School of Psychology

The Role of Social Cognition in the Own-Age Bias: An Exploration of Individuation and Categorisation Processes

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HRE2017-0812

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Abstract

The ability to recognise unfamiliar faces is biased by social cues. Faces with characteristics that indicate a shared group membership with the observer are better recognised than those that indicate a different group membership. One of these biases is the own-age bias (OAB), wherein recognition of own-age faces is superior to that of other-age faces. Potential models to explain biases like the OAB have been proposed, with perceptual-expertise and social-cognitive processes offered as potential mechanisms. Studies evaluating the role of these processes in the OAB have, however, largely only examined the role of perceptual-expertise with very few studies assessing social-cognition.

The aim of this thesis was to explore the contribution of social-cognition to the OAB. To do so, the categorisation-individuation model (CIM; Hugenberg, Young, Bernstein & Sacco, 2010, *Psychological Review*, *117*, 4) was used as a guiding framework. The CIM proposes that own-group biases like the OAB are caused by motivation, category activation, and individuation experience factors and that differences in these factors result in individuation or categorisation style encoding of faces. The OAB is said to be caused by a tendency for own-age faces to be individuated, while other-age faces are categorised, resulting in later recognition performance being better for own-age than other-age faces. The four empirical chapters of this thesis addressed the three components of the CIM and their effect on the OAB in young adult observers. Chapter 2 investigated a motivational manipulation, Chapter 3 and 4 investigated category activation manipulations, and Chapter 5 investigated an individuation experience manipulation.

In Chapter 2, a motivational manipulation was explored. Recognition performance for young and older adult faces was compared when faces were neutral or emotional in expression. Previous literature has suggested that because emotional expressions convey important social information about a person's intent they can motivate face processing to capture identity-diagnostic information useful for later recognition. The results of Chapter 2 supported this, as the OAB that was observed for neutral faces was absent for emotional faces.

In Chapter 3 and 4, category activation was explored. The CIM suggests that stronger category activation and out-group categorisation will result in more

categorical style encoding of faces and hence poorer recognition performance. In Chapter 3, recognition performance for middle aged other-age faces was explored in contexts that highlighted their similarity to the age in-group or out-group. Participants were tasked with remembering middle aged faces alongside either young adult own-age faces, or older adult faces other-age faces. When presented in a task with young adult faces, it was predicted that out-group categorisation would be stronger for middle-aged faces than when they were presented in a task with more own-age dissimilar older adult faces, resulting in poorer recognition memory performance. However, middle aged face recognition did not differ between conditions.

The findings of Chapter 3 suggest category activation does not influence the OAB, however, this is inconsistent with another study that found a category activation manipulation targeting age salience, to moderate the OAB (Bryce & Dodson, 2013, *Psychology and Aging*, *28*, 87, Exp 2). To address this, Chapter 4 attempted to replicate the finding. Young adult participants were tasked with remembering either a mix of young and older adult faces, or only young or older adult faces. Bryce and Dodson's original experiment found that while the OAB was present within the mixed age condition (young and older adult faces), it was not present between the pure age conditions (young or older adult faces). However, the three experiments of Chapter 4 consistently found an OAB in recognition memory performance for mixed and pure age conditions and could not replicate this finding.

Lastly, Chapter 5 explored an experimental manipulation of individuation experience. Current evidence suggests individuation experience may contribute to the OAB, though this has largely been concluded from studies examining the OAB in participants with pre-existing differences in other-age contact. In this chapter, young adult participants' performance on a recognition memory test was compared before and after they received individuation and categorisation training. During training, participants were instructed to individuate one set of faces, and categorise another (one set comprised older adult faces, the other child faces, counterbalanced across participants). Recognition performance for novel older adult faces improved following individuation training for older adult faces, but not following categorisation training.

Taken together the findings of this thesis support the role of social-cognition in the OAB. Using the CIM framework, evidence was found to support the role of motivation and individuation experience. Emotional expressions and individuation focussed training improved recognition memory for other-age older adult faces. The role of categorisation in the OAB was however, not supported. As such, the results of this thesis suggest that theoretical frameworks that place less emphasis on categorisation, and more on motivation may be better suited to describe the OAB than the CIM. They also suggest that the mechanisms mediating the OAB may differ from those of other own-group biases like the own-race bias where categorisation has been demonstrated to play a role. Future research can expand on this thesis to further our understanding of how the OAB may differ from other own-group biases and to explore how these findings can be applied to the development of training interventions to reduce the OAB in real-world settings.

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Attributions of Empirical Work

Chapter 2: Emotional Expressions Reduce the Own-Age Bias

	Concept/ Design	Data Acquisition	Data Analysis	Interpretation	First Draft	Revision	Final Approval
S. L. Cronin	✓	✓	✓	✓	✓	✓	✓
I acknowledge that these represent my contribution to the above research output Signed:							
B. M. Craig	✓			✓		✓	✓
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O. V. Lipp	✓			✓		✓	✓
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Chapter 3: Stable Middle Aged Face Recognition: No Moderation Of The Own-Age Bias Across Contexts

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O. V. Lipp	✓			✓		✓	✓
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Chapter 4: **An Own-Age Bias in Mixed- and Pure-List Presentations: No Evidence for the Social-Cognitive Account**

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O. V. Lipp	✓			✓		✓	✓
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Chapter 5: Individuation Training Improves Older Adult Face Recognition in Young Adults

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Contents

CHAPTER 1 - GENERAL INTRODUCTION

Faces provide a rich source of information that is essential for navigating social interactions. Among information regarding race, sex, age and emotional expression, one of the most important types of information we can extract from a face is its identity. When we view a face we extract and encode information to use in later recognition (Bruce & Young, 1986). Over time, face representations become more detailed and we are able to identify the same face in a variety of situations such as in different poses and under different lighting, as well as access sematic information that we know about the person (Bruce & Young, 1986; Johnston & Edmonds, 2009). Once we have a strong familiar representation of a person and have gained experience in recognising their face, it is rare to mistake them for someone else (e.g., Bruce et al., 1999; Clutterbuck & Johnston, 2005). In the early stages of identity learning, however, where faces are 'unfamiliar' we are error prone (e.g., Bruce et al., 1999; Clutterbuck & Johnston, 2005). This has led to debates regarding whether we have expertise in processing all faces, or only familiar faces (e.g., A. W. Young & Burton, 2018a, 2018b, 2018c; Rossion, 2018; Sunday & Gauthier, 2018).

While it is debated whether or not we are unfamiliar face experts, we do nonetheless, see interesting differences in the way we process different types of unfamiliar faces. Our ability to recognise unfamiliar faces has been shown to vary systematically with their category memberships (e.g., Herlitz & Loven, 2013; Meissner & Brigham, 2001; Scott & Fava, 2013; Wiese, Komes, & Schweinberger, 2013). For instance, we are better able to recognise faces from our own-age group, than other age groups; the own-age bias (OAB; Wiese, Komes, et al., 2013).

This thesis will examine the OAB and explore the contribution of categorisation and individuation processes to the bias. The OAB manifests as more accurate recognition of faces when they are members of the same age group as the observer compared to another age group (Wiese, Komes, et al., 2013). Models of the bias have suggested that it may be the result of perceptual-expertise processes, social-cognitive processes, or a combination of both. This thesis will explore the role of these factors in producing the OAB in light of the categorisation-individuation model which incorporates both perceptual-expertise and social-cognitive processes (Hugenberg, Young, Bernstein, & Sacco, 2010). First, however, I will give an overview of the relevant literature, discussing further face identity recognition biases, theoretical perspectives and models to explain them, the categorisation-individuation model, and an overview of what we currently know about the OAB.

Face Identity Recognition Biases

Collectively referred to as own-group biases, our recognition memory for faces from in-groups is better than for out-groups. This pattern has been observed for faces varying in race (Meissner & Brigham, 2001), age (Wiese, Komes, et al., 2013) and sex (Herlitz & Loven, 2013). Additionally, this pattern has also been noted when observers are provided with other cues to in-group/out-group membership not derived from physical face features. For instance information provided about a person's university affiliation (Hehman, Mania, & Gaertner, 2010), sexual orientation (Rule, Ambady, Adams, & Macrae, 2007) and even bogus personality type groups (Bernstein, Young, & Hugenberg, 2007) have been shown to produce own-group biases.

Exploration of these own-group biases has been varied. The bulk of research has examined the own-race bias (ORB) which manifests as better recognition of own- than other-race faces. As such, the proposed mechanisms underlying own-group biases have been developed in the context of the ORB. The contribution of a range of factors such as perceptual characteristics, expertise, social factors, motivations, and cognition have been explored (see Meissner & Brigham, 2001 for a review of these in the ORB). The most prominent models have, however, centred on perceptual-expertise and social cognition.

Perceptual Expertise Models

The perceptual-expertise models suggest that differences in memory occur because of differential experience with groups of faces. These accounts are broadly split into perceptual processing and mental representation accounts. Perceptual processing accounts suggest that increased contact and practice processing faces results in efficient encoding of identity information. Mental representation accounts instead suggest that what is encoded is stored in a way that maximises the discriminability of commonly seen types of faces.

Contact based expertise accounts. Contact accounts suggest that people tend to have greater contact with people from their in-groups than out-groups and as a result are afforded more experience in processing and recognising own-group faces (see Meissner & Brigham, 2001 for a discussion). More exposure to a particular type of face will allow an observer more practice at encoding and recognising it. Through a trial and error process, observers learn where to attend on the face for more successful encoding and later recognition of identity. With more practice, observers process and focus on less categorical information, instead encoding more invariant, individuating information. As such, the tendency for increased contact with own-group faces results in more efficient encoding of these faces than other-group faces. This in turn results in more accurate recognition of own-group than other-group faces.

Multidimensional face space. In contrast to contact based accounts, the face space model proposed by Valentine (1991) suggests that differences in recognition performance are a result of how face representations are stored. Faces are said to be encoded as representations in a multidimensional space. The numerous dimensions of the space represent all the possible physical features used to encode faces and to discriminate between them, for example face shape and eye spacing. At the centre of the space, where dimensions intersect, is the norm face which represents the average of all faces encountered and adjusts to reflect the faces a person has observed. The faces represented closer to the norm are more typical, while those represented further away are more distinctive.

Our tendency to encounter and encode more own-group faces results in a face space that is optimised to represent own-age faces. The distribution of these faces on the dimensions of the space will be such that their central tendency falls around the norm face. Other-group faces that are encountered less often will in contrast, not be well represented in the space and representations will tend to cluster together away from the norm. Given that there is always a margin of error in face encoding, the clustering of other-group face representations makes them more easily confusable with one another and results in poorer recognition of these faces compared to own-group faces.

Social-Cognitive Models

In contrast to the perceptual expertise accounts, proponents of social-cognitive accounts suggest that biases are caused by differential judgements made about faces. These judgements are often in reference to the face being processed, such as whether it belongs to an in-group or out-group member, but can also relate to the observer's current state and intentions. As a result, faces are encoded in a manner that highlights information useful for later recognising them, or not.

Cognitive disregard. This early model of face recognition proposed by Rodin (1987) suggested that attention is allocated differently to faces of different groups. Cues of disregard result in shallower processing of faces with less attention directed to information useful for later recognition. These cues signal to the observer that faces are not worth paying attention to and so they are not processed beyond the category level. In the case of own-group biases, out-group membership serves as a disregard cue which results in poorer memory for other-group faces compared to own-group faces.

