents participants' tendency to report having seen a target face emotion. Four 3 (face age: young vs. middle-aged vs. old) × 3 (face emotion: happy vs. neutral vs. angry) × 3 (mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on hit rate, false-alarm rate, d', and C of face emotions, respectively.

For hit rate of face emotion, there was a significant main effect of face age, $F(2, 98) = 9.42$, $p < .001$, $\eta_p^2 = .16$, a significant main effect of face emotion, $F(2, 98) = 18.47$, $p < .001$, $\eta_p^2 = .27$, which were qualified by a significant interaction between face age and face emotion, $F(4, 96) = 9.09$, $p < .001$, $\eta_p^2 = .28$. As is shown in Figure 3, there were no own-age biases for hit rate of either happy face emotion or angry face emotion, though there was a small trend that young adult faces had higher hit rate than middle-aged faces (happy faces and angry faces) and old adult faces (angry faces). In contrast, there was a significant other-age bias for recognizing the neutral face emotion, such that college student participants had a higher hit rate for old adult faces than young adult faces and middle-aged faces. There were no other main effects or interaction effects, $Fs < 2.00$, $ps > .10$, $\eta_p^2 < .05$.

For false-alarm rate of face emotion, there was a significant main effect of face age, $F(2, 98) = 7.34$, $p = .001$, $\eta_p^2 = .13$, a significant main effect of face emotion, $F(2, 98) = 16.49$, $p < .001$, $\eta_p^2 = .25$, which were qualified by a significant interaction between face age and face emotion, $F(4, 96) = 8.53$, $p < .001$, $\eta_p^2 = .26$. As is shown in Figure 4, the percentage of falsely recognizing unpresented angry face emotion was higher for young adult faces than old face, but not different from middle-aged faces, suggesting an

Study 1



Study 2

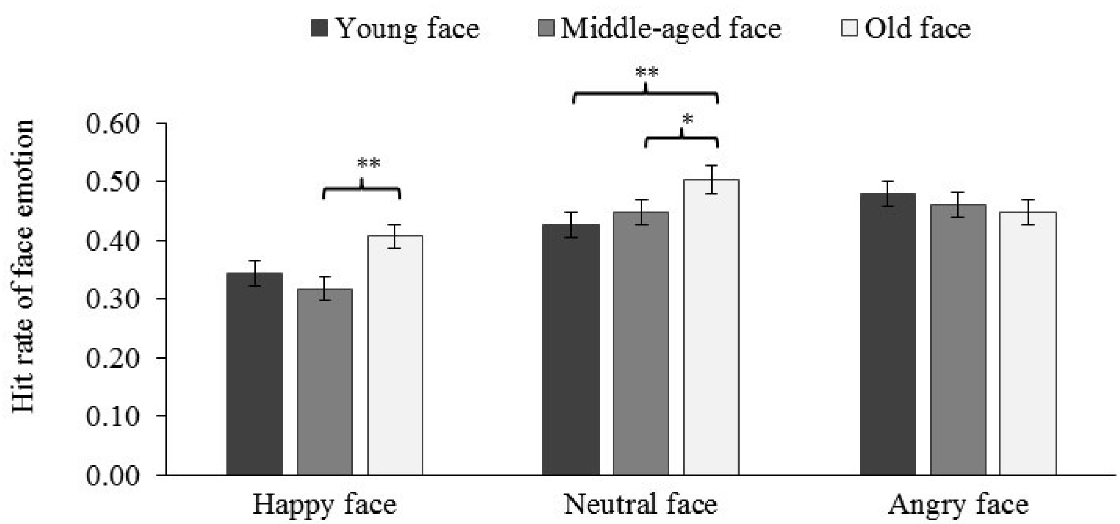


Figure 3: (Study 1) The hit rate for recognizing face emotions. There were no significant own-age bias in recognizing face emotions, though there was a small trend that young adult faces had higher hit rate than middle-aged faces (happy faces and angry faces) and old adult faces (angry faces). Error bars represent +/- *SE* mean. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

own-age bias in false-alarm rate for angry face emotion. There was no such other-age bias for happy face emotion or neutral face emotion. In contrast, there was an other-age bias for neutral face emotion, with the false-alarm rate higher for old adult faces than young adult faces. There were no other main effects or interaction effects, $Fs < 2.00$, $ps > .10$, $\eta_p^2 < .05$.

For d' of face emotion, only the main effect of face age was significant, $F(2,\ 98) = 9.84$, $p < .001$, $\eta_p^2 = .17$. In general, the discriminability of recognizing face emotions was higher for old adult faces than young adult faces ($p < .001$); and there was no difference between young adult faces and middle-aged faces, or between middle-aged faces and old adult faces. There were no other significant main or interaction effects, $Fs < 1.50$, $ps > .20$, $\eta_p^2 < .05$.

For C of face emotion, there was a significant main effect of face age, $F(2,\ 98) = 3.53$, $p = .033$, $\eta_p^2 = .07$, a significant main effect of face emotion, $F(2,\ 98) = 21.55$, $p < .001$, $\eta_p^2 = .31$, which were qualified by a significant interaction between face age and face emotion, $F(4,\ 96) = 11.74$, $p < .001$, $\eta_p^2 = .33$. As indicated by Figure 5, participants generally tended to report having not seen the target face emotions ($C > 0$). For angry face emotion, participants' tendency to report having not seen the angry face emotion was lower for young adult faces than old adult faces but not different from middle-aged faces, suggesting an own-age bias. And participants' tendency to report having seen the happy face emotion was lower for young adult faces than middle-aged faces but not different from old adult faces, suggesting an own-age bias. There was no such own-age bias for neutral face emotion. In addition, there was a significant interaction between mood condition and face age, $F(4,\ 198) = 2.60$, $p = .038$, $\eta_p^2 = .05$. As is indicated in Figure 6, for participants in the anxious mood condition, the tendency to report having not seen the target face emotion was higher for middle-aged faces than both young adult faces and old adult faces, suggesting an own-age bias. There were no differences among face ages for participants in the positive or neutral mood conditions.

Discussion

First, attention of faces did not reveal an own-age bias or an interaction between mood condition and own-age bias, but only a main effect of mood condition. In particular, participants in positive mood condition had shorter reaction time than participants in

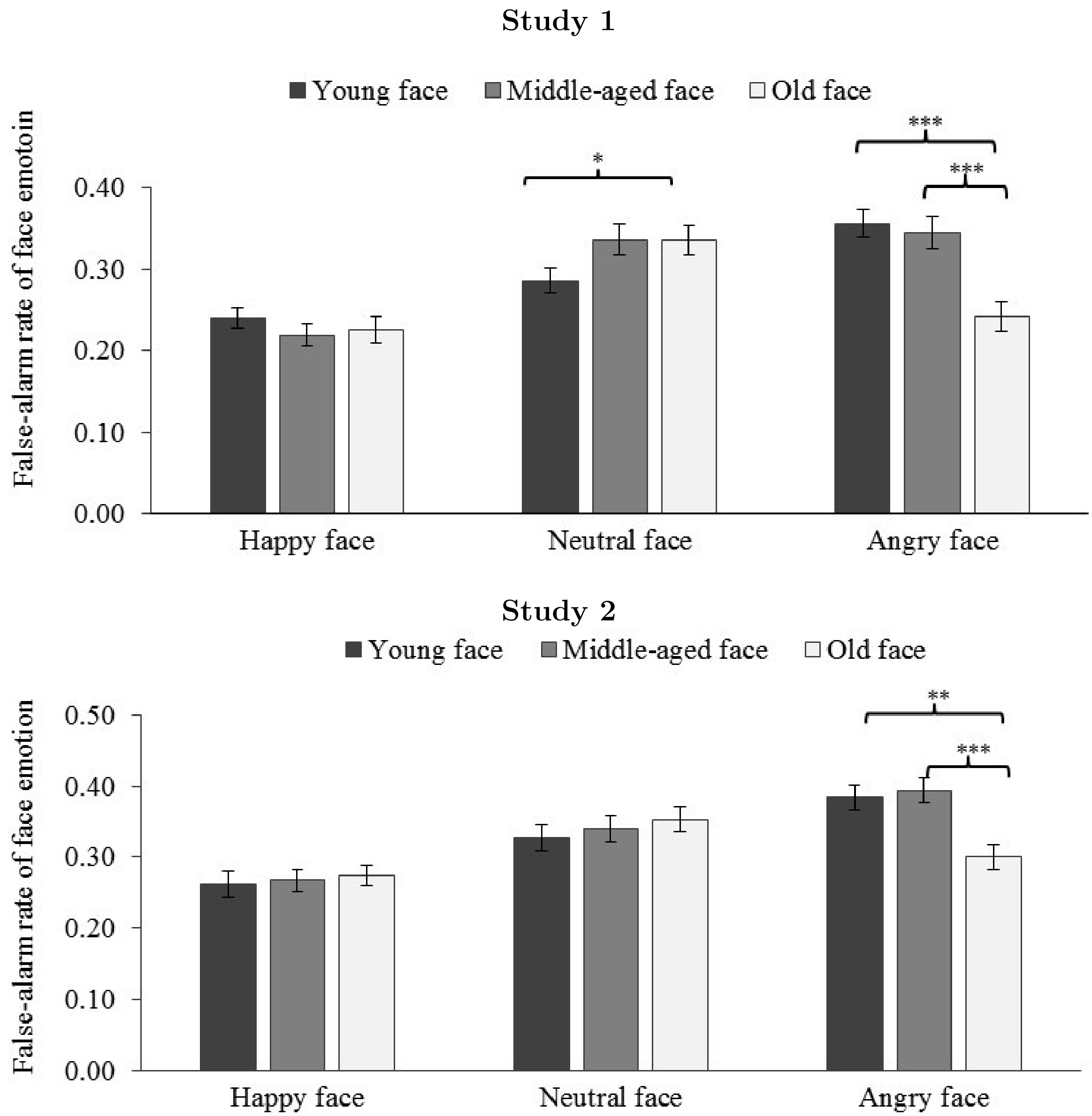


Figure 4: Face emotion moderated the own-age bias in false-alarm rate of face emotion. For angry faces, the false-alarm rate was higher for young adult faces than old adult faces. There was no such own-age bias for happy faces or neutral faces, suggesting an angry-potentiated effect. Error bars represent +/- SE mean. $^{*}p < .05$, $^{**}p <)$ .01, $^{***}p <$ .001

neutral and anxious conditions. Given that participants in the three mood conditions in Study 1 differed significantly in anxious mood but not significantly in positive mood,