Feature selection model. Building on Rodin's (1987) work, Levin (2000) proposed that rather than faces being disregarded when classified as other-group, they are instead attended to differently. The model suggests attention, and subsequent encoding, is directed to different features on own- and other-group faces which results in differences in later recognition. Levin argued that we tend to think categorically about out-group members and as such, our attention is directed to facial features that help us to categorise them, but not recognise them. In contrast we tend to think more individually about in-group members and so our attention is focussed on individuating features that are useful for later recognition.

In-group/out-group model. Sporer's (2001) model was the first social-cognitive model to incorporate some element of expertise. The in-group/out-group model proposes that in-group faces are processed in an automatic way that reflects the expertise we have for them. Encoding is deep and captures configural, identity-diagnostic information useful for later recognition. Cues to out-group membership, however, prompt a categorisation process that results in either an attentional disregard response, or encoding that is shallow, feature-based and enhances category-diagnostic information in memory not useful for later recognition.

The Categorisation-Individuation Model

In response to emerging evidence in support of both perceptual-expertise and social-cognition processes in the ORB, and the variety of proposed mechanisms in early social-cognition models, Hugenberg et al. (2010) developed a model that considers both. The categorisation-individuation model (CIM) argues that the ORB is multiply determined by motivation, categorisation, and individuation experience factors. The model and its components have since been argued to account for own-group biases more broadly (Hugenberg, Wilson, See, & Young, 2013) and for the current thesis, the CIM will serve as the framework to guide evaluation of social-cognition in the OAB.

Building on earlier accounts of the ORB, the CIM explains differences in face recognition through categorisation and individuation processes. Categorisation is the process of classifying exemplars into groups based on shared qualities while individuation is the processes of discriminating exemplars based on their unique qualities. The core difference in face processing that results in the ORB, is argued to be that own-race faces tend to be individuated while other-race faces tend to be categorised. The combined effects of motivation, categorisation and individuation experience determine whether faces are encoded in an individuation or categorisation style, and as such, how well they can later be recognised.

Motivation. Observer motives can direct encoding style. Situational cues may motivate perceivers to attend to category- or identity-diagnostic facial features. One such cue is face race, with motivation to attend to individuating features low when faces are other-race faces. The model also predicts that motivations may arise from both cues in the target face to be remembered, and through cues from the perceiver themselves. In support of target cue effects, Ackerman et al. (2006) observed that threat cues in other-race faces could improve memory. When presented with other-race African American faces to remember, angry faces were recognised better than when they were presented with neutral expressions. In another study examining perceiver cues, Hugenberg, Miller, and Claypool (2007) demonstrated that the ORB could be alleviated purely by instructing people to encode the faces differently, though other studies have suggested that manipulating motivation in this way may not always successfully moderate the ORB (e.g. Crookes & Rhodes, 2017; Wan, Crookes, Reynolds, Irons & McKone, 2015). The manipulation involved informing participants of the ORB and giving them instructions on how they could better remember other-race faces. In the subsequent memory test, participants who received instructions were less biased than a control group.

Category activation. The categorisation component of the CIM model refers to strength with which a category is activated when viewing a face. When presented with a face, categories are spontaneously activated and attention is directed to category-diagnostic facial features. Other-race faces have been observed to elicit stronger category activations and as such, greater attention is drawn to category features in these faces compared to own-race faces (Levin, 2000). This also explains why in addition to own-group biases in recognition memory, contrasting other-group effects in categorisation have been observed where categorisation is faster for other-group than own-group faces (e.g., Levin, 2000; Zhao & Bentin, 2011).

In addition to race being a categorisation cue, the model predicts that when other categorisation modulating cues are present, attention can be shifted for both own- and other-race faces. In support of the model, research has found that when enhancing categorisation for own-race faces, memory performance can be reduced. S. G. Young, Hugenberg, Bernstein, and Sacco (2009) found that when increasing race salience for own-race faces by presenting them in a memory task following exposure to other-race faces, recognition memory performance was poorer than when no other faces were presented before the task.

Individuation experience. The individuation experience factor of the CIM refers to perceptual-expertise gained in individuating faces. Processing efficiencies gained through experience discriminating faces of a particular social category assists in later encoding of faces for recognition. Typical greater exposure to own-race faces affords more opportunity to practice identity recognition and helps attune perceivers to identity-diagnostic features in own-race faces. In contrast, typically fewer opportunities to gain individuation experience with other-race faces results in less efficient and more effortful encoding of individuating features.

While the role of perceptual-expertise in the ORB has been proposed previously, the CIM emphasises the co-acting role of motivation in both producing expertise and activating it. Mere exposure to large quantities of exemplars from a category is insufficient for individuation expertise; processing with motivation to remember identities is necessary. In addition to this, the CIM predicts that the potential benefit of expertise is only realised under motivated conditions.

We can see evidence of the role of individuation experience in a study by Tanaka and Pierce (2009) where participants were provided with individuation or categorisation training for two other-race face groups. They were instructed to learn face-label pairs in which faces of one race were paired with unique labels (individuation condition) and the other a shared label (categorisation condition). Assessments of memory pre- and post-training demonstrated that individuation experience where participants intentionally practiced individuation, improved memory above and beyond the categorisation condition.

The Own-Age Bias

So far we have discussed own-group biases generally, and models which have been derived from research on the ORB. This thesis, however, is concerned specifically with the own-age bias (OAB). The OAB is characterised by better recognition of faces from one's own-age group compared to faces from other-age groups (Wiese, Komes, et al., 2013). Originally noted in young adult participants' superior recognition of young than older adult faces (Bartlett & Leslie, 1986; Fulton & Bartlett, 1991; Mason, 1986), research has found the OAB to be applicable for multiple observer and target age groups. For instance, the OAB has been observed in young adult observers with older adult (Anastasi & Rhodes, 2006; He, Ebner, & Johnson, 2011; Wiese, 2012; Wiese, Schweinberger, & Hansen, 2008; Wolff, Wiese, & Schweinberger, 2012; Wright & Stroud, 2002) and child other-age faces (Harrison & Hole, 2009; Hills & Lewis, 2011; Wright & Stroud, 2002), in older adult observers with young adult other-age faces (Anastasi & Rhodes, 2005; Perfect & Harris, 2003; Wiese, Komes, & Schweinberger, 2012), and in child observers with young adult other-age faces (Anastasi & Rhodes, 2005; Crookes & McKone, 2009; Hills, 2012; Hills & Lewis, 2011). While the particular age range of each age group varies slightly across studies and face databases, children can be considered under 13 years old, young adults between 18 and 35 years old, middle aged adults between 40 and 55 years old, and older adults as over 65 years old (Rhodes & Anastasi, 2012).

A meta-analysis conducted by Rhodes and Anastasi (2012) estimated the size of the OAB. They examined OAB effect sizes in the literature, focussing on sensitivity (an observer's ability to discriminate between faces they have and have not seen before), hits (correct identifications of faces seen before), false alarms (incorrect identifications of faces not seen before), and response bias (the tendency for observers to indicate they have or have not seen a face before). Overall, they found an OAB in all but response bias. The findings were however, moderated by participant age. Sensitivity was 1.99 times more likely to be higher for own-age than other-age faces and effect sizes were significantly larger than zero for child, young adult, and older adult observers, though not middle aged observers for which there was little data. Hits were 1.55 times more likely for own-age than other-age faces, though effect sizes only differed from zero for young and older adult observers. False alarms were 1.55 times more likely for other-age than own-age faces, and the effect size was different from zero only for young adult observers. The analysis did not demonstrate a response bias OAB, however, on closer inspection there were reliable effects for young adult and older adults though they ran in opposite directions. For young adults, responding was more conservative for own-age than other-age faces, while for older adults responding was more liberal for own-age than other-age faces.

Much of the research regarding the OAB has thus far been to examine its existence in different populations. Little research, in contrast, has aimed to identify the mechanism/s that produce it. The majority of research to date has explored the role of contact and perceptual-expertise. Exploration of perceptual-expertise mechanisms has found some support. Correlations between reported contact with other-age people and memory performance have been observed such that greater contact with the other-age group is related to a smaller OAB (Ebner & Johnson, 2009; He et al., 2011). People who work with other-age groups such as primary school teachers and geriatric nurses and have very high levels of other-age contact have also been observed to be less biased than the general public (Harrison & Hole, 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Wiese, Wolff, Steffens, & Schweinberger, 2013). Additionally, holistic processing has been shown to be more efficient for own-age relative to other-age faces, and to vary with reported contact suggesting greater expertise with own-age faces (Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008; Macchi Cassia et al., 2009). However, research has thus far only examined pre-existing differences in contact and expertise. We therefore cannot yet infer a causal relationship between expertise and the OAB, nor rule out other explanations such as the involvement of social factors like motivation and attitudes.

Evaluation of the role of social-cognition in the OAB has been minimal. Social-cognitive models developed for the ORB suggest that the processes producing the ORB are also applicable to differences in recognition among own- and other-age faces, yet at the commencement of this thesis project, the role of these processes in producing the OAB had not been adequately tested. A study by Anastasi and Rhodes (Exp 2, 2006) explored face recognition in young and older adult participants using an old/new recognition task. During the encoding phase, participants categorised faces of young, middle aged, and older adults as either young, middle aged, or older adult. After a 48 hour period, they returned to the laboratory and completed a memory test. When the authors compared recognition performance between own-age and other-age faces no OAB was observed. But, when perceived age of faces was considered and hit rates were examined, accuracy was higher for faces categorised as the participant's own-age group than as either of the other-age groups. This suggests that perceived in-group or out-group membership of a face may confer a memory advantage or disadvantage distinct from actual group membership. However, given the paradigm, the effect was only able to be observed in hit rates, and further research in needed.

Another study by Bryce and Dodson (2013) instead aimed to manipulate categorisation processes. They had participants complete memory tests with face sets comprising only one age group (own- or other-age), or two. They expected category salience, and hence categorisation, to be low in the single age group condition and high in the two age group condition. The results showed that the OAB emerged only when category salience was high, such that recognition performance was higher for own-age faces when category salience was high compared to low. Bryce and Dodson suggested that the categorisation cue resulted in increased perceived relevance of own-age faces and that the data support a social-cognitive account of the OAB. The result, however, has yet to be replicated.

Thesis Overview

The current evidence for the mechanisms underlying the OAB is incomplete and there is a lack of evaluation of the role of social-cognition. The aim of this thesis was to investigate the contribution of social-cognitive processes, in light of the CIM, to the OAB. Four studies addressed; motivation (Chapter 2), categorisation (Chapter 3 & 4), and individuation experience (Chapter 5).

In Chapter 2, a series of experiments examined the role of emotional expression on the OAB. According to the CIM and literature examining the influence of emotional expression on the ORB, emotional expressions may act as motivational cues to inform encoding styles. This is such that emotional faces convey functionally relevant information to whether a face's identity is important to remember. Different emotional expressions convey different meaning and hence relevance, so I examined the effects of happy, angry and sad expressions on the recognition of young and older adult faces in young adults. I found that memory was better for other-age faces when emotional compared to neutral and that the OAB was absent when faces were emotional. As such, the data support the role of motivation in the OAB.

In Chapter 3 and Chapter 4, the effects of category activation were explored. These chapters examined manipulations that altered which category was activated (Chapter 3) and whether a category was activated (Chapter 4). The CIM suggests that stronger category activation leads to more categorisation style encoding. In Chapter 3 context was manipulated by altering stimulus set composition to influence perceived category membership of middle aged faces. Middle aged other-age faces were positioned as similar or dissimilar to young adult own-age faces by presenting them in a task with either young or older adult faces. However, I did not find any support for categorisation moderating the OAB; middle aged face recognition was stable across contexts.

Chapter 4 examined a salience manipulation that sought to supress or activate age categorisation and hence the OAB by varying the age of face remembered between-groups (low salience) or within-participants (high salience). Consistent with Chapter 3, this manipulation of category activation also did not change the OAB. Together Chapter 3 and Chapter 4 do not support the role of social-cognition or the CIM model.

Lastly, Chapter 5 examined the role of individuation experience in a pre/post training study. This component of the CIM suggests that individuation experience contributes to the OAB. The current literature has not examined an experimental manipulation of individuation experience to evaluate its causal role. To do so, this study examined young adult participant's memory for young, older adult, and child faces before and after a training intervention. During training, participants gained individuation experience with faces from one of the other-age groups. The results showed that, at least for older adult faces, this individuation training intervention improved other-age face recognition and that the effects were independent of changes in implicit attitudes.

Together, the results of this thesis provide some support for social-cognition in the OAB and the CIM. Evidence was found for motivation and individuation experience in the OAB. However, no evidence was found for the effect of category activation. Results and implications of the empirical work, and future directions are discussed in the broader context of this thesis in Chapter 6.

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CHAPTER 2 - EMOTIONAL EXPRESSIONS REDUCE THE OWN-AGE BIAS[1]

Abstract

We are better at recognising faces of our own age group compared to faces of other age groups. It has been suggested that this own-age bias (OAB) might occur because of perceptual-expertise and/or social-cognitive mechanisms. While there is evidence to suggest effects of perceptual-expertise, little research has explored the role of social-cognitive factors. To do so, we looked at how the presence of an emotional expression on the face changes the magnitude of the OAB. Across three experiments young adult participants were presented with young and older adult faces to remember. Neutral faces were first presented alone (Experiment 1) to validate the proposed paradigm, and then presented along with angry (Experiment 2), and sad or happy faces (Experiment 3). The presence of an emotional expression improved the recognition of older adult faces, reducing the OAB which was evident for neutral faces. These results support the involvement of social-cognitive factors in the OAB, suggesting that a perceptual-expertise account cannot fully explain this face recognition bias.

Faces contain a host of socially useful information that we are adept at extracting and recognising. After even brief exposures to a person's face we have the capacity to later recognise them. However, despite this skill, systematic variation in recognition performance still arises. A number of face recognition biases have been discovered which suggest that the socially relevant information communicated by faces might impact on our capacity to recognise them (Herlitz & Loven, 2013; Meissner & Brigham, 2001; Scott & Fava, 2013; Wiese, Komes, & Schweinberger, 2013). The own-age bias (OAB) is one such phenomenon.

The OAB is the finding that we are better at recognising faces of our own age group relative to faces of other age groups (Wiese et al., 2013). While most studies have demonstrated an OAB for young adult observers (e.g. Anastasi & Rhodes, 2006; Harrison & Hole, 2009; He, Ebner, & Johnson, 2011; Wallis, Lipp & Vanman, 2012), it has also been shown in older adults (e.g. Anastasi & Rhodes, 2005; Perfect & Harris, 2003; Wiese, Komes, & Schweinberger, 2012) and in children (e.g. Anastasi & Rhodes, 2005; Crookes & McKone, 2009; Hills, 2012; Hills & Lewis, 2011), albeit to a weaker extent. There has been much discussion regarding the mechanisms that lead to face recognition biases with accounts drawing on a range of potential drivers including perceptual characteristics, expertise, social factors, motivations, cognitions, stereotypes and more (see Wiese et al., 2013 for a review). These accounts for the OAB have been derived from research on the more extensively investigated own-race bias (ORB). The ORB refers to the observation that own-race faces are recognised better than other-race faces (Meissner & Brigham, 2001). Here, two prominent accounts from the ORB literature will be discussed in reference to the OAB: the perceptual-expertise account and the social-cognitive account.

Perceptual-expertise accounts of the OAB hold that the bias occurs because of our tendency to have greater experience with, and exposure to, in-group than out-group members (Wiese et al., 2013). In the case of age, our social structures tend to result in us spending more time with people of our own age; whether that is at school, at work, or in social situations with our similarly aged friends. As such, the faces that we see the most, and have to recognise most often, are own-age faces. We should therefore, become familiar with the perceptual components of these faces and through practice, become effective at encoding the information that is most useful for differentiating them. On the other hand, we are exposed to other-age faces less frequently and should have less opportunity to build up the expertise needed to be able to effectively encode and recognise them.

The majority of work investigating the underlying mechanism of the OAB has been focussed on the perceptual-expertise account. In this research, it is suggested that increased contact with an age group will increase recognition performance for faces of that age. This has been demonstrated largely in studies showing a correlation between more own-age than other-age contact and a larger OAB (Ebner & Johnson, 2009; He et al., 2011). The evidence is strengthened by studies showing that the OAB is attenuated or eliminated in groups with high other-age contact such as geriatric nurses, trainee teachers and maternity ward nurses (Wiese, Wolff, Steffens & Schweinberger, 2013; Harrison & Hole, 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009). However, there is a lack of experimental studies that manipulate real-life contact. Until such evidence is gathered it is difficult to discern how much of the result is due to differences in contact, and how much may be attributable to other factors, such as differences in motivation or liking of other-age groups, that may correlate with increased contact and reduced recognition bias.

An alternate group of accounts of the OAB that has received less attention but may also explain some of the effects noted above are the social-cognitive accounts. While often proposed as potential mechanisms for the OAB, they have not been well investigated. Again, as with perceptual-expertise, most support for the influence of social-cognitive factors on face recognition is found in the context of the ORB (Meissner & Brigham, 2001). Broadly, the social-cognitive accounts suggest that our social evaluations of, and cognitions about the faces we see can bias us to perceive and encode them in different ways, and affect how well we can later recognise them. For instance, in-group and out-group evaluations might result in us paying more attention to the individual person, or to the group that person belongs to. In such a case, we should expect to be better at encoding in-group faces as more attention is paid to in-group faces' individuating characteristics, but worse at encoding out-group faces as less attention is paid to them and processing is more focused on group membership information which does not facilitate later recognition (Levin, 2000).

One avenue for investigating the influence of social-cognitive factors in the ORB literature has been to present faces with emotional expressions. Emotions convey socially relevant information that may combine with group membership to indicate whether it is important to remember a face, or may bias impressions of the person whose face is being looked at. In the ORB literature, research has largely looked at the effects of angry expressions. Ackerman et al. (2006) proposed a functional account whereby we only allocate cognitive resources to remembering faces that appear relevant and important to remember. As anger communicates threat, this should highlight the importance of devoting resources to better encode and remember otherwise poorly remembered out-group faces which will in turn, reduce the ORB. Ackerman et al. (2006) found support for this functional account, with a reduction in the ORB observed for angry Caucasian and African American faces in a sample of Caucasian observers.

This anger effect has since been replicated by others, although emphasis has been placed on different social-cognitive mechanisms. Krumhuber and Manstead (2011) replicated the anger findings and extended them to fearful expressions. They suggested that negative intergroup relations are primed when negative expressions are viewed and that the resulting intergroup antagonism facilitates the processing of out-group faces with negative expressions, reducing the recognition bias. Young and Hugenberg (2012) also replicated the ORB reduction for angry faces and demonstrated that a reduction can be produced through other means, such as instruction. When participants with higher levels of other-race contact were instructed to individuate faces their ORB was reduced. They argued that their findings support the categorisation-individuation model proposed by Hugenberg, Young, Bernstein, and Sacco (2010) which proposes that both perceptual-expertise and social-cognitive factors contribute to recognition biases. The model suggests that expertise improves recognition but that social-cognitive factors can improve it even further by motivating us to maximise our individuation of faces.

The reliability of the finding that anger facilitates other-race face recognition has, however, been the subject of recent scrutiny. Gwinn, Barden, and Judd (2015) reviewed past studies and pointed to a lack of variability in stimulus sets used. This was such that studies which found that anger reduced the ORB used the same stimulus materials. Additionally, these face sets were not complete in their counterbalancing of poser and expression, i.e. some posers always displayed the same expression. When Gwinn et al. (2015) had the stimuli rated for distinctiveness they also discovered that the angry African American faces were rated as more distinctive than the neutral African American faces, and that this difference was much larger than the difference between Caucasian angry and neutral faces. Testing the effect again, Gwinn et al. (2015) developed a new and improved set of stimuli and recruited both Caucasian and African American participants. Their findings deviated from Ackerman et al.'s (2006), with anger having different effects depending on participant race. In both cases, recognition performance was reduced for angry African American faces. This in turn reduced the ORB for African American participants, but exacerbated it for Caucasians. Gwinn et al. (2015) proposed a stereotype congruency account to explain their findings suggesting that expressions that are consistent with a racial group stereotype result in more categorical face processing while those that are inconsistent result in more individualistic face processing. As a result, stereotype consistent faces should be recognised worse than stereotype inconsistent faces.

There seems to be evidence that emotional expressions influence the magnitude of the ORB in some way. Whether emotional expressions also have the capacity to change the size of the OAB is unclear. Ebner and Johnson (2009) looked at differences in emotion categorisation and identity recognition in young and older adult participants. Their stimuli were neutral, angry, and happy young and older adult faces. The emotion categorisation task also served as an incidental learning phase which was later followed by a surprise recognition task. However, no OAB was produced in the small sample (32 young and 24 older adults) and results were reported collapsed across participant age. This study aims to revisit the question of whether or not emotion can moderate the OAB.

The aim of this series of experiments is to determine whether emotional expressions change the magnitude of the OAB in young adult participants. We chose to use a young adult sample for this study given that they produce the most robust, reliable OAB (Rhodes & Anastasi, 2012). Participants were presented with young and older adult male faces and asked to remember them for a later recognition test. Faces were presented with either neutral or emotional expressions and the size of the OAB was compared and results evaluated in light of the predictions made by the functional and stereotype congruency accounts. While there are other social-cognitive accounts applicable to this research question, these two were chosen for explicit evaluation given their competing predictions for the first emotion of interest, anger.

In Experiment 1 only neutral faces were presented in order to confirm that the proposed paradigm produced the OAB. In Experiment 2, neutral and angry faces were presented as this emotion has been suggested to be most relevant by the ORB literature. We predict that angry expressions will reduce the OAB. Both the functional account and stereotype congruency account make this prediction, although for different reasons. In the case of the functional account, we expect anger to increase older adult recognition by increasing the importance of remembering these now potentially threatening out-group faces. In the case of the stereotype congruency account, we expect anger to worsen young adult recognition due to the stereotypic associations between young men and anger (Montepare & Dobish, 2013). In Experiment 3 neutral and sad or happy faces were presented to further extend the findings and evaluate differences between the functional and stereotype congruency accounts. For these emotions, the predictions regarding how the OAB magnitude will change vary between accounts. Based on the functional account we expect happy expressions to reduce the OAB by providing an affiliative signal, making out-group older adult faces more socially relevant and improving their recognition. For sad expressions we do not expect the OAB to change as sad expressions do not communicate any immediate risk or reward for the observer that would warrant more resources being devoted to the encoding of out-group faces. For a stereotype congruency account we expect sad expressions to exacerbate the OAB as sadness is stereotypically congruent with older adults and should reduce performance for these faces (Montepare & Dobish, 2013). For happy expressions we predict no moderation. While there is some suggestion that young adults may expect high arousal positive emotions to decline over the lifespan, there is no strong stereotypic association with either age as both age groups are still considered to experience the emotion often (Montepare & Dobish, 2013).