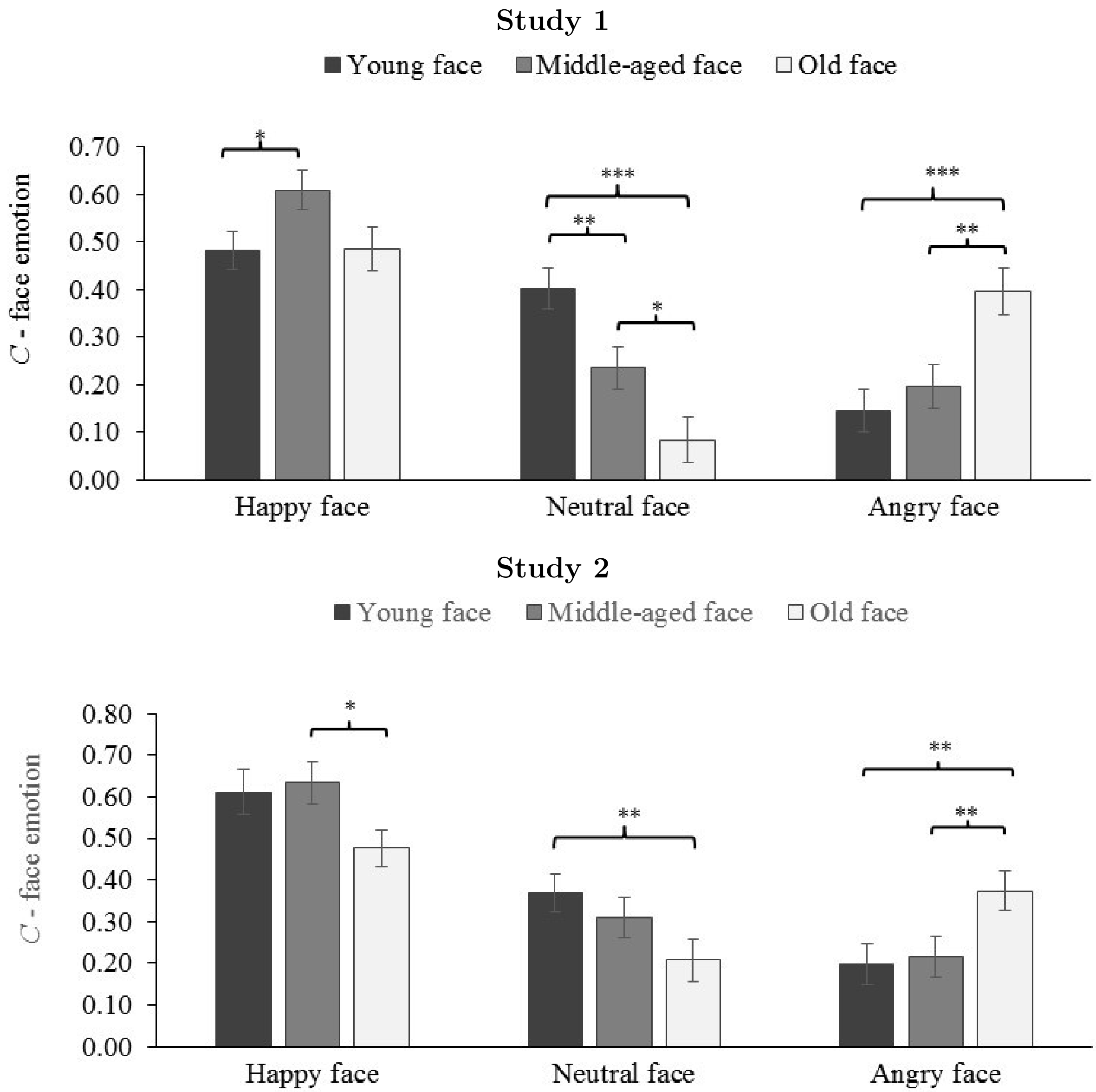


Figure 5: Face emotion moderated the own-age bias in response tendency of recognizing face emotions. There was an own-age bias for recognizing angry face emotion, but not for happy or neutral face emotion. Error bars represent +/- SE mean. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

the mood effects should be more related to the differential levels of anxious mood rather than positive mood among the three conditions. It is likely that the lower anxiety of participants in the positive mood condition had less narrowed attentional scope than

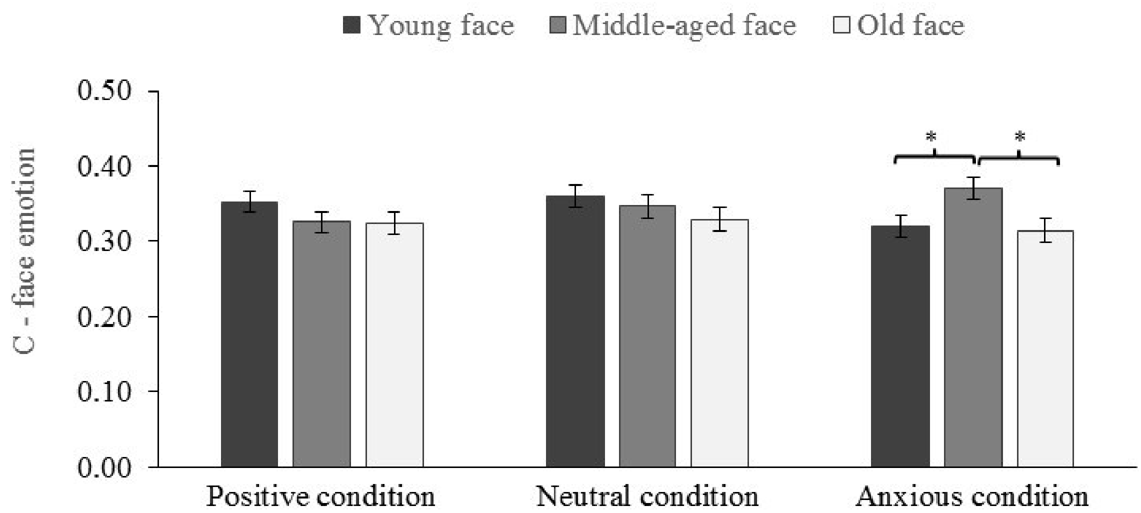


Figure 6: (Study 1) Perceiver's mood moderated the response tendency (C) in recognizing face emotions. There was an own-age bias for participants in anxious condition but not for participants in positive and neutral conditions.

participants in neutral and anxious mood conditions, which made it easier to disengage attention from the face images. Inconsistent with my expectation, however, mood condition did not moderate the own-age bias in memory of faces. Without previous theoretical and empirical literature as reference, it is unknown whether the missing moderation of mood was influenced by the experimental design. Thus, I re-examined this effect in Study 2.

Second, I found significant own-age biases in general memory hit rate, false-alarm rate and response tendency C. In particular, young adult faces had higher hit and false-alarm rate than middle-aged and old adult faces. Also, the response tendency to report having seen the face was higher for young adult faces than middle-aged and old adult faces. for young adult faces than middle-aged and old adult faces. These findings suggest that young adults were not only more likely to recognize presented young adult faces than other-age faces, but also were more likely to report having seen young adult faces than other-age faces, no matter if they had truly seen the faces before, supporting my hypothesis that own-age faces elicit an illusory familiarity.

Third, I found that the own-age biases in hit rate, false-alarm rate and response tendency of recognizing face emotions varied across different face emotions. Inconsistent with my expectation, however, the false-alarm rate and response tendency showed an angry-potentiated effect when there are sufficient cognitive resources at the encoding phase. Participants had a higher false-alarm rate for young adult faces than old adult faces in recognizing angry face emotion, and there was no such own-age bias for happy and neutral face emotions. For response tendency, both happy and angry face emotions revealed an own-age bias, with a more prominent own-age bias observed for angry face emotion. There was no own-age bias for neutral face emotion. For hit rate and d', however, there were no own-age biases for recognizing any face emotion, which was inconsistent with my expectation and previous studies (Ebner et al., 2013; Ebner & Johnson, 2010, Study 1). Unexpectedly, there was a significant other-age bias for the hit rate recognizing the neutral face emotion, and also a significant other-age bias in d' of discriminating presented vs. unpresented face emotions. A detailed discussion of this other-age bias was provided in the general discussion section.

Finally, the moderation of perceiver's mood on the own-age bias was only significant for response tendency but not other indices of face memory performance. For participants in anxious condition but not positive and neutral conditions, the tendency to report not having seen the face emotion was lower for young adult faces than middle-aged faces. This finding supports my expectation that the own-age bias was more prominent under anxious mood, which narrows cognitive processing, compared with happy and neutral moods.

Study 2

Study 1 demonstrated significant own-age biases in general memory hit rate, false-alarm rate and response tendency, as well as a significant moderation of face emotion for the memory of face emotions. In Study 2, I intended to investigate whether these effects would remain robust when faces are encoded with insufficient cognitive resources. In particular, I presented the digits and face images simultaneously in each trial. In this way participants' attentional resources would be highly focused on the digits, with limited resources left to encode the faces.