Experiment 1

The series of experiments presented in this paper were completed online using Amazon Mechanical Turk which varies from previous OAB studies which generally have participants complete studies in the laboratory. Conducting studies online means that some control over experimental setting, device used, and participant supervision is lost. As such, the paradigm developed for this study was first tested with neutral faces to ensure that the OAB was observed in this setting. The paradigm is largely comparable to those of other face recognition studies with the main point of difference being the addition of a reaction time task to the encoding phase where participants are initially exposed to the faces they will later be asked to recognise. While this phase of the experiment takes just over a minute to complete, there is the potential that an online participant might not attend to the faces on screen like a supervised lab participant would. As such, during encoding, participants were instructed to respond when each face disappeared from the screen.

Method

Participants. Prior to recruitment a power analysis was conducted using G*Power to determine sample size (Faul, Erdfelder, Lang, & Buchner, 2007). We estimated the sample size required to find the Face Emotion × Face Age interaction which would allow us to fully explore the effect of emotional expression on the OAB. Given the lack of relevant literature in the OAB field, we took a conservative estimate of the comparable Face Emotion × Face Race interaction (η_p^2=.11; Gwinn et al., 2015). The analysis indicated 68 participants would be required to achieve an 80% chance of detecting an effect of this size. We oversampled to account for potential data loss, recruiting 96 participants. While this first experiment does not include emotional expressions, we chose to sample a similar number of participants to confirm the OAB would be observed with the sample size to be used in subsequent experiments. Ethics approval was obtained from the Curtin University human research ethics committee.

The analysed sample consisted of 64 Amazon Mechanical Turk workers who participated in exchange for USD2.80 (38 males, 26 females, M_{age}=25.91, SD_{age}=2.94, range=19-30). Thirty-one additional participants were removed prior to analyses as they did not meet demographic requirements (Caucasian adults 31 years old or younger; 30 participants) or they experienced program sequencing errors during the experiment (1 participant). The race and age demographic requirements chosen reflect the characteristics of faces in the young adult stimulus set and serve to highlight in-group membership of these faces.

Stimuli. The face stimuli used in this experiment were sourced from the FACES database (Ebner, Riediger, & Lindenberger, 2010). Images of 24 young adult and 24 older adult male posers were chosen displaying neutral expressions. Young adult faces were aged between 19 and 31 years old and older adult faces were aged between 69 and 80 years old. Stimuli were limited to male faces so as to not introduce another social cue (sex) that might indicate in-group or out-group membership. The database provides two versions of each expression, an A and a B version, both of which were used in the experiment. Images were colour and 335 × 419 pixels in size.

Procedure. Participants completed a recognition memory task that consisted of an encoding phase, filler task, and a recognition test. Learning was intentional in the encoding phase, with participants instructed to pay attention to the faces as they would be asked to remember them later. This intentional learning paradigm is consistent with many other OAB studies (Rhodes & Anastasi, 2012) and also had the added benefit of increasing the likelihood that the online sample would attend to the faces throughout encoding. To further facilitate this, participants were also tasked with pressing the spacebar as quickly as they could when faces disappeared from the screen. Text reminders to "remember the face" and "press spacebar after it disappears" were presented at the bottom of the screen during each trial. Twenty-four images (12 young, 12 older adult) were displayed one at a time for 1000 or 1500ms with a 1500ms inter-stimulus interval (half of the faces were presented for 1000 and half for 1500ms, with an equal number of young and older adult faces presented for each duration; presentation duration for each poser was counterbalanced between-participants). Presentation time was varied so that the reaction time task was less predictable.

After the encoding phase participants completed eight word puzzles. This filler task took approximately five minutes and was designed to remove the encoded faces from working memory so that long-term face recognition could be assessed in the test phase. The puzzles consisted of a grid of nine letters with the centre letter bolded. Participants were asked to generate the longest word they could using the nine letters that included the centre letter in the 30 seconds allotted for each puzzle.

Next, participants completed the recognition test where all of the faces from posers they had seen in encoding were presented again, intermixed with an unseen set of 24 faces (12 young, 12 older adult). All of the faces presented were new images (i.e. if participants saw version A in the encoding phase they would see version B in the test phase). Images were presented one at a time for up to 10s and participants were instructed to respond ‘seen’ or ‘not seen’ to each face using the ‘e’ and ‘i’ keys, with response mapping counterbalanced across participants. If they responded ‘seen’ they were prompted with an additional remember/know/guess question asking if they “remember the face, think they know it, or are making a guess”. This question probed if participants’ memory came from recollection (remember), familiarity (know) or guessing processes (Gardiner & Richardson-Klavehn, 2000). To conclude, demographics were collected (age, sex and race) along with a measure of group contact that measured how often participants had contact with young and older adults. The measure included two questions for each age group: “*How often do you have personal (i.e., face-to-face) contact with young adults/older adults (approx. between 18 to 30 years of age/approx. 65 years of age and older)?*” and “*How often do you have other types of contact (e.g., phone, e-mail, letter) with young adults/older adults (approx. between 18 to 30 years of age/approx. 65 years of age and older)?*”. Responses were taken on a 1-8 scale from *“daily”* to *“less than once a year”* (Ebner & Johnson, 2009).

Data Analysis. To assess differences in recognition memory the signal detection measure of sensitivity (*d’*) was compared between conditions. To calculate *d’* the difference between the z-transformed hit rates and false alarm rates is taken, with positive scores indicating more accurate recognition. To deal with extreme hit and false alarm rates where z-transformations yielded infinite scores (0 and 1), the loglinear adjustment approach was taken (Hautus, 1995). In this approach, before hit and false alarm rates are calculated, 0.5 is added to each of the raw hit and false alarm counts, and 1 is added to the number of signal trials and the number of noise trials.

Results for the remember/know/guess data and the group contact data are not reported in the main analyses for this study. However, further detail on these can be found in the Supplementary Analyses (Appendix A) where differences among the proportion of remember, know and guess responses for young and older adult faces, and differences in group contact and correlations between group contact and OAB magnitude were examined. Group contact did not correlate with OAB magnitude and there were no significant results of interest that would change the interpretations of our main analyses.

Results

A paired samples t-test of the *d'* scores confirmed that the paradigm produces an OAB (see Figure 1). Participants had higher sensitivity to young than older adult faces ($t(63) = 4.14$, $p<.001$, $d_{av}=0.64$).

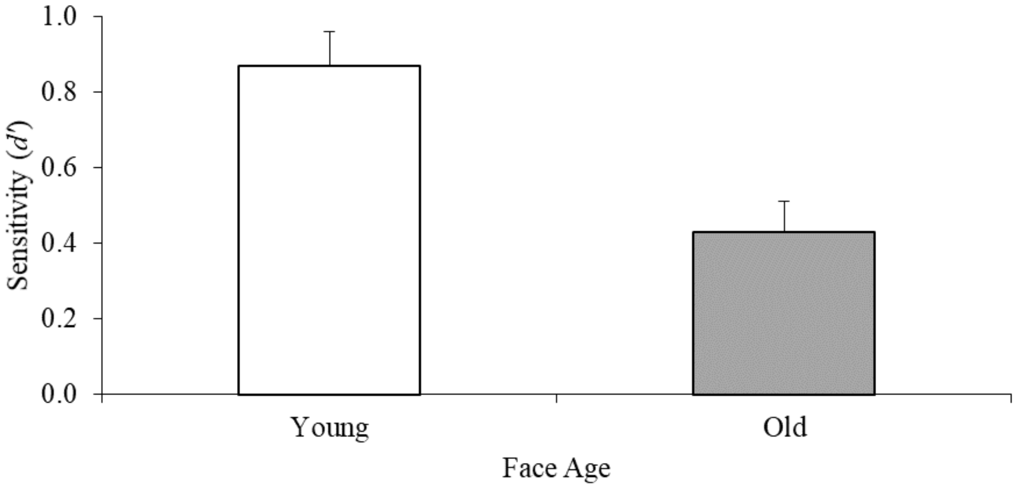

Figure 1. Sensitivity to young and older adult faces as measured by *d'* in Experiment 1. Error bars are 1 standard error of the mean.

Experiment 2

Experiment 1 confirmed that the paradigm produces the OAB. The second experiment looked at how angry expressions affect the OAB. If, like in the case of the ORB, social-cognitive factors play a role in the OAB, we expect to see this bias reduce when expressions are angry. For results to be consistent with the functional account, we expect the reduction to occur because of improved older adult recognition. For results to be consistent with the stereotype congruency account, we expect the reduction to occur because of worsened young adult recognition.

Method

Participants. The analysed sample consisted of 72 Amazon Mechanical Turk workers (47 males, 24 females, 1 other; M_{age}=26.00, SD_{age}=0.51, range=19-30) who received USD2.80 for participating. An additional 28 participants were excluded prior to analyses as they did not meet demographic requirements (23 participants) or they experienced program sequencing errors during the experiment (5 participants).

Stimuli, procedure, and data analysis. The experiment proceeded as per Experiment 1 with the following differences. The stimulus set was expanded to include the angry expressions for each of the posers from Experiment 1. The same overall number of stimuli were used in the experiment, but half of the young and older adult faces were presented with angry expressions (counterbalanced between-participants). A single item measure of social identification was added that asked participants to respond to the statements *"I identify with older adults (65years+)"* and *"I identify with young adults (18-30years)"* on a 1-7 Likert scale from *"strongly disagree"* to *"strongly agree"* (Postmes, Haslam, & Jans, 2013; Reysen, Katzarska-Miller, Nesbit, & Pierce, 2013).

Detail on additional analyses conducted on the remember/know/guess, group contact, and the group identification data can be found in the Supplementary Analyses (Appendix A). Group contact did not correlate with OAB magnitude, and there were no significant results that would change the interpretations of our main analyses.

Results

The *d'* scores were subjected to a 2 (face age: young, old) × 2 (face emotion: neutral, angry) repeated measures ANOVA (see Figure 2, left panel). Results show that there was an overall OAB (F(1, 71) = 10.15, p=.002, η_p^2 = .125). Neither the main effect of face emotion (F(1, 71) = 0.32, p=.574, η_p^2 = .004) nor the Face Age × Face Emotion interaction reached significance (F(1, 71) = 2.14, p=.148, η_p^2 = .027). In order to directly test our predictions, planned analyses were conducted. We investigated the presence of the OAB for neutral and angry faces separately. The analyses confirmed that while the OAB was present for neutral faces (F(1, 71) = 10.16, p=.002, η_p^2 = .125), it was not present when the faces were angry (F(1, 71) = 0.79, p=.378, η_p^2 = .011).

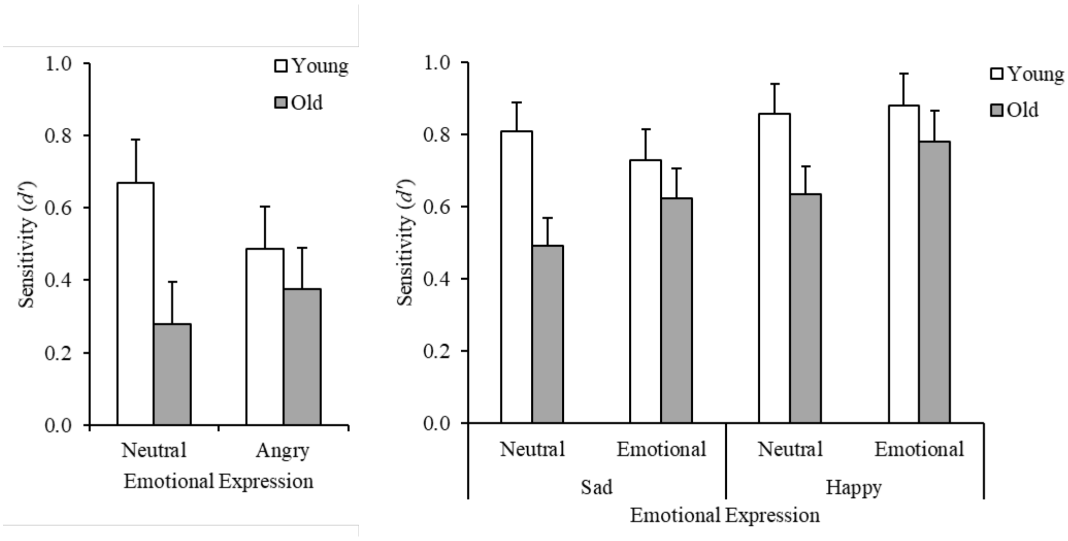

Figure 2. Sensitivity to faces varying in age and emotional expression as measured by *d'* in Experiment 2 (left) and Experiment 3 (right). Error bars are 1 standard error of the mean.

Discussion

These results provide some support for the notion that anger can attenuate the OAB and that social-cognitive factors influence it. However, the lack of a significant Face Age × Face Emotion interaction means that we are unable to evaluate the predictions of the specific social-cognitive accounts. Figure 2 (left panel) seems to suggest that the largest change in recognition is a reduction for young adult faces when angry compared to neutral. However, without statistical support, the OAB reduction could be driven by improved older adult recognition or a combination of both. Experiment 3 used sad and happy expressions to further explore the functional and stereotype congruency accounts.

Experiment 3

To further explore the effect of emotional expression on the OAB and which social-cognitive account may explain this moderation, sad and happy expressions were examined. As in Experiment 2, the size of the OAB was examined when faces were neutral, and when emotional (sad or happy). For the results to be consistent with a functional account, we expect that sad expressions will not moderate the OAB, but happy expressions will reduce it through improved recognition of older adults. This is because sad expressions do not signal risk or potential reward that might make a face more relevant, but happy expressions are signals of affiliation which may give them functional relevance. For the results to be consistent with a stereotype congruency account, we expect that sad expressions will exacerbate the OAB by reduced recognition of older adult faces and that happy expressions will not influence the OAB. Sadness is stereotypic of older adults (Montepare & Dobish, 2013) which should prompt more categorisation of these faces, reducing recognition performance, while happiness is not strongly stereotypic of either age group.

Method

Participants. Participants were 180 Amazon Mechanical Turk workers (100 male, 79 female, 1 other; M_{age}=26.22, SD_{age}=7.43, range=18-31; n_{sad}=94, n_{happy}=86) who received USD2.80 for participating. An additional 14 participants were excluded prior to analyses as they did not meet demographic requirements (11 participants) or they experienced program sequencing errors during the experiment (3 participants).

Stimuli, procedure, and data analysis. Experiment 3 proceeded as per Experiment 2 with the following exceptions. Participants were randomly allocated to the sad or happy condition in which they either saw neutral and sad faces, or neutral and happy faces. Participants saw the same total number of faces, and the same number of neutral and emotional faces as in Experiment 2, only in the current experiment the angry faces were replaced with either sad or happy faces (manipulated between-participants).

Detail on additional analyses conducted on the remember/know/guess, group contact, and the group identification data can be found in the Supplementary Analyses (Appendix A). Group contact did not correlate with OAB magnitude. Some significant differences emerged in the remember/know/guess data but these were inconsistent with findings of Experiment 1 and 2 and did not shed any additional light on our findings. There were no other significant findings that would change the interpretation of our main analyses.

Results

The *d'* scores were subjected to a 2 (face age: young, old) × 2 (face emotion: neutral, emotional) × 2 (emotion type: sad, happy) mixed ANOVA, with face age and face emotion varied within-participants, and emotion type varied between-participants (see Figure 2, right panel). As in Experiment 2, there was an overall OAB ($F(1, 178) = 16.02$, $p<.001$, $\eta_p^2 = .083$), and a trend towards a significant Face

Age × Face Emotion interaction emerged ($F(1, 178) = 2.98$, $p=.086$, $\eta_p^2 = .016$). There was no main effect of face emotion ($F(1, 178) = 1.39$, $p=.240$, $\eta_p^2 = .008$), or emotion type ($F(1, 178) = 2.27$, $p=.134$, $\eta_p^2 = .013$). The remaining effects were non-significant ($F<1$).

To directly test our predictions, planned comparisons were conducted to determine if the OAB was present when the faces were neutral, sad, or happy. The OAB was present for neutral faces in both groups – when these faces were presented alongside sad faces ($F(1, 178) = 13.75$, $p<.001$, $\eta_p^2 = .072$), and alongside happy faces ($F(1, 178) = 6.24$, $p=.013$, $\eta_p^2 = .034$). The OAB was not present, when faces were sad ($F(1, 178) = 1.11$, $p=.293$, $\eta_p^2 = .006$) or when they were happy ($F(1, 178) = 0.92$, $p=.340$, $\eta_p^2 = .005$).

Discussion

As in Experiment 2, these findings demonstrate an influence of emotional expressions on the OAB and suggest that social-cognitive mechanisms are involved in the bias. Additionally, they suggest emotional expressions in general, regardless of the specific expression, are able to reduce and eliminate the OAB. However, the results cannot provide support for any specific social-cognitive mechanism involved. Without a significant Face Age × Face Emotion interaction, we cannot explore whether reduction of the OAB occurred due to poorer recognition of young faces or improved recognition of older adult faces, or some combination of both. In turn this means we cannot evaluate if these results fit a functional or stereotype congruency account, or if neither is suitable to account for the data.

The results from Experiments 2 and 3 show similar trends (see Figure 2). To confirm this impression, we conducted a more powerful combined analysis to explore how emotional expression moderates the bias, and which social-cognitive mechanism may be driving the attenuation of the OAB.

Combined Analysis

A combined analysis of Experiments 2 and 3 was conducted, such that Experiment 2 was incorporated into the Experiment 3 design, with anger as the third level of the factor emotion type.

Results

The *d'* scores were subjected to a 2 (face age: young, old) × 2 (face emotion: neutral, emotional) × 3 (emotion type: sad, happy, angry) mixed ANOVA, with face age and face emotion varied within-participants, and emotion type varied between-participants. Overall, the OAB emerged ($F(1, 249) = 26.51, p<.001, \eta_p^2 = .096$). The Face Age × Face Emotion interaction also reached significance ($F(1, 249) = 5.35, p=.021, \eta_p^2 = .021$). Follow-up comparisons demonstrated that the OAB was present for neutral faces ($F(1, 249) = 30.00, p<.001, \eta_p^2 = .108$), but not for emotional faces ($F(1, 249) = 2.77, p=.097, \eta_p^2 = .011$). The difference was driven by increased sensitivity for older adult emotional faces, relative to neutral faces ($F(1, 249) = 4.36, p=.038, \eta_p^2 = .017$), with no differences in sensitivity seen between young neutral and emotional faces ($F(1, 249) = 1.83, p=.178, \eta_p^2 = .007$). There was no main effect of face emotion ($F(1, 249) = 0.34, p=.563, \eta_p^2 = .001$). There was a main effect of emotion type ($F(2, 249) = 5.64, p=.004, \eta_p^2 = .043$). Pairwise comparisons conducted with independent samples t-tests revealed that sensitivity was overall lower for participants in the angry, compared to the happy ($t(156) = 3.34, p=.001, d_s = 0.53$) and sad emotion type groups ($t(164) = 2.14, p=.033, d_s = 0.34$). However, sensitivity did not differ significantly between the happy and sad emotion type groups ($t(178) = 1.32, p=.186, d_s = 0.20$). All other effects were non-significant ($F<1$).

General Discussion

The aim of this study was to determine if emotional expression moderates the OAB and the results suggest that it does. The OAB was evident for neutral young and older adult faces, but was eliminated when expressions were angry (Experiment 2), sad or happy (Experiment 3). A combined analysis indicated that this bias reduction was attributable to improved recognition of older adult faces when emotional. These findings are consistent with the ORB literature in which emotion has also been demonstrated to moderate the bias (Ackerman et al., 2006; Krumhuber & Manstead, 2011; Young & Hugenberg, 2012), and suggests that the OAB is also in part driven by social-cognitive processes. However, the effect of emotion on the OAB appears to be quite small and neither the functional account nor the social-congruency account can fully explain the pattern of results.

We predicted that given the functional account, angry and happy faces would improve older adult face recognition, while sad faces would not change it (Ackerman et al., 2006). Both angry and happy faces convey information that makes them more relevant to the observer; anger communicates potential threat and danger, while happiness conveys affiliative intent and opportunity for social connection. This should have prompted better encoding and recognition of these emotional faces, especially the poorly remembered older adult faces, and reduced the OAB. These predictions are supported by the data. Our findings for sad faces however, are not consistent with this account. There is no personal risk or reward evoked by sad expressions making these faces less relevant and less important to remember. The presence of sadness was not predicted to moderate the OAB, however sadness also attenuated the OAB in a manner consistent with the other expressions.

Based on the stereotype congruency account we predicted stereotype congruency to impede recognition, with reductions in sensitivity for angry young and sad older adult faces, and no changes seen for happy faces (Gwinn et al., 2015). Anger is more stereotypical of young adults (Montepare & Dobish, 2013) and the congruence of the angry-young face pairing was predicted to facilitate categorical processing of these faces, worsening recognition of young adult faces and reducing the OAB. A reduction in recognition was also predicted for sad older adult faces given the stereotypical associations of sad older adults (Montepare & Dobish, 2013), having the effect of increasing the magnitude of the OAB. Again, our findings only partially align with these predictions. Anger was found to reduce the OAB, but it could not be determined if that was due to reduced recognition of young angry faces. However, neither of the predictions for sad nor happy expressions were supported with both emotions producing OAB reductions. It is possible that our participants did not subscribe to the stereotypes reported in the literature and that we have based our interpretation of the results on. Future research should include measures of stereotype beliefs to further clarify findings.

Looking to other accounts proposed in the literature, Krumhuber and Manstead's (2011) intergroup antagonism account also cannot reconcile these findings. In this account, negative expressions are predicted to improve the recognition of negatively evaluated out-group faces. Our data do show improvements in older adult face recognition when emotional, however the emotional expressions that improved recognition encompass both negative and positive expressions, the latter of which is inconsistent with this account.