Method

Participants

One hundred and ten college students were recruited, who participated to fulfill course requirement for their enrollment in a psychology introductory course. Four participants' data were excluded from analyses due to extremely low correct rate in attention task. Another five participants' data were excluded due to extremely long reaction time in attention task. The remaining sample included 102 participants, aged 18-32 years old (M = 19.57, SD = 1.90, 49.0% female). The majority of participants were European American (83.3%), with a small portion of African American (7.8%), Asian (6.9%), and Hispanic (2.0%)

Materials and Procedure

The materials and procedure were the same as Study 1, except the face attention task. As is shown in Figure 1, in each trial of the attention task, three digits and face images were presented simultaneously. The three digits ranged from 0 to 9, and were presented in random locations on top of the face image. Participants were asked to indicate the digit that had the medium value of the three, and to do this as accurately and rapidly as possible. The trials switched only when participants made a response by pressing a number key on the keyboard. The between-trial interval was 1000 ms, during which participants were asked to concentrate on a cross in the center of the screen. Same as Study 1, no instruction or information was provided about the face images.

Results

Descriptive analyses

Table 1 presents the descriptive statistics, as well as F tests on the difference in test scores between participants in the three mood conditions. Results indicated that participants in the three mood conditions were comparable in terms of baseline negative mood, depressive symptoms, and cognitive test scores. However, participants in neutral mood induction condition (M = 3.52, SD = 0.22) had significantly higher baseline positive mood than participants in the positive mood condition (M = 2.73, SD = 0.22); and there were no other between-condition differences ($p > .05$).

Manipulation check

The effectiveness of mood induction procedure. Firstly, I examined participants' mood change following the mood induction procedure. Two 2 (assessment: baseline vs. post-induction) × 3 (condition: positive vs. neutral vs. anxious) within-between ANOVAs were performed on positive mood score and anxious mood score, respectively, in order to examine the effectiveness of the positive and anxious mood induction procedures. Results indicated a significant assessment × condition interaction for positive mood, $F(2, 99) = 17.55$, $p < .001$, $\eta_p^2 = .26$, and anxious mood, $F(2, 99) = 16.15$, $p < .001$, $\eta_p^2 = .25$. After mood induction, participants in the positive mood condition indicated an increase in positive mood (Mdifference = 0.55, p = .001) while participants in neutral (Mdifference = -0.50, p = .004) and anxious conditions (Mdifference = -0.76, $p < .001$) indicated a decrease in positive mood; in addition, participants in anxious mood condition indicated a marginally significant increase in anxious mood (Mdifference = 0.26, p = .065), while participants in the positive mood condition (Mdifference = -0.84, $p < .001$) and neutral mood condition (Mdifference = -0.47, p = .001) indicated a significant decrease in anxious mood. These findings indicated that the positive mood induction procedure effectively induced

Post-induction mood state between the three conditions. Because participants in the three conditions differed in baseline positive mood, I examined the differences in post-induction positive and anxious mood among the three mood conditions using univariate ANOVAs. Results indicated a significant between-condition difference in post-induction positive mood, $F(2, 99) = 6.14$, $p = .003$, $\eta_p^2 = .11$, and a significant between-condition difference in post-induction anxious mood, $F(2, 99) = 13.01$, $p < .001$, $\eta_p^2 = .21$. Pairwise comparisons indicated that participants in the positive mood condition (M = 3.29, SD = 0.24) reported significantly higher positive mood than participants in anxious condition (M = 2.16, SD = 0.24, p = .003), and participants in neutral condition reported higher positive mood than participants in anxious condition (p = .04). The positive mood did not differ between positive mood condition and neutral mood condition neutral (M = 3.02, SD = 0.24, p = 1.00). For anxious mood, participants in anxious condition reported significantly higher anxious mood (M = 1.73, SD = 0.16) than participants in neutral (M = 0.89, SD = 0.16, p = .001) and positive conditions (M = 1.73, SD = 0.16, $p < .001$); and participants in neutral condition were not significantly different from participants in positive condition in terms of post-induction anxious mood, p = .771.

Attention of faces

Data of participants' reaction time were cleaned in the same way as Study 1. A 3 (face age: young adult vs. middle-aged vs. old adult) × 3 (face emotion: happy vs. neutral vs. angry) × 3 (Mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on the cleaned reaction time. However, there were no main or interaction effects, $Fs < 2.10$, $ps > .100$, $\eta_p^2 < .05$.

Memory of faces

General memory of faces

Same as Study 1, four 3 (face age: young vs. middle-aged vs. old) × 3 (Mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on general hit rate, general false-alarm rate, general d', and general C, respectively.

For general hit rate, there was a significant main effect of face age, $F(2, 98) = 7.08$, $p = .001$, $\eta_p^2 = .13$. Consistent with expectation, participants had a higher percentage of recognizing presented young adult faces (M = .64, se = .02) than middle-aged faces (M = .58, se = .03, p = .002) and old adult faces (M = .57, se = .03, p = .003), indicating an own-age bias; and the hit rate was not significantly different between middle-aged and old adult faces (p = 1.00). There was no significant main effect of mood condition, $F(2, 99) = 0.71$, $p = .496$, $\eta_p^2 = .01$, and no significant interaction between mood condition and face age, $F(4, 198) = 0.21$, $p = .931$, $\eta_p^2 = .00$.

For general false-alarm rate, there was a significant main effect of face age, $F(2, 98) = 11.03$, $p < .001$, $\eta_p^2 = .18$. Consistent with expectation, participants had a higher percentage of falsely recognizing unpresented young adult faces (M = .59, se = .03) than middle-aged faces (M = .55, se = .03, p = .057) and old adult faces (M = .51, se = .03, $p < .001$), indicating an own-age bias; and the false-alarm rate was significantly different between middle-aged and old adult faces (p = .002). There was no main effect of mood condition, $F(2, 99) = 0.81$, $p = .448$, $\eta_p^2 = .02$, and no significant interaction between mood condition and face age, $F(4, 198) = 0.59$, $p = .673$, $\eta_p^2 = .01$.

For general d', there was no main effect of face age, $F(2, 98) = 2.36$, $p = .100$, $\eta_p^2 = .05$, no main effect of mood condition, $F(2, 99) = 0.22$, $p = .802$, $\eta_p^2 = .00$, and no interaction between face age and mood condition, $F(4, 198) = 0.96$, $p = .432$, $\eta_p^2 = .02$.

For general C, there was a significant main effect of face age, $F(2, 98) = 11.18$, $p < .001$, $\eta_p^2 = .19$. Consistent with expectation, participants had a higher percentage of reporting having seen young adult faces (M = -.35, se = .07) than middle-aged (M = -.22, se = .08, $p < .001$) and old adult faces (M = -.11, se = .08, $p < .001$), indicating an own-age bias; the response tendency was also significant between middle-aged faces and old adult faces (p = .007). There was no significant main effect of mood condition, $F(2, 99) = 0.62$, $p = .542$, $\eta_p^2 = .01$, and no significant interaction between mood condition and face age, $F(4, 198) = 0.19$, $p = .945$, $\eta_p^2 = .00$.

Memory of face emotion

As in Study 1, four 3 (face age: young adult vs. middle-aged vs. old adult) × 3 (face emotion: happy vs. neutral vs. angry) × 3 (Mood condition: positive vs. neutral vs. anxious) between-within subject ANOVAs were performed on hit rate-emotion, false-alarm rate-emotion, d'-emotion, and C-emotion, respectively.

For hit rate of face emotion, there was a significant main effect of face age, $F(2, 98) = 5.59$, $p = .005$, $\eta_p^2 = .10$, and a significant main effect of face emotion, $F(2, 98) = 17.66$, $p < .001$, $\eta_p^2 = .27$, which were qualified by a significant interaction between face age and face emotion, $F(4, 96) = 3.09$, $p = .019$, $\eta_p^2 = .11$. The findings were similar to

Study 1 (see Figure 3): there were no own-age biases for hit rate of either happy face emotion or angry face emotion, though there was a small trend that young adult faces had higher hit rate than middle-aged faces (happy faces and angry faces) and old adult faces (angry faces). In contrast, there was a significant other-age bias for recognizing the neutral face emotion, such that college student participants had a higher hit rate for old adult faces than young adult faces and middle-aged faces. In addition, there was a significant interaction between mood condition and face emotion, $F(4, 198) = 2.97$, $p = .021$, $\eta_p^2 = .06$. As is indicated in Figure 7, participants in neutral mood condition and angry mood condition demonstrated a higher hit rate for angry faces than happy faces, whereas participants in the positive mood condition did not show such difference. There were no other significant effects, $Fs < 2.00$, $ps > .10$, $\eta_p^2 < .05$.

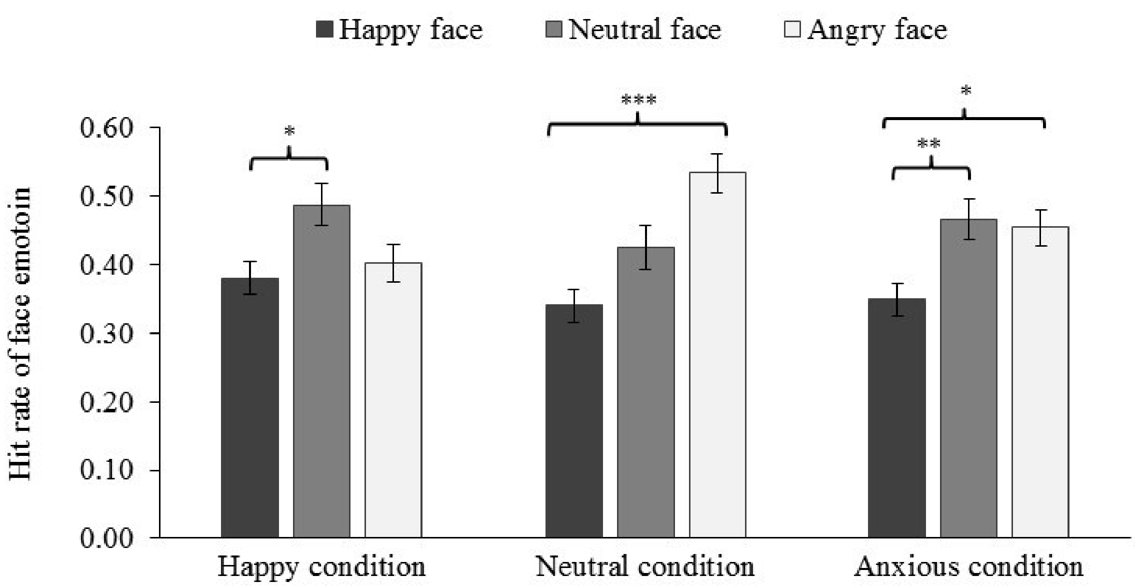


Figure 7: (Study 2) The interaction between mood state and face emotion on hit rate-emotion. Error bars represent +/- *SE* mean. *$p < .05$. **$p < .01$. ***$p < .001$

For false-alarm rate of face emotion, there was a significant main effect of face age, $F(2, 98) = 5.03$, $p = .008$, $\eta_p^2 = .09$, a significant main effect of face emotion, $F(2, 98) = 12.64$, $p < .001$, $\eta_p^2 = .21$, which were qualified by a significant interaction between face age and face emotion, $F(4, 96) = 4.72$, $p = .002$, $\eta_p^2 = .16$. As is shown in Figure

4, participants had a higher false-alarm rate of false recognizing angry face emotion for young adult faces than old adult faces. There was no such own-age bias for either happy face emotion or neutral face emotion. There were no main effects or interaction effects of mood condition, $Fs < 2.00$, $ps > .500$, $\eta_p^2 < .04$.

For d' of recognizing face emotions, only the main effect of face age was significant, $F(2, 98) = 4.79$, $p = .010$, $\eta_p^2 = .09$. Participants had higher d' in recognizing face emotions for old adult faces than middle-aged faces ($p = .009$), and there were no differences between young adult faces and old adult faces ($p = .097$) or between young adult faces and middle-aged faces ($p = 1.00$).

For response tendency of recognizing face emotions, there was a significant main effect of face age, $F(2, 98) = 6.49$, $p = .002$, $\eta_p^2 = .12$, a significant main effect of face emotion, $F(2, 98) = 16.14$, $p < .001$, $\eta_p^2 = .25$, which were qualified by a significant interaction between face age and face emotion, $F(4, 96) = 5.06$, $p = .001$, $\eta_p^2 = .17$. As indicated by Figure 5, participants generally tended to report having not seen the target face emotions. For angry face emotion, participants' tendency to report having not seen the angry face emotion was lower for young adult faces than old adult faces, suggesting an own-age bias. Participants also had lower tendency to report having not seen the faces for middle-aged faces than old adult faces; there was no difference between young adult faces and middle-aged faces. There was no such own-age bias for memory of happy or neutral face emotion. There were no significant main or interaction effects of mood condition, $Fs < 2.50$, $ps > .05$, $\eta_p^2 < .05$.

Discussion

For attention of faces, there was no own-age bias or a moderation of mood condition on the own-age bias. In contrast to study 1, there was no significant main effect of mood condition in Study 2.

The findings of general memory of faces were consistent with Study 1, though the effect sizes were smaller in Study 2. When participants' cognitive resources were highly occupied by the digit task, with insufficient resources left to encode the face images, young adults were more likely to recognize presented young adult faces than other-age faces, were more likely to falsely report having seen unpresented young adult faces than unpresented other-age faces, and had a tendency to report having seen young adult faces than other-age faces, no matter if they had truly seen the faces before.

For memory of face emotions, the findings were similar to Study 1. There were significant other-age biases in false-alarm rates and response tendencies for angry face emotion but not for happy and neutral face emotions, suggesting an angry-potentiated effect. For hit rate and d', however, I did not find an own-age bias for any face emotion.

I also found a significant interaction between mood condition and face emotion in participants' hit rate of face emotion. Participants in neutral and anxious mood conditions had a higher percentage of recognizing presented angry faces than happy faces; but this preference for angry faces was not observed for participants in positive mood condition. The reduced preference for angry faces under positive mood is consistent with extensive studies that found a "mood-congruence effect", or a preference in processing information that is congruent with the perceiver's mood state (for reviews, see Blaney, 1986; Singer & Salovey, 1988).

General Discussion

Attention of faces

First, it must be noted that participants' reaction time may reflect differential attentional processes in Study 1 and Study 2. In study 1 when face images were presented prior to the digits, a longer reaction time may indicate more difficulty in disengaging attention from the face images, and may also indicate more difficulty in inhibiting the face images in the background. Thus, the attentional process in Study 1 may consist of both a component of attentional disengagement and a component of inhibitory control. In study 2 when face images and digits appeared simultaneously, a longer reaction time might have resulted from more difficulty in suppressing the interference of face background, indicating a major component of inhibitory control but barely any process of attentional disengagement.

I did not find a significant own-age bias in participants' reaction time, nor did I find significant moderation effects of face emotion or perceivers' mood state in attention reaction time. In contrast, Ebner and Johnson (2010) found that young adults had longer RT in the attention task when young adult faces rather than old adult faces appeared in the background, indicating a significant own-age bias. One possible reason for these inconsistent findings is that the attention task in the present study may have been more difficult than the one used in Ebner and Johnson (2010)'s study, making the reaction time insensitive to the interference of the face images. In particular, participants in Ebner and Johnson (2010)'s study needed to identify the different digit from the other two matching digits, with the three digits ranging from 1 to 3, and all three digits located in the center of the face image. In contrast, participants in the present study needed to identify the digit that had the middle value of the three, with the three digits ranging from 0 to 9, and located in random locations on top of the face image. The difference in the difficulty of the two kinds of attention tasks is also indicated by participants' RT, with an average of RT shorter than 800 ms in Ebner & Johnson (2010)'s study, versus over 1500 ms in the present study. The high difficulty of the attention task in the present study may have produced heavy attentional load on participants, and resulted in little attentional resources left to process the face images, which reduced the variance that is necessary to observe an own-age bias. Consistent with this explanation, previous studies (Lavie, 1995; Lavie, Hirst, de Fockert, & Viding; 2004) found that high perceptual load of the primary task reduces the interference of the distractors. Future research is needed to examine the own-age bias in attention using a task with relatively lower difficulty.

Memory of faces

If the face in the background received little attention allocation in the encoding phase, one might expect an absence of own-age bias in participants' memory performance due to the insufficient encoding. In contrast, Neumann, End, Luttmann, Schweinberger and Wiese (2015) found that the attention allocation during the encoding phase did not influence the presence of own-age bias, or the ERPs elicited by the young adult vs. old adult faces, suggesting no necessary linkage between the own-age bias in memory and attentional allocation in the encoding phase. Consistent with this finding, I found significant own-age bias in general memory hit rate, false-alarm rate, and response tendency not only in Study 1 when face images were encoded with sufficient cognitive resources, but also in Study 2 when face images were encoded with insufficient cognitive resources; though the effect sizes of the own-age bias in Study 2 were indeed smaller than those of Study 1. Consistent with previous studies (e.g., Bryce & Dodson, 2013; Wiese et al., 2008), participants had a higher percentage of correctly recognizing the presented young adult faces than middle-aged and old adult faces. While previous research on the own-age bias was focused on memory accuracy, the present study found a presence of own-age bias in memory false-alarm rate and subjective response tendency. In particular, participants had a higher percentage of falsely reporting having seen young adult faces than other-age faces, and also a higher tendency to report having seen young adult faces than other-age faces, suggesting an illusory feeling of familiarity for own-age faces. Jacoby's attributional theory (Jacoby, Kelley, & Dywan, 1989; Jacoby & Whitehouse, 1989) suggests that people are more likely to report having seen a target in the past if they are currently more fluent in processing this target. Based on this theory, as young adults had more frequent daily contact experience with their own-age partners than other-age partners, and typically adopt the more efficient configural processing of young adult faces and employ the less efficient featural processing of old adult faces (Gauthier & Tarr, 1997; Maurer, Le Grand, & Mondloch, 2002), they are more likely to report having seen a young face than a middle-aged or old face, no matter whether or not they have actually seen it. It must be noted that the direction of the own-age bias in false-alarm rate in the present study is inconsistent with Rhodes and Anastasi (2012)'s meta-analysis that found generally higher false-alarm rate for other-age faces than own-age faces. In addition, there was no own-age bias in the general memory discriminability, which was inconsistent with Rhodes and Anastasi (2012)'s meta-analysis results, but was consistent with the findings of Ebner & Johnson (2009) that also tested face memory using emotional faces. Given that all the studies included in the Rhodes and Anastasi (2012) study used neutral faces rather than emotional faces, our findings suggest that face processing can be different when face images have emotional values.

For the moderation of face emotion on the own-age bias, I found an angry-potentiated effect on the own-age bias in false alarm rate and response tendency in both Study 1 when there were sufficient cognitive resources to encode the faces and also in Study 2 when there were insufficient cognitive resources. This finding is inconsistent with Ebner et al. (2013)'s argumentation that the angry-potentiated effect would only be present when were insufficient cognitive resources available. The robustness of the angry-potentiated effect regardless of the availability of cognitive resources may suggest that the age categorization and the emotional valence of the faces do not compete for cognitive resources during face encoding, but are more likely to be integrated as a whole. Nevertheless, the finding provided support for Ebner et al. (2013)'s argumentation that young adults' relative process in processing negative vs. positive information enhanced the detection of the own-age bias. Consistent with this argumentation, I found that college-age student participants in both Study 1 and Study 2 had higher hit rates and false-alarm rates for angry faces than happy faces, and the tendency to report having not seen a face emotion was lower for angry face emotion than happy face emotion, suggesting a preference for processing angry faces than happy faces.