Hugenberg et al.'s (2010) categorisation-individuation model may be able to explain our findings. This model incorporates perceptual-expertise and social-cognitive factors, suggesting that the ORB is produced by both. Through contact and experience we improve our individuation of particular groups of faces. However, the full potential of experience is not realised unless we are motivated to individuate as well. In our case, emotional expressions may motivate people to individuate faces more. Emotional expressions communicate important social information about the experiences and current state of the person displaying them. Compared to faces with neutral expressions, emotional expressions may increase our perception of a person as an individual rather than a group member and change our focus from processing categorical to individuating information. In the current study emotional expressions improved recognition for older adult faces but not for young faces. This may be because participants are already sufficiently motivated to individuate own-age faces and as such, the presence of an emotional expression only confers an additional advantage to other-age faces.

Alternatively, emotional expressions may engage more attention and thus improve encoding of face identity. In addition to the OAB in face recognition, age related biases have also been shown in the allocation of attention to faces. People look longer at own-age relative to other-age faces (He et al., 2011) and are more distracted by own-age faces when they are task irrelevant (Ebner & Johnson, 2010). Time spent looking at own-age compared to other age faces has also been shown to predict the magnitude of the OAB (He et al., 2011). Emotional expressions likewise attract attention, with more attention given to emotional relative to neutral facial expressions (Yiend, 2010). It may be that the presence of emotional expressions on other-age older adult faces engaged attention more, and that this enhanced engagement of attention improved face encoding. The same improvement in face recognition may be absent for young adult faces as attention is already sufficiently engaged by own-age faces regardless of emotional expression.

It is possible that stimulus-level perceptual factors also contributed to our results. Emotional expressions change the nature of the face, scrunching and stretching features, and introducing colour changes. These sorts of changes could make faces more distinctive. In the case of young adult faces and face matching performance, this has been observed for happy expressions (Mileva & Burton, 2018).

Matching performance was found to be better when faces were happy compared to neutral, and this was determined to be a result of idiosyncratic information present in the smile. If emotional expressions increase the distinctiveness of older adult faces more than they do for young faces, this could explain the recognition improvement for older adult emotional faces. However, in this case we would still expect to see at least some improvement for young adult recognition as performance for these faces is not yet at ceiling (*d'* scores were on average less than 1.0, while near perfect performance of 99% hits and 1% false alarms would give a *d'* of 4.65), but we do not. To control for stimulus effects future research should investigate different own- and other-age groups. This would allow the influence of stimulus qualities, like distinctiveness, to be separated from the effects of own- and other-age group membership. If the effects are driven by age group membership, the improvements noted for emotional other-age faces in the present study should hold regardless of how old the own-age and other-age faces are.

Overall, our study confirmed that the OAB is moderated by emotional expressions and suggests that it cannot be entirely explained by perceptual-expertise factors, but is likely the result of a combination of perceptual-expertise and social-cognitive factors. The current research is silent as to what these social-cognitive factors are, but suggests that they are uniform across emotional expressions. This finding is inconsistent with social-cognitive accounts implicated in the ORB that predict improvements and/or decrements that differ across expressions, due to their functionality as social signals or their stereotypicality. This may suggest that there are differences in the underlying mechanisms of the ORB and OAB. It also highlights the utility of including more than one expression in research that addresses their effect on psychological processes.

For an aging population the current results are good news as they suggest that there are ways that young adults can mitigate the effects of the OAB on their recognition of older adults. Rather than just increasing the amount of contact young adults have with older adults, making those interactions more emotionally expressive might also help to improve memory. In order to fully explore and understand the specific social-cognitive factors that help produce this outcome, future research should expand on the current experiments by examining more varied emotions as well as whether the findings generalise to other (age) in-groups and out-groups.

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CHAPTER 3 - STABLE MIDDLE AGED FACE RECOGNITION: NO MODERATION OF THE OWN-AGE BIAS ACROSS CONTEXTS

Abstract

It has been proposed that the own-age bias (OAB) is caused by perceptual-expertise and/or social cognitive mechanisms. Investigations into the role of social-cognition have, however, yielded mixed results. One reason for this may be the tendency for research to focus on the OAB between young and older adult faces in young adult observers, where other-age individuation experience is low. Evidence from the other-race bias field suggests social-cognitive manipulations may only be successful when observers have sufficient other-group individuation experience to draw on. To explore this, we examined biases involving middle aged other-age faces and the influence of a context manipulation. Across four experiments young adult participants were presented with middle aged faces alongside young adult or older adult faces to remember. We predicted that in contexts where middle aged faces were positioned as other-age faces (alongside young adult faces) recognition performance would be worse than when they were positioned as relative own-age faces (alongside older adult faces). However, the context manipulations did not moderate middle age face recognition. This suggests that past findings that context does not change other-age face recognition also holds for other-age faces for which observers have higher individuation experience. These findings are consistent with a perceptual-expertise account of the OAB but more investigation of the generality of these results is required.

The own-age bias (OAB) is the phenomenon wherein identity recognition of unfamiliar faces is better for own-age than other-age faces (see Wiese, Komes, & Schweinberger, 2013 for a review). It has been observed in age groups across the lifespan with the strongest bias observed in young adults where other-age faces are of older adults (Rhodes & Anastasi, 2012). Theoretical perspectives have largely suggested that perceptual-expertise and/or social-cognitive mechanisms cause the effect (Wiese, Komes, et al., 2013).

Perceptual-expertise accounts suggest that people tend to have greater expertise in processing own-age than other-age faces and that this is why we observe the OAB (Wiese, Komes, et al., 2013). The social-cognitive accounts, in contrast, posit that the OAB occurs because of differential judgements made about own- and other-age faces which bias encoding to capture information useful for individuating or categorising a face (Wiese, Komes, et al., 2013). An integrative account, the categorisation-individuation model (CIM), has also been proposed, where perceptual-expertise and social-cognition are said to jointly produce own-group biases such as the OAB through motivational, category activation and individuation experience factors (Hugenberg et al., 2010).

Research examining the effects of perceptual-expertise and social-cognition on the OAB has found evidence in support of each. In support of perceptual-expertise accounts, other-age contact has been observed to negatively correlate with OAB magnitude (Ebner & Johnson, 2009; He, Ebner, & Johnson, 2011) and people with high levels of other-age contact (e.g., trainee teachers, preschool teachers, geriatric nurses, nursing home assistants) have been observed to be less biased than the general population (Harrison & Hole, 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Wiese, Wolff, Steffens, & Schweinberger, 2013; Proietti, Pisacane, & Macchi Cassia, 2013). The literature that has examined social-cognition, on the other hand is less clear. Manipulations such as the use of emotional expressions (e.g., Cronin, Craig & Lipp, 2019), instructions to individuate (e.g., Craig & Thorne, 2019), and tasks that require individuation (e.g., Proietti, Laurence, Matthews, Zhou, & Mondloch, 2018) have yielded mixed results. It appears that in some circumstances social-cognitive manipulations may moderate the OAB, however, it is unclear under what conditions these manipulations will be successful.

Research investigating the OAB has been biased towards exploring the OAB between young and older adult faces. This has particularly been the case when it comes to exploring social-cognition. However, considering the CIM, individuation experience is said to contribute to the OAB and the tendency for young adults to have quite low other-age contact with older adults might be constraining the size of social-cognitive effects. If a certain level of individuation experience is required to facilitate an influence of social cognition, then examining the OAB between young and older adults may reduce or eliminate the possible influence of social-cognitive effects.

Research from the ORB field supports the idea that individuation experience is important to consider when using social cognition manipulations. Young and Hugenberg (2012) explored the interaction between perceptual-expertise and social-cognition in their study of the ORB and found evidence of individuation experience facilitating social-cognitive manipulations. The authors manipulated motivation by instructing participants to individuate other-race faces and found that while the ORB was present in a control condition, it was eliminated in the instruction group. Importantly, they also found that in the instruction group, the size of the ORB correlated with interracial experience such that participants with higher experience with other-race people had smaller ORBs. They suggested that the motivation manipulation was facilitated by individuation experience, such that when participants had more interracial experience they were able to individuate the other-race faces and be less biased. In a subsequent experiment, however, Young and Hugenberg manipulated motivation using angry expressions and found that angry other-race faces were remembered better than their neutral counterparts, but that the ORB did not correlate with interracial experience. They concluded from this that strong prompts of social-cognition, such as emotional expressions, may overcome the ORB on their own but that weaker forms, such as instructions, interact with perceptual-expertise to moderate the ORB.

Comparing Young and Hugenberg's (2012) findings to similar studies in the OAB field we find support only for a strong manipulation of social-cognition. When examining the role of emotional expressions (angry, happy and sad expressions), Cronin et al. (2019) found that this strong prompt of social-cognition reduced the OAB between young own-age and older adult other-age faces relative to neutral expressions and that the OAB did not correlate with inter-group contact. In contrast, when Craig and Thorne (2019) employed Young and Hugenberg's instruction manipulation in a study examining the OAB between young own-age and older adult other-age faces, the weak social-cognitive manipulation did not moderate the OAB. Given that strong but not weak social-cognitive manipulations were successful in reducing the OAB it may be that young adults tend to have insufficient experience with older adults and this prevents some social-cognitive effects from being observed.

In contrast to the OAB between young and older adults, the OAB between young and middle aged adults has received limited attention. Few studies have examined middle aged participants or included middle aged faces as other-age stimuli (Anastasi & Rhodes, 2005, 2006; Fulton & Bartlett, 1991; Randall, Tabernik, Aguilera, Anastasi, & Valk, 2012; Wolff, Wiese, & Schweinberger, 2012; Wright & Stroud, 2002). The outcomes of these studies have been mixed, finding the OAB approximately half of the time. From a perceptual-expertise viewpoint this might be because young adults are likely to have more contact with middle aged adults than they do with older adults. They will tend to have more expertise in encoding individuating information from these faces and better overall recognition that sometimes prevents the OAB. From a social-cognitive perspective, young adult and middle aged faces may sometimes be perceived as belonging to one in-group and hence receive similar styles of encoding that prevents the OAB from emerging (Anastasi & Rhodes, 2006).

Both young adults' high level of contact with middle aged faces and the potential malleability of middle aged face categorisation provide an opportunity to explore the influence of social-cognition in a way that may overcome issues with past research. By exploring the OAB between young adult and middle aged faces in young adult observers, we are able to overcome the potential boundary issue that other-age contact has on recognition performance improvement. Young adult participants will have more inter-age experience that can facilitate social-cognitive manipulations. Additionally, the flexibility of in-group/out-group categorisation for middle aged faces offers a potentially stronger social-cognitive manipulation to explore. As such, by exploring the OAB between young and middle aged faces we will have a stronger test of the social-cognitive account and the CIM.

The aim of this series of experiments was to explore the role of social-cognition in the OAB and to explore if contextual manipulations of perceived in-group similarity change recognition performance for middle aged faces. To do so, Experiments 1-2 explored recognition performance for middle aged faces in contexts where these faces were presented alongside own-age faces of young adults (middle aged faces as the other-age faces), or alongside more dissimilar other-age faces of older adults (middle aged faces as the relative own-age faces). In Experiment 1a and 1b, participants were asked to remember middle-aged faces along with either young adult (Experiment 1a) or older adult (Experiment 1b) faces. In Experiment 2, we replicated Experiment 1a and 1b in a single design and added a third condition examining recognition for young and older adult faces. Finally Experiment 3 examined the effect of context under different encoding conditions wherein out-group categorisation saliency was emphasised.