Inconsistent with my expectation, the hit rate of recognizing neutral face emotion, and the sensitivity of differentiating presented vs. unpresented neutral face emotion did not reveal an own-age bias, but display an unexpected other-age bias in both Study 1 and Study 2. These findings are also inconsistent with the previous studies that found own-age bias in memory of neutral faces (e.g., Bryce & Dodson, 2013; He, Ebner, & Johnson, 2011). One possible reason for the other-age bias in the present study is that the study design and the formula of computing the hit rate of specific face emotion was different from those used in previous studies. In the previous studies that used only neutral faces (e.g., Bryce & Dodson, 2013; He, Ebner, & Johnson, 2011), participants saw only one face in each memory test trial, and responded by choosing "unpresented/new face" or "presented/old face" to each tested face. In this case, the hit rate was computed through dividing the number of correct responses of "presented face" by the number of truly presented face, and participants obtained a "hit" as long as they correctly recognized a presented face. In contrast, in the memory test of the present study, participants were shown happy, neutral and angry emotions of a face, and participants need to identify the specific face emotion they saw. In this case, the hit rate of recognizing a neutral face was computed through dividing the number of faces that participants correctly recognized as "neutral face emotion" by the number of faces that participants correctly recognized as "presented face". Thus, in order to get a "hit" for neutral face emotion in the present study, participants did not only need to correctly recognize a presented face, but also need to correctly report that the face was presented in neutral emotion. Even though participants in the present study were better at recognizing a face as presented for young adult faces than old adult faces (as indicated by the own-age bias in general memory hit rates), it is likely that participants had more difficulty in correctly recognizing the neutral face emotion for young adult faces than old adult faces, resulting in an other-age bias in memory hit rate for the neutral face emotion.

Despite the absence of own-age bias in discriminability d', participants displayed significant own-age bias as well as moderation effects of face emotion in memory false-alarm rates and response tendencies. In particular, young adults were better at recognizing presented own-age faces than other-age faces, and were more likely to report having seen own-age vs. other-age faces, no matter if they had truly seen the faces in the past. Together, these findings suggest that false memories and response tendency are more than just noise in the memory performance, but can reflect unique and distinct cognitive processing bias compared with memory accuracy (d' and hit rate). Focusing only on memory hit rate and discriminability, with false-alarm rate and response tendency simply accounted for or excluded might have blurred or concealed some individual differences in processing bias.

In contrast to Study 1 that found an angry-potentiated effect for the own-age bias when there were sufficient cognitive resources, previous studies on face attention, face identification and face memory did not find the angry-potentiated effect with sufficient cognitive resources. Specifically, Ebner and Johnson (2010; Study 1) did not observe a moderation of face emotion on the own-age bias in attention reaction time when participants attended to the faces with sufficient cognitive resources. Also, Noh & Isaacowitz (2011) found that young adults' own-age orienting benefit in special cuing task was only present for neutral and positive facial cues, but displayed an "other-age" orienting benefit for sad faces. Furthermore, Ebner et al. (2013) found alleviated own-age bias related brain activities for angry face emotion compared with happy and neutral face emotions while participants were viewing and identifying the face emotions. It must be noted that selective attention, gaze orienting, and face identification were all at earlier stage of processing, which require relatively fewer cognitive resources and relied more on automatic processing (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; hman & Mineka, 2001), compared with recognition memory investigated in the present study. Therefore, these findings suggest that when cognitive resources are fully available, the potentiating effect of angry face emotion for the own-age bias tend to be more prominent at later stage of face processing than earlier stage of face.

In study 1, the moderation of perceiver's mood was only observed for the response tendency but not the other indices of memory performance. Consistent with my expectation, the own-age bias in response tendency was only present in anxious condition but not in happy and neutral conditions, suggesting that the narrowing effect of anxious mood potentiates the own-age bias, compared with happy and neutral moods. For the reason why I did not observe a moderation of perceiver's mood on the own-age bias in attention reaction time and other indices of memory performance, two explanations seem plausible. First, it is likely that the induced positive and anxious mood in the present study were too mild to moderate the own-age bias. Second, it is possible that the own-age bias is a unique type of processing bias that is not susceptible to perceiver's mood state. Although anxious mood has been found to increase processing bias toward threatening stimuli (Friedman & Förster, 2010), and positive mood has been found to broaden processing scope and reduce processing bias (Fredrickson, 1998; 2000), they may not influence the own-age bias in face processing. Future studies are needed, on the one hand, to provide more evidence about the moderation of positive and anxious mood on the own-age bias; and on the other hand, to investigate the potential moderation of other mood states that have been found to increase processing bias, such as sadness (Becker & Leinenger, 2011) and anger (Ford, Tamir, Gagnon, Taylor, & Bruny, 2012; Van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001).

In order to compare Study 1 and Study 2 in terms of the findings of the own-age bias, the moderation of the face emotion and people's mood state, I conducted separate between-within subject ANOVA analyses for corrected reaction time, general memory performance, and memory of face emotions by adding the study design (study 1-with sufficient cognitive resources vs. study 2-insufficient cognitive resources) as a between-subject factor. For attention reaction time, participants in Study 2 (with insufficient cognitive resources) had longer reaction time than participants in Study 1 (sufficient cognitive resources) for happy face emotion (p = .016) and angry face emotion (p = .023); and the two studies did not differ for neutral face emotion (p = .091). For general memory performance, participants in Study 1 had a higher memory accuracy (d'; $p <$ .001) and lower false alarm rate (p = .006) than participants in Study 2. The two studies did not differ in memory hit rate and response tendency ($ps >$ .10). For memory of face emotion, in general, participants in Study 1 had a higher hit rate ($ps <$ .05) and d' ($ps <$ .05) in recognizing face emotions than participants in Study 2, and had lower false alarm rate ($p <$ .001) than participants in Study 2. In addition, participants in Study 1 had a higher percentage of reporting having seen a presented face emotion than participants in Study 2 ($p <$ .001). However, participants in Study 1 and Study 2 did not differ in the effects of face age, or the moderation of mood state or face emotion on the own-age bias. Together, these between-study analysis results indicate that when cognitive resources are more sufficient at the encoding phase, college-age student participants tend to have higher memory accuracy in recognizing presented faces and presented face emotions, and had lower percentage of falsely recognizing unpresented face emotions. But the sufficiency of cognitive resources would not influence the own-age bias, or the moderation of mood state and face emotion.

The findings of the present study have important implications for intergenerational interactions and social judgment in people's daily life. Firstly, young adults' better general memory accuracy and greater illusory familiarity of young faces than old faces may increase young adults' perceived social closeness with same-age social contacts than other-age contacts. This perceived closeness would in turn lead to stronger motivation to invest in social relationship with same-age partners than the relationship with other-age partners. Consequently, other-age contacts, especially old adults, may be frequently ignored or isolated from young adults' social network. Secondly, the observed angry-potentiated effect of the own-age bias suggests that young adults' chance of falsely interpreting a happy or neutral facial emotion as an angry facial emotion may be higher when interacting with a young adult rather than when interacting with an old adult. Such age-related bias in facial emotion interpretation may increase young adults' positive age stereotype toward old adults, such as perceiving old adults as warmer and more generous than young adults (Cuddy & Fiske, 2002). This positive age stereotype may then elicit benevolent behaviors toward old adults, such as respect and help (Cuddy, Fiske, & Glick, 2007).

Limitations and outlook

There are a few limitations in the present study.

First, participants' memory hit rates were generally very low, particularly for the memory of face emotion. Due to this floor effect, participants' memory hit rates may not be sensitive to the distraction of the face images, and thus may have concealed the potential own-age bias. The floor effect in memory accuracy may result from the high difficulty of the memory test. As participants in the present study received no instruction about the face images at the encoding phase, and tended to focus their attention on the demanding digit identification task, in contrast to many previous studies that asked participants to concentrate on the face stimuli (e.g.,Bryce & Dodson, 2013; Wiese et al., 2008). In addition, participants generally rated the face memory task as very hard in the follow-up questionnaire on a five-point likert scale ranging from "very difficult (1)" to "very easy (5)" (Study 1: M = 1.65, SD = 0.79; Study 2: M = 1.41, SD = 0.68). Considering the extremely high difficulty of the memory task, it is likely that participants' memory responses were largely biased by their response tendency or illusory familiarity of the faces, and thud did not truly reflect individual's working memory capacity. Future research should consider reducing the difficulty of the memory test, such as decreasing the number of face stimuli in the encoding phase or reducing the number of distractors in the retrieval phase, or increasing the stimuli presentation time at encoding phase.

Second, the sample only included younger adults but not middle-aged or older adults. Thus, it remains a question whether the findings of the moderation of face emotion on the own-age bias in face memory will apply to middle-aged and older adult participants. Although there is a lack of direct empirical evidence about the age difference in the moderation of face emotion on the own-age bias, lifespan developmental studies suggest the moderation of face emotion on the own-age bias could vary across different age groups. Firstly, in comparison to younger adults, older adults displayed a preference in attending to and remembering the positive information while avoiding processing negative information (Carstensen & Mikels, 2005; Mather & Carstensen, 2005), as emotional regulation strategies. Thus, older adults "positivity effect" may result in a stronger own-age bias for positive faces than angry faces, in contrast to the "angry-potentiated effect" observed among younger adults. Secondly, it has been found that older adults are worse than younger adults in identifying angry face emotions, but the two age groups did not differ in the ability of identifying happy or neutral face emotions (Ebner & Johnson, 2009). Older adults' relatively higher difficulty in identifying angry face emotion may lead to lower interference of the angry face images at the attention/encoding phase, and/or worse recognition of the presented angry face emotions at the retrieval phase, compared to young adults. Thus, it is likely that these potential age differences in the ability of encoding and retrieving angry facial emotions would predict age differences in the moderation of face emotion on the own-age bias. It calls for future research to investigate the moderation of face emotion on the own-age bias among middle-aged and older adults, to advance our understanding about the lifespan development of the face processing abilities.

Third, I did not measure participants' daily contact experience with same-age partners and other-age partners, and thus was not able to investigate the association between the amount of contact experience and the own-age bias. It calls for future research to investigate this association to improve our understanding about the mechanism underlying the own-age bias.

Finally, I cannot exclude the possibility that the ethnicity of the face images and participants may have confounded the observed effects. On the one hand, the sample lacked its cultural diversity, with most participants being European American and other ethnicities underrepresented. On the other hand, although the face actors of the face images were all Germans, they were diverse in colors of skin, hair and eyes, which suggest different sub-ethnic groups. Because the ethnicity of participants and face images were not controlled in the present study, they could have confounded the observed own-age bias. It calls for future research to investigate the potential moderation of the ethnicity of perceivers and face stimuli on the own-age bias in processing emotional face images.

Conclusions

To my knowledge, this is the first study that investigated the own-age bias and its potential emotional moderators in memory when people encode the face stimuli in situation of sufficient or insufficient cognitive resources. Based on the findings, I can draw the following conclusions: First, young adults displayed an own-age bias in memory of faces, including a higher percentage of falsely recognizing unpresented own-age vs. other-age faces, and a higher tendency to report having seen own-age faces than other-age faces. Importantly, such own-age bias in memory is robust even when faces are encoded with insufficient cognitive resources. Second, there is an "angry-potentiated effect" on the own-age bias in memory false alarm rate and response tendency in both the situation of sufficient cognitive resources and in the situation of insufficient cognitive resources. Third, perceivers' mood moderates the own-age bias in response tendency when there were sufficient cognitive resources, with the own-age bias only present under anxious mood but not present under positive or neutral mood.

Table 1: Descriptive Statistics of Control Variables in Study 1 (N = 105) and Study 2 (N = 102) for the Three Mood Conditions

	Positive condition		Neutral condition		Anxious condition			
Tests	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*
Study 1								
Baseline positive mood	2.50	1.43	3.60	1.51	3.27	1.34	5.52	.005
Baseline anxious mood	1.64	1.35	1.66	1.05	1.86	1.41	0.30	.740
Post-induction positive mood	3.08	1.46	2.99	1.58	2.33	1.29	2.81	.065
Post-induction anxious mood	0.59	0.79	1.25	1.15	1.99	1.61	11.59	<.001
Depressive symptoms	1.49	0.75	1.47	0.27	1.64	0.46	1.03	.359
Shipley Vocabulary	29.97	3.28	28.71	3.95	28.14	3.51	2.43	.093
Digit Symbol	66.28	9.23	70.06	9.04	66.80	10.82	1.53	.221
Letter-Number Sequence	11.25	1.95	10.74	2.23	10.69	2.41	0.72	.492
Study 2								
Baseline positive mood	2.73	1.27	3.52	1.15	2.89	1.41	3.49	.034
Baseline anxious mood	1.40	1.07	1.36	0.71	1.46	1.22	0.08	.919
Post-induction positive mood	3.26	1.27	3.02	1.39	2.13	1.55	6.01	.003
Post-induction anxious mood	0.56	0.73	0.89	0.67	1.78	1.21	16.06	.000
Depressive symptoms	1.64	0.30	1.56	0.42	1.56	0.34	0.46	.630
Shipley Vocabulary	31.91	3.67	30.21	4.04	29.65	4.77	2.63	.077
Digit Symbol	68.12	9.52	67.48	11.71	69.06	11.51	0.18	.840
Letter-Number Sequence	11.09	2.58	11.36	2.58	11.65	2.23	0.43	.654

Table 2: Attention and General Memory Performance for the Three Mood Conditions

Tests	Positive condition		Neutral condition		Anxious condition	
	M	*SD*	*M*	*SD*	*M*	*SD*
Study 1						
Raw Attention RT (ms)	1548.59	240.09	1729.00	293.40	1743.35	386.80
Attention correct rate (%)	0.93	0.12	0.95	0.04	0.95	0.04
General Hit	0.56	0.17	0.58	0.19	0.62	0.21
General False Alarm	0.45	0.20	0.46	0.23	0.47	0.22
General discriminability	0.34	0.30	0.37	0.34	0.49	0.27
General Response Bias	-0.03	0.54	-0.09	0.66	-0.13	0.64
Study 2						
Raw Attention RT (ms)	1803.76	372.38	1787.07	337.43	1751.09	404.38
Attention correct rate (%)	0.95	0.04	0.95	0.04	0.95	0.03
General Hit	0.63	0.22	0.59	0.24	0.57	0.24
General False Alarm	0.58	0.23	0.55	0.24	0.51	0.25
General discriminability	0.20	0.24	0.15	0.29	0.19	0.25
General Response Bias	-0.32	0.69	-0.23	0.77	-0.12	0.77

REFERENCES

Anastasi, J. S., & Rhodes, M. G. (2006). Evidence for an Own-Age Bias in Face Recognition. *North American Journal of Psychology*, *8*, 237–252.

Anderson, A. K., Christoff, K., Panitz, D., De Rosa, E., Gabrieli, J. D. E. (2003). Neural correlates of the automatic processing of threat facial signals. *Journal of Neuroscience*, 23, 5627-5633.

Bailey, P. E., Slessor, G., Rendell, P. G., Bennetts, R. J., Campbell, A., & Ruffman, T. (2014). Age differences in conscious versus subconscious social perception: the influence of face age and valence on gaze following. *Psychology and Aging*, *29*, 491–502. http://doi.org/10.1037/a0036249

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychological Bulletin*, *133*, 1–24. http://doi.org/10.1037/0033-2909.133.1.1

Becker, M. W., & Leinenger, M. (2011). Attentional selection is biased toward mood-congruent stimuli. *Emotion*, *11*, 1248-1254. doi:10.1037/a0023524

Blaney, P. H. (1986). Affect and memory: a review. *Psychological Bulletin*, *99*, 229–246. http://doi.org/10.1037/0033-2909.99.2.229

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety, *14*, 789–808. http://doi.org/10.1080/026999300 50156636

Bryce, M. S., & Dodson, C. S. (2013). Cross-age effect in recognition performance and memory monitoring for faces. *Psychology and Aging*, *28*, 87-98. doi:10.1037/ a0030213

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognitiom: Aging and the positivity effect. *Current Directions in Psychological Science*. http://doi.org/10.1111/j.0963-7214.2005.00348.x

Cuddy, A. C., & Fiske, S. T. (2002). Doddering but dear: Process, content, and function in stereotyping of older persons. In T. D. Nelson (Ed.), *Ageism: Stereotyping and prejudice against older persons* (pp. 3-26). Cambridge, MA, US: The MIT Press.

Cuddy, A. C., Fiske, S. T., & Glick, P. (2007). The BIAS map: Behaviors from inter-group affect and stereotypes. *Journal of Personality and Social Psychology*, *92*, 631-648. doi:10.1037/0022-3514.92.4.631

Ebner, N. C., He, Y., & Johnson, M. K. (2011). Age and emotion affect how we look at a face: Visual scan patterns differ for own-age versus other-age emotional faces. *Cognition and Emotion*, *25*, 983-997. doi:10.1080/02699931.2010.540817

Ebner, N. C., & Johnson, M. K. (2009). Young and older emotional faces: are there age group differences in expression identification and memory? *Emotion (Washington, D.C.)*, *9*, 329–39. http://doi.org/10.1037/a0015179

Ebner, N. C., & Johnson, M. K. (2010). Age-Group Differences in Interference from Young and Older Emotional Faces. *Cognition and Emotion*, *24*, 1095–1116. http://doi.org/10.1080/02699930903128395

Ebner, N. C., Johnson, M. R., Rieckmann, A., Durbin, K. a., Johnson, M. K., & Fischer, H. (2013). Processing own-age vs. other-age faces: Neuro-behavioral correlates and effects of emotion. *NeuroImage*, *78*, 363–371. http://doi.org/10.1016/j.neuroimage.2013.04.029

Ebner, N. C., Riediger, M., & Lindenberger, U. (2010). FACES--a database of facial expressions in young, middle-aged, and older women and men: development and validation. *Behavior Research Methods*, *42*, 351–362. http://doi.org/10.3758/BRM.42.1.351

Ford, B. Q., Tamir, M., Brunyé, T. T., Shirer, W. R., Mahoney, C. R., & Taylor, H. a. (2010). Keeping your eyes on the prize: anger and visual attention to threats and rewards. *Psychological Science : A Journal of the American Psychological Society / APS*, *21*, 1098–1105. http://doi.org/10.1177/0956797610375450

Ford, B. Q., Tamir, M., Gagnon, S. A., Taylor, H. A., & Brunyé, T. T. (2012). The angry spotlight: Trait anger and selective visual attention to rewards. *European Journal of Personality*, *26*, 90-98. doi:10.1002/per.1840

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General*, *130*, 681–700. http://doi.org/10.1037/0096-3445.130.4.681

Fredrickson, B. L. (1998). What Good Are Positive Emotions? *Review of General Psychology : Journal of Division 1, of the American Psychological Association*, *2*, 300–319. http://doi.org/10.1037/1089-2680.2.3.300

Fredrickson, B. L. (2000). Cultivating positive emotions to optimize health and well-being. *Prevention & Treatment*. http://doi.org/10.1037/1522-3736.3.1.31a

Friedman, R. S., & Förster, J. (2010). Implicit affective cues and attentional tuning: an integrative review. *Psychological Bulletin*, *136*, 875–893. http://doi.org/10.1037/a0020495

Gauthier, I., & Tarr, M. J. (1997). Becoming a “Greeble” expert: Exploring mechanisms for face recognition. *Vision Research*, *37*, 1673–1682. http://doi.org/10.1016/S0042-6989(96)00286-6

Hautus, M. J. (1995). Corrections for extreme proportions and their biasing effects on estimated values of d'. *Behavior Research Methods, Instruments & Computers*, *27*, 46-51. doi:10.3758/BF03203619

Hermans, D., Vansteenwegen, D., & Eelen, P. (1999). Eye Movement Registration as a Continuous Index of Attention Deployment: Data from a Group of Spider Anxious Students. *Cognition and Emotion*. http://doi.org/10.1080/026999399379249

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other race recognition deficit. *Psychological Review, 117,* 1168–1187. doi:10.1037/a0020463

Jackson, M. C., Linden, D. J., & Raymond, J. E. (2014). Angry expressions strengthen the encoding and maintenance of face identity representations in visual working memory. *Cognition and Emotion*, *28*, 278-297. doi:10.1080/02699931.2013.816655

Jacoby, L. L., Kelley, C. M., & Dywan, J. (1989). Memory attributions. In H. I. Roediger, F. M. Craik, H. I. Roediger, F. M. Craik (Eds.) , *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 391-422). Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General*, 118, 126–135.