We predicted that if social-cognitive processes contribute to the OAB, recognition performance for middle aged faces would differ depending on whether they were the relative own-age group or relative other-age group. When middle aged faces were the relative own-age faces we expected them to be recognised better than when they were the relative other-age faces. When out-group saliency was enhanced in Experiment 3, we expected to see poorer recognition of middle aged faces, compared to performance in the other experiments. In all experimental conditions we predicted that the relative own-age faces would be recognised more accurately than the relative other-age faces, demonstrating a relative OAB. However, if the OAB is driven by perceptual-expertise mechanisms only, we still expected this relative OAB (as we expected reported contact to increase with in-group similarity) but no changes in recognition performance of middle aged faces across conditions.

Experiment 1

Method

Experiment 1 consisted of two experiments reported here as Experiment 1a and Experiment 1b. They were conducted consecutively rather than concurrently and as such they are reported as separate experiments rather than separate conditions. The procedure for Experiment 1a and 1b was identical with the exception that

Experiment 1a included only middle-aged and young adult face stimuli, while Experiment 1b included only middle-aged and older adult face stimuli.

Participants. Participants were recruited from Amazon Mechanical Turk and compensated USD2.90 for their time. Demographic inclusion criteria were to be aged between 18 and 31 and Caucasian, and served to highlight in-group membership with the young adult face stimuli. Ethical approval was obtained from an Australian University.

Experiment 1a. Ninety participants' data were analysed (41 male, 48 female, 1 other; M_{age}=26.79, SD_{age}=2.78, range=19-30). Four other participants were excluded prior to analysis as they did not meet demographic requirements (2 participants) or experienced experimental sequencing or completion errors (2 participants).

Experiment 1b. Ninety-two participants' data were analysed (47 male, 45 female; M_{age}=26.40, SD_{age}=2.80, range=20-31). Six other participants were excluded as they did not meet demographic requirements (3 participants) or experienced experimental sequencing or completion errors (3 participants).

Stimuli. Faces were from the FACES database (Ebner, Riediger, & Lindenberger, 2010). Faces of 48 middle aged (Experiment 1a and 1b), 48 young (Experiment 1a only), and 48 older adults (Experiment 1b only) were used (age categories prescribed by the authors of the database), with two images available for each identity giving a total of 192 images of faces in each experiment. Faces were of male Caucasians displaying neutral expressions, and between the ages of 39 and 55 (middle aged), 19 and 31 (young adult), or 69 and 80 (older adults). Images were in colour and 335 × 419 pixels in size.

Procedure. An old/new recognition task conducted online was used which included an exposure phase, filler task, and recognition test. In the exposure phase participants were instructed to remember faces that were presented one at a time on screen and to press the spacebar as quickly as they could when the face disappeared from the screen. In line with previous experiments on the OAB conducted online (Cronin et al., 2019), this secondary reaction time task was designed to ensure participants were looking at the screen. Twenty-four faces were viewed (12 from each age group) in a randomized sequence for 1000 or 1500ms (an equal number of trials for each face age were presented for each duration, and duration was counterbalanced between-participants for face identity), separated by an inter-stimulus interval of 1500ms following the response. Text reminders to "remember the face" and "press spacebar after it disappears" were presented at the bottom of the screen on each trial. The identities of faces seen in exposure, and new identities seen later in test were counterbalanced between-participants. Following the exposure phase, participants completed an unrelated filler task for approximately five minutes (see Cronin et al., 2019 for details).

In the test phase, participants were presented with 48 faces and tasked with identifying which they had seen before. Half of these faces were the faces seen in exposure, and half were new (12 from each age group). All faces were new images; either because they were new identities, or because they were a second photograph of the identities that had been seen in encoding. Faces were presented one at a time for up to 10 seconds and participants responded with 'seen' or 'unseen' using the 'e' and 'i' keys (response mapping was counterbalanced between-participants). When participants made a 'seen' response, a follow-up remember/know/guess question was presented that probed memory (Gardiner & Richardson-Klavehn, 2000). The question asked if participants "remember the face, think they know it, or are making a guess". Participants were instructed to respond 'remember' if they specifically remembered seeing the face, 'know' if it felt familiar but they could not remember it specifically, and 'guess' if they were guessing.

At the conclusion of the experiment, a questionnaire was completed. Participants reported their age, sex, and race, and completed measures of age group contact and social group identification. The contact measure was sourced from Ebner and Johnson (2009) and asks "*How often do you have personal (i.e., face-to-face) contact with young adults/middle aged adults/older adult (approx. between 18 to 30 years of age/approx. between 40 to 55 years of age/approx. 65 years and older)?*" and "*How often do you have other types of contact (e.g., phone, e-mail, letter) with young adults/middle aged adults/older adults (approx. between 18 to 30 years of age/approx. between 40 to 55 years of age/approx. 65 years and older)?*" Responses are given on a 1-8 scale ("*daily*", "*2–3 times per week*", "*once per week*", "*2–3 times per month*", "*once per month*", "*2–3 times per year*", "*once per year*", "*less often*") and the responses to the two questions are averaged to give one contact score for each age group in line with previous research (Ebner & Johnson, 2009). Social group identification was measured using a single item measure of social identification where participants were asked to respond to the statements "*I identify with young adults (18-30 years)*", "*I identify with middle aged adults (40-55 years)*", and "*I identify with older adults (65+ years)*" on a 1-7 Likert scale from "*strongly disagree*" to "*strongly agree*" (Postmes, Haslam, & Jans, 2013; Reysen, Katzarska-Miller, Nesbit, & Pierce, 2013).

Data Analysis. Data were analysed with frequentist statistics and supplemented with Bayesian statistics to aid in interpretation of null effects. Bayesian statistics were conducted with JASP 0.8.5.1 using default non-informative priors (Cauchy prior scale = 0.707) and Bayes Factors were reported. Bayes Factors indicate the strength of evidence for H_1 over H_0 with increasing values above 1 providing stronger support for H_1, while decreasing values below 1 providing stronger support for H_0. We used Jeffery's (1961) conventions to guide our interpretation of Bayes Factors in which values above 3 or below 0.33 provide evidence for H_1 and H_0, respectively. A Bayes Factor of 1 provides no evidence, while values between 1-3 and 0.33-1 provide only anecdotal evidence for H_1 and H_0, respectively.

The primary outcome measure for this study is recognition performance as measured by sensitivity (*d'*). To calculate *d'* the difference between z-transformed hit and false alarm rates is taken. Hit rates represent the proportion of the time that previously seen faces were correctly identified as 'seen'. False alarm rates represent the proportion of the time that not previously seen faces were incorrectly identified as 'seen'. Positive scores indicate better recognition. Log-linear adjustments were applied to hit and false alarm calculations in line with recommendations by Snodgrass and Corwin (1988) prior to calculating *d'* wherein 0.5 was added to the raw counts of hits and of false alarms, and 1 was added to the number of trials with previously seen faces and the number of trials with new faces. Where hit and false alarm rates are reported these are the unadjusted rates.

Response bias (*C*) was calculated as an index of participants' propensity to respond 'seen' compared to 'unseen'. This is calculated by taking the negative average of the z-transformed hit and false alarm rates. Positive scores indicate a conservative bias with more inclination to respond ‘unseen’ than ‘seen’, and negative scores indicate a liberal bias with more inclination to respond ‘seen’ than ‘unseen’. Zero indicates no response bias.

Remember/know/guess scores were calculated to represent the proportion of time each response (remember/know/guess) was made in each face age condition (young, middle aged, older adult). Scores for each face age condition were compared for each response type. Across the three experiments of this study, and 24 tests, only one significant difference was found. It did not add meaningfully to our interpretation of results and so is not reported in the main analyses. The remember/know/guess analyses can be found in the supplement (Appendix B).

Results

Experiment 1a

Analysis of responses to age group contact and social group identification measures confirmed that participants had more contact ($t(88)=4.19$, $p<.001$, $d_{av}=0.55$, $BF_{10}=282.25$) with young ($M=1.80$, $SD=1.02$) than middle aged adults ($M=2.51$, $SD=1.54$) and higher identification ($t(89)=9.25$, $p<.001$, $d_{av}=1.56$, $BF_{10}=6.05\times10^{11}$) with young ($M=5.98$, $SD=1.37$) than middle aged adults ($M=3.47$, $SD=1.85$). Neither reported contact nor social group identification correlated with *d’* in either face age (all $r^2<.015$, all $p>.256$).

Analysis of the *d’* data using a paired samples t-test showed that there was no difference in performance between young and middle aged faces ($t(89)=0.61$, $p=.544$, $d_{av}=0.08$, $BF_{10}=0.14$; see Figure 1). Examination of response bias however, suggests that responses were more conservative to young than middle aged faces ($t(89)=2.98$, $p=.004$, $d_{av}=0.38$, $BF_{10}=7.25$; see Table 1). Participants made more false alarms ($t(89)=2.67$, $p=.009$, $d_{av}=0.33$, $BF_{10}=3.46$) and trended towards making more hits ($t(89)=1.78$, $p=.079$, $d_{av}=0.22$, $BF_{10}=0.50$) to middle aged faces compared to young faces.

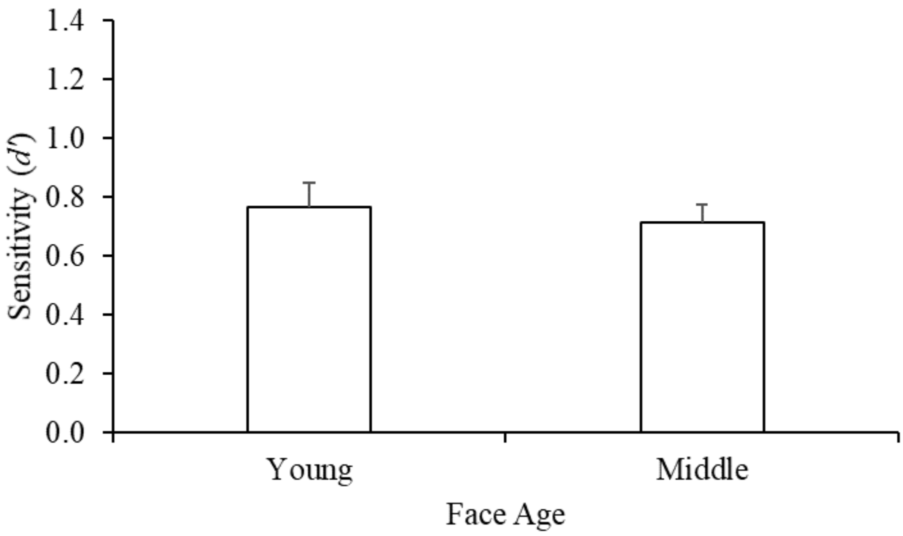

Figure 1. Sensitivity to faces varying in age as measured by *d'* in Experiment 1a. Error bars are 1 standard error of the mean.

Table 1

Mean sensitivity (d'), hit rates, false alarm rates, and response bias (C) to young and middle aged faces in Experiment 1a

	d'	Hits	False Alarms	*C*
Young	0.77(0.78)	.48(.23)	.21(.17)	0.45(0.46)
Middle	0.71(0.58)	.53(.19)	.27(.17)	0.28(0.41)

Note: Standard deviations are reported in brackets.

Experiment 1b

Participants had more contact ($t(91)=7.72$, $p<.001$, $d_{av}=0.88$, $BF_{10}=6.04\times10^8$) with middle aged ($M=2.19$, $SD=1.28$) than older adults ($M=3.50$, $SD=1.71$) and higher identification ($t(91)=7.51$, $p<.001$, $d_{av}=0.63$, $BF_{10}=2.31\times10^8$) with middle aged ($M=3.33$, $SD=1.62$) than older adults ($M=2.38$, $SD=1.39$). Neither reported contact nor social group identification correlated with *d'* in either face age (all $r^2<.013$, all $p>.281$).

Paired samples t-tests revealed that there was no difference in *d'* between middle aged and older adult faces ($t(91)=1.35$, $p=.180$, $d_{av}=0.16$, $BF_{10}=0.27$; see Figure 2). However, participants were more conservative when making responses to middle aged compared to older adult faces ($t(91)=4.28$, $p<.001$, $d_{av}=0.54$, $BF_{10}=381.03$) which resulted in fewer hits ($t(91)=3.09$, $p=.003$, $d_{av}=0.36$, $BF_{10}=9.28$) and fewer false alarms ($t(91)=4.85$, $p<.001$, $d_{av}=0.57$, $BF_{10}=3093.44$) for middle aged compared to older adult faces (see Table 2).

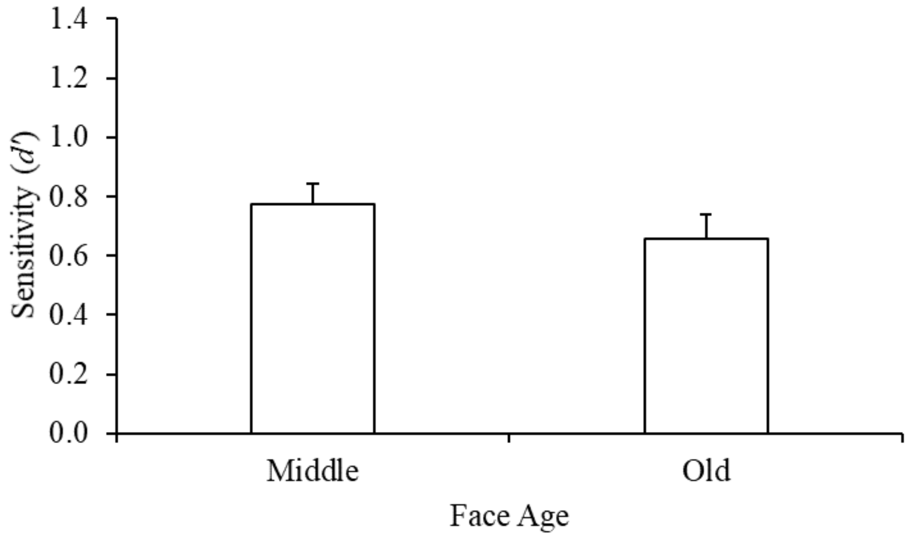

Figure 2. Sensitivity to faces varying in age as measured by *d'* in Experiment 1b. Error bars are 1 standard error of the mean.

Table 2

Mean sensitivity (d'), hit rates, false alarm rates, and response bias (C) to middle aged and older adult faces in Experiment 1b

	d'	Hits	False Alarms	*C*
Middle	0.77(0.68)	.46(.24)	.20(.17)	0.49(0.50)
Old	0.66(0.81)	.55(.23)	.30(.21)	0.22(0.49)

Note: Standard deviations are reported in brackets.

Combined Analysis

Recognition of middle aged faces was compared between Experiments 1a and 1b using an independent samples t-test which found no difference in *d'* ($t(180)=0.63$, $p=.527$, $d_s=0.09$, $BF_{10}=0.19$). An analysis comparing response bias however, found that when middle aged faces were the relative own-age group (Experiment 1b) responding was more conservative than when they were the relative other-age group

(Experiment 1a; $t(180)=3.06$, $p=.003$, $d_s=0.45$, $BF_{10}=11.61$). Additional examination of hits and false alarm rates shows that both are higher in Experiment 1a than 1b, though the Bayesian analyses only support the finding for false alarms (hits: $t(171.91)=2.11$, $p=.036$, $d_s=0.31$[2], $BF_{10}=1.25$; false alarms: $t(180)=2.94$, $p=.004$, $d_s=0.44$, $BF_{10}=8.57$).

Discussion

The *d'* results of Experiment 1a and 1b suggest that, in line with a perceptual-expertise account of the OAB, recognition performance for middle aged faces does not depend on whether the accompanying stimuli make these faces the relative own-age group or other-age group. Response bias analyses in contrast suggest that patterns of response to middle aged faces might be influenced by the age of the other faces encountered in the task. This is such that while participants can discriminate the seen and unseen faces equally well, their scores are being produced by a different pattern of responding. This might indicate that a face's similarity to the age in-group is influencing participants' decision making at test. However, as both hit and false alarm rates were higher in Experiment 1a than 1b it is unclear how responding differed. It is possible that responses differed only as a function of the particular participants we sampled. To explore these findings further, Experiment 2 aimed to replicate Experiment 1a and 1b in a single experiment and include a third condition with young and older adult faces to allow comparison between young adult faces and between older adult faces across conditions.

Experiment 2

Method

Participants. Data from 272 participants were analysed ($n_{YO}=93$, $n_{YM}=90$, $n_{MO}=89$; 113 male, 159 female; $M_{age}=26.0$, $SD_{age}=2.93$, range=18-31), with an additional 31 excluded as they did not meet demographic requirements (10 participants) or experienced experimental sequencing or completion errors (21 participants).

[2] Levene's test indicated variances were not equal ($F(1,180)=7.87$, $p=.006$) so degrees of freedom were adjusted from 180 to 171.91.

Stimuli. All stimuli included in Experiment 1a and 1b were used. This was such that there were faces of young, middle aged and older adults.

Procedure. The procedure was the same as Experiment 1a and 1b with the exception that participants were randomly allocated to one of three groups, with the groups differing in which two face ages they saw. Group YO saw young and older adult faces, Group YM saw young and middle aged faces, and Group MO saw middle aged and older adult faces. Age group contact and social group identification questions were asked of all three age groups.

Results

The groups did not differ on age or any of the contact or social identification measures (all F<2.0, all p>.138, all BF_{10}<1.00). Participants had significantly more contact and higher identification with young adults (contact: M=1.56, SD=0.96; identification: M=6.43, SD=0.96) than middle aged adults (contact: M=2.05, SD=1.14; identification: M=3.64, SD=1.72), and with middle aged than older adults (contact: M=3.72, SD=1.78; identification: M=2.41, SD=1.52; all t>7.09 all p<.001, all $BF_{10}>5.7\times10^8$). No correlations were found between reported contact and identification, and d' for each face age (all r^2<.006, all p>.340).

Within task comparisons were conducted with paired samples t-tests to assess if there was an OAB (or relative OAB) in d' for each group. Results showed that while there was a bias in Group YO (t(92)=3.43, p=.001, d_{av}=0.38, BF_{10}=25.12) and Group MO (t(88)=2.82, p=.006, d_{av}=0.34, BF_{10}=4.71), there was no bias in Group YM (t(89)=1.06, p=.292, d_{av}=0.13, BF_{10}=0.20). When analysing response bias, all groups showed more conservative responding to relative own-age faces compared to relative other-age faces (Group YO: t(92)=3.81, p<.001, d_{av}=0.41, BF_{10}=79.24; Group YM: t(89)=2.74, p=.008, d_{av}=0.32, BF_{10}=3.82; Group MO: t(88)=4.75, p<.001, d_{av}=0.45, BF_{10}=2015.96).

Independent samples t-tests comparing d' across conditions showed that for young faces (t(181)=0.01, p=.989, d_s<.001, BF_{10}=0.16, see Figure 3), middle aged faces (t(177)=1.08, p=.284, d_s=0.16, BF_{10}=0.28) and older adult faces (t(180)=0.53, p=.595, d_s=0.08, BF_{10}=0.18), recognition performance did not differ. Analysis of response bias in the same manner showed a similar pattern of results to the d' data (see Table 3). Response bias did not differ across condition for young (t(181)=1.00,

p=.319, d_s=0.15, BF_{10}=0.26), older adult ($t(180)$=0.43, p=.670, d_s=0.06, BF_{10}=0.18), or middle aged faces ($t(177)$=1.35, p=.179, d_s=0.20, BF_{10}=0.38). However, in the case of the middle aged face comparisons, the Bayesian statistics provided only anecdotal evidence for the null. Hit and false alarm rate comparisons also produced no differences across conditions (all t<0.80, all p>.427, all BF_{10}<0.22) with the exception that in the case of middle aged faces, there was a trend to more false alarms when they were the relative other-age compared to relative own-age group ($t(177)$=1.74, p=.084, d_s=0.26, BF_{10}=0.64).

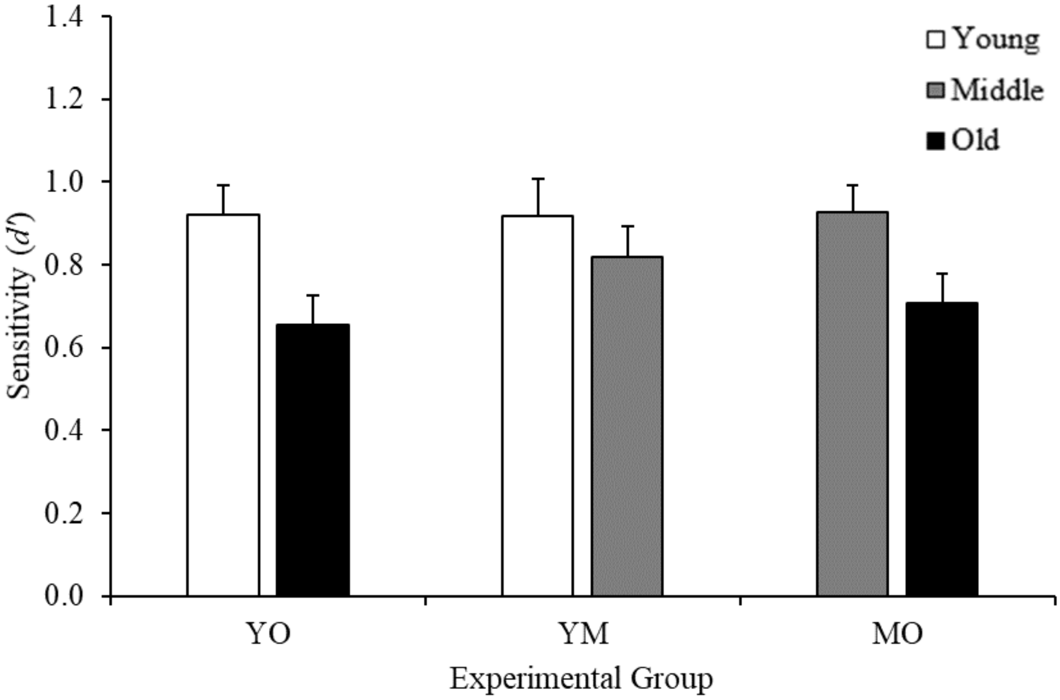

Figure 3. Sensitivity to faces varying in age as measured by *d'* in each experimental group of Experiment 2. Error bars are 1 standard error of the mean.

Table 3

Mean sensitivity