Jefferies, L. N., Smilek, D., Eich, E., & Enns, J. T. (2008). Emotional valence and arousal interact in attentional control. *Psychological Science*, *19*, 290-295. doi:10.1111/j.1467-9280.2008.02082.x

Kircanski, K., Joormann, J., & Gotlib, I. H. (2015). Attention to emotional information in Social Anxiety Disorder with and without co-occurring depression. *Cognitive Therapy and Research*, *39*, 153-161. doi:10.1007/s10608-014-9643-7

Kuhbandner, C., Lichtenfeld, S., & Pekrun, R. (2011). Always look on the broad side of life: Happiness increases the breadth of sensory memory. *Emotion, 11*, 958–964. http://doi.org/10.1037/a0024075

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal Of Experimental Psychology: Human Perception and Performance*, *21*, 451-468. doi:10.1037/0096-1523.21.3.451

Lavie, N., Hirst, A., de Fockert, J. W., & Viding, E. (2004). Load Theory of Selective Attention and Cognitive Control. *Journal of Experimental Psychology: General*, *133*, 339-354. doi:10.1037/0096-3445.133.3.339

Mason, S. E. (1986). Age and gender as factors in facial recognition and identification. *Experimental Aging Research*, *12*, 151–154. http://doi.org/10.1080/03610738608259453

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*. http://doi.org/10.1016/j.tics.2005.08.005

Maurer, D., Le Grand, R., & Mondloch, C. J. (2002). The many faces of configural processing. *Trends in Cognitive Sciences*. http://doi.org/10.1016/S1364-6613(02)01903-4

Neumann, M. F., End, A., Luttmann, S., Schweinberger, S. R., & Wiese, H. (2015). The own-age bias in face memory is unrelated to differences in attention—Evidence from event-related potentials. *Cognitive, Affective & Behavioral Neuroscience*, *15*, 180-194. doi:10.3758/s13415-014-0306-7

Noh, S. R., & Isaacowitz, D. M. (2011). Age differences in the emotional modulation of attention: Effects of own-age versus other-age emotional face cues on the alerting and orienting networks. *Journal of Cognitive Psychology*, *23*, 709-722. doi:10.1080/20445911.2011.570255

Ohman & Mineka, S. (2001). Fears, phobias, and preparedness: toward an evolved module of fear and fear learning. *Psychological Review*, *108*, 483–522. http://doi.org/10.1037/0033-295X.108.3.483

Ohman, A., Lundqvist, D., & Esteves, F. (2001). *The face in the crowd revisited: a threat advantage with schematic stimuli. Journal of personality and social psychology* (Vol. 80).

Olivers, C. N. L., & Nieuwenhuis, S. (2006). The beneficial effects of additional task load, positive affect, and instruction on the attentional blink. *Journal of Experimental Psychology. Human Perception and Performance*, *32*, 364–379. http://doi.org/10.1037/0096-1523.32.2.364

Phillips, J. P., & Giancola, P. R. (2008). Experimentally induced anxiety attenuates alcohol-related aggression in men. *Experimental and Clinical Psychopharmacology*, *16*, 43–56. http://doi.org/10.1037/1064-1297.16.1.43

Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401. doi: 10.1177/014662167700100306

Roediger, H. L., Balota, D. A., & Watson, J. M. (2001). Spreading activation and the arousal of false memories. In H. L. Roediger, J. S. Nairne, I. Neath, & A. M. Surprenant (Eds.), The nature of remembering: Essays in honor of Robert G. Crowder (pp. 95–115). Washington, DC: American Psychological Association.

Rhodes, M. G., & Anastasi, J. S. (2012). The own-age bias in face recognition: a meta-analytic and theoretical review. *Psychological Bulletin*, *138*, 146–74. http://doi.org/10.1037/a0025750

Rowe, G., Hirsh, J. B., & Anderson, a K. (2007). Positive affect increases the breadth of attentional selection. *Proceedings of the National Academy of Sciences of the United States of America*, *104*, 383–388. http://doi.org/10.1073/pnas.0605198104

Singer, J. A., & Salovey, P. (1988). Mood and memory: Evaluating the network theory of affect. *Clinical Psychology Review*. http://doi.org/10.1016/0272-7358(88)90060-8

Slessor, G., Laird, G., Phillips, L. H., Bull, R., & Filippou, D. (2010). Age-related differences in gaze following: does the age of the face matter? *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *65*, 536–41. http://doi.org/10.1093/geronb/gbq038

Tamir, M., & Robinson, M. D. (2007). The happy spotlight: positive mood and selective attention to rewarding information. *Personality and Social Psychology Bulletin*, *33*, 1124–1136. http://doi.org/10.1177/0146167207301030

Tanaka, J. W., Kiefer, M., & Bukach, C. M. (2004). A holistic account of the own-race effect in face recognition: Evidence from a cross-cultural study. *Cognition*, *93*. http://doi.org/10.1016/j.cognition.2003.09.011

Van Honk, J., Tuiten, A., de Haan, E., van den Hout, M., & Stam, H. (2001). Attentional biases for angry faces: Relationships to trait anger and anxiety. *Cognition and Emotion*, *15*, 279-297. doi:10.1080/02699930042002222

Wechsler, D. (1981). The psychometric tradition: Developing the Wechsler Adult Intelligence Scale. *Contemporary Educational Psychology, 6*, 82-85. doi: 10.1016/0361-476x(81)90035-7

Whittlesea, B. W. A. (2002). False memory and the discrep- ancy–attribution hypothesis: The prototype-familiarity illu- sion. Journal of Experimental Psychology: General, 131, 96–115.

Wiese, H., Schweinberger, S. R., & Hansen, K. (2008). The age of the beholder: ERP evidence of an own-age bias in face memory. *Neuropsychologia*, *46*, 2973–85. http://doi.org/10.1016/j.neuropsychologia.2008.06.007

Wolff, N., Wiese, H., & Schweinberger, S. R. (2012). Face recognition memory across the adult life span: Event-related potential evidence from the own-age bias. *Psychology and Aging*, *27*, 1066-1081. doi:10.1037/a0029112

Wright, A. C., Hallquist, M. N., Swartz, H. A., Frank, E., & Cyranowski, J. M. (2014). Treating co-occurring depression and anxiety: Modeling the dynamics of psychopathology and psychotherapy using the time-varying effect model. *Journal of Consulting and Clinical Psychology*, *82*, 839-853. doi:10.1037/a0034430

Zachary, R. A. (1986). Shipley Institute of Living Scale: Revised Manual. Los Angeles: Western Psychological Service

APPENDICES

Appendix A

Background Questionnaire

I. Demographic Questions

1) What is your date of birth? (mm/dd/yyyy) _______/_________/____________

2) As of today's date, how old are you? _______________ years

3) What is your sex?

   [1] Male [2] Female

4) Are you of Hispanic, Spanish, or Latino origin? (e.g., Mexican, Puerto Rican)

   [1] Yes [2] No

5) Which do you feel best describes your racial background? (Multiple answers are possible!)

   [1] White and/or European American
   [2] Black and/or African American
   [3] Native American or Alaska Native
   [4] Asian
   [5] Native Hawaiian or Pacific Islander
   [6] Other (Please Specify):

6) What is the highest level of education you have completed?

   Grade School 1st 2nd 3rd 4th 5th 6th
   Junior/High School 7th 8th 9th 10th 11th 12th
   Trade, Business or Technical School 1 yr 2 yrs 3 yrs 4 yrs more than 4 yrs
   College 1 yr 2 yrs 3 yrs 4 yrs more than 4 yrs
   Graduate School 1 yr 2 yrs 3 yrs 4 yrs 5 yrs 6 yrs more than 6 yrs

7) What is the highest degree you have received?

   [1] High school diploma or equivalency (GED)
   [2] Associate Degree
   [3] Bachelor's Degree
   [4] Master's Degree
   [5] Doctorate (e.g., PhD, MD, JD, EdD, PsyD)
   [6] Other (Please Specify):

8) What is your current employment situation? (Check all that apply!)

   [1] Working full-time
   [2] Working part-time
   [3] In training / education (e.g. student)
   [4] Retired or retired on disability

[5] Unemployed or laid off
[6] Keeping house or raising children full-time
[7] Other (Please Specify):

9) What kind of work do (did) you do? (Job Title)

10) What is your current total household income for the past 12 months? (Check one!)

[1] Between $0 and $9,999
[2] Between $10,000 and $19,999
[3] Between $20,000 and $29,999
[4] Between $30,000 and $39,999
[5] Between $40,000 and $49,999
[6] Between $50,000 and $59,999
[7] Between $60,000 and $69,999
[8] Between $70,000 and $79,999
[9] Between $80,000 and $89,999
[10] Between $90,000 and $99,999
[11] $100,000 or more

11) Marital Status: Are you currently:

[1] Single, never married
[2] Married, or living in a long-term relationship
[3] Divorced, not remarried
[4] Widowed, not remarried

12) Do you have children?

[1] Yes If Yes, how many?
[2] No

13) Is English your native language?

[1] Yes
[2] No

14) Do you speak other languages fluently?

[1] Yes If Yes, please list?

____

[2] No ________________

15) Overall, how satisfied are you with your life?

extremely unsatisfied	average	extremely satisfied
O --------- O --------- O --------- O --------- O --------- O --------- O		

Appendix B

The Center-for-Epidemiological-Studies-Depression-Scale (CES-D).

Below is a list of the ways you might have felt or behaved. Please indicate how often you have felt this way during the PAST WEEK.

How often have you felt … during the past week?	*Rarely or none of the time (less than 1 day)*	*Some or a little of the time (1-2 days)*	*Occasionally or a moderate amount of time (3-4 days)*	*Most or all of the time*
1). I was bothered by things that usually don't bother me.	O	O	O	O
2). I did not feel like eating; my appetite was poor.	O	O	O	O
3). I felt that I could not shake off the blues even with help from my family or friends.	O	O	O	O
4). I felt I was just as good as other people.	O	O	O	O
5). I had trouble keeping my mind on what I was doing.	O	O	O	O
6). I felt depressed.	O	O	O	O
7). I felt that everything I did was an effort.	O	O	O	O
8). I felt hopeful about the future.	O	O	O	O
9). I thought my life had been a failure.	O	O	O	O
10). I felt fearful.	O	O	O	O
11). My sleep was restless.	O	O	O	O

The Center-for-Epidemiological-Studies-Depression-Scale (CES-D) Continued.

Below is a list of the ways you might have felt or behaved. Please indicate how often you have felt this way during the PAST WEEK.

12). I was happy.	O--------------------------O--------------------------O----------------------------O
13). I talked less than usual.	O--------------------------O--------------------------O----------------------------O
14). I felt lonely.	O--------------------------O--------------------------O----------------------------O
15). People were unfriendly.	O--------------------------O--------------------------O----------------------------O
16). I enjoyed life.	O--------------------------O--------------------------O----------------------------O

Appendix C

Shipley Vocabulary Test (Zachary, 1986)

In the test below, the first word in each line is printed in capital letters. Opposite it are four other words. Circle the *one word* which means the *same thing*, or most nearly the same thing, as the first word. If you don't know, guess. Be sure to circle the *one word* in each line that means the same thing as the first word.

1)	TALK	draw	eat	speak	sleep
2)	PERMIT	allow	sew	cut	drive
3)	PARDON	forgive	pound	divide	tell
4)	COUCH	pin	eraser	sofa	glass
5)	REMEMBER	swim	recall	number	defy
6)	TUMBLE	drink	dress	fall	think
7)	HIDEOUS	silvery	tilted	young	dreadful
8)	CORDIAL	swift	muddy	leafy	hearty
9)	EVIDENT	green	obvious	skeptical	afraid
10)	IMPOSTOR	conductor	officer	book	pretender
11)	MERIT	deserve	distrust	fight	separate
12)	FASCINATE	welcome	fix	stir	enchant
13)	INDICATE	defy	excite	signify	bicker
14)	IGNORANT	red	sharp	uninformed	precise
15)	FORTIFY	submerge	strengthen	vent	deaden
16)	RENOWN	length	head	fame	loyalty
17)	NARRATE	yield	buy	associate	tell
18)	MASSIVE	bright	large	speedy	low
19)	HILARITY	laughter	speed	grace	malic

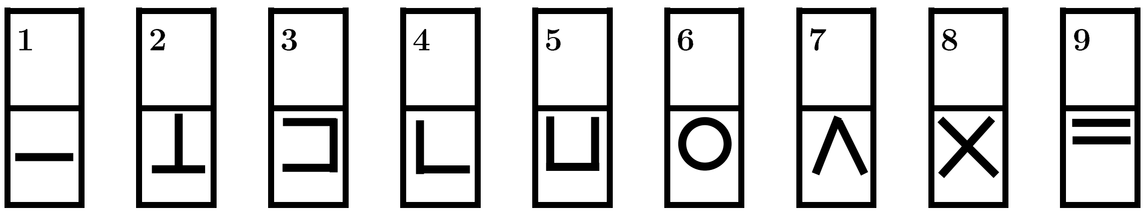
20)	SMIRCHED	stolen	pointed	remade	soiled
21)	SQUANDER	tease	belittle	cut	waste
22)	CAPTION	drum	ballast	heading	ape
23)	FACILITATE	help	turn	strip	bewilder
24)	JOCOSE	humorous	paltry	fervid	plain
25)	APPRISE	reduce	strew	inform	delight
26)	RUE	eat	lament	dominate	cure
27)	DENIZEN	senator	inhabitant	fish	atom
28)	DIVEST	dispossess	intrude	rally	pledge
29)	AMULET	charm	orphan	dingo	pond
30)	INEXORABLE	untidy	involatile	rigid	sparse
31)	SERRATED	dried	notched	armed	blunt
32)	LISSOM	moldy	loose	supple	convex
33)	MOLLIFY	mitigate	direct	pertain	abuse
34)	PLAGIARIZE	appropriate	intend	revoke	maintain
35)	ORIFICE	brush	hole	building	lute
36)	QUERULOUS	maniacal complaining	curious	devout	
37)	PARIAH	outcast	priest	lentil	locker
38)	ABET	waken	ensue	incite	placate
39)	TEMERITY	rashness	timidity	desire	kindness
40)	PRISTINE	vain	sound	first	level

Appendix D

Digit Symbol Substitution Task (Wechsler, 1981)

In this task, each number from 1 to 9 is assigned a certain symbol. In the rows below, the space under the numbers is blank. Your task is it to enter the correct symbol under each number as fast as possible. Please enter the symbols in sequence.

Please practice the entering of symbols for the following digits!



2	1	3	7	2	4	8

On the next page, you will find number sequences. Please enter the correct symbol successively under each number. It is not important to print very nice symbols; however, the symbol should be recognizable.

Please work with all speed! Try to fill in as many symbols as possible! You have 90 seconds.

Appendix E

Measure of Mood State for Baseline and after Emotion Induction Procedure

How do you feel at this moment?

	No such feeling-- *Very much*
Happy	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Depressed	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Angry	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Worried	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Excited	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Tense	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Cheerful	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Anxious	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Sad	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Pleased	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Calm	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Nervous	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Delighted	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Afraid	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*
Annoyed	*O* ----------- *O* ------------ *O* ------------ *O* ----------- *O* ----------- *O* ------------ *O*

Appendix F

Letter-Number Sequencing

Note: If a participant scores a 0 on all three trials within a set, then you may stop.

TRIALS		SCORE 0 or 1
Trial 1	L – 2 *(2 – L)*	
Trial 2	6 – P *(6 – P)*	
Trial 3	B – 5 *(5 – B)*	
Trial 1	F – 7 – L *(7 – F – L)*	
Trial 2	R – 4 – D *(4 – D – R)*	
Trial 3	H – 1 – 8 *(1 – 8 – H)*	
Trial 1	T – 9 – A – 3 *(3 – 9 – A – T)*	
Trial 2	V – 1 – J – 5 *(1 – 5 – J – V)*	
Trial 3	7 – N – 4 – L *(4 – 7 – L – N)*	
Trial 1	8 – D – 6 – G – 1 *(1 – 6 – 8 – D – G)*	
Trial 2	K – 2 – C – 7 – S *(2 – 7 – C – K – S)*	
Trial 3	5 – P – 3 – Y – 9 *(3 – 5 – 9 – P – Y)*	
Trial 1	M – 4 – E – 7 – Q – 2 *(2 – 4 – 7 – E – M – Q)*	
Trial 2	W – 8 – H – 5 – F – 3 *(3 – 5 – 8 – F – H – W)*	
Trial 3	6 – G – 9 – A – 2 – S *(2 – 6 – 9 – A – G – S)*	
Trial 1	R – 3 – B – 4 – Z – 1 – C *(1 – 3 – 4 – B – C – R – Z)*	
Trial 2	5 – T – 9 – J – 2 – X – 7 *(2 – 5 – 7 – 9 – J – T – X)*	
Trial 3	E – 1 – H – 8 – R – 4 – D *(1 – 4 – 8 – D – E – H – R)*	
Trial 1	5 – H – 9 – S – 2 – N – 6 – A *(2 – 5 – 6 – 9 – A – H – N – S)*	
Trial 2	D – 1 – R – 9 – B – 4 – K – 3 *(1 – 3 – 4 – 9 – B – D – K – R)*	
Trial 3	7 – M – 2 – T – 6 – F – 1 – Z *(1 – 2 – 6 – 7 – F – M – T – Z)*	
	TOTAL SCORE →	

Appendix G

Follow-Up Questionnaire

We have some questions about the session as a whole that may help us to improve studies in the future!

1) In today's session, were instructions clear and intelligible?

[1] Yes

[2] No If No, what was not clear to you?________________________________

2) Did you experience difficulties in answering certain questions?

[1] Yes If Yes, what was the problem?__________________________________

[2] No

3) How hard do you feel the Number Identification Task was?

Very hard	O --- O --- O --- O --- O	Very easy

4) How hard do you feel the face memory task was?

Very hard	O --- O --- O --- O --- O	Very easy

5) Have you ever seen the film clip before?

[1] Yes

[2] No

6) Do you have any comments about the film clips you watched?

____

7) Please leave your other comments and suggestions below. We are honestly interested in your opinion in order to improve future research.

____

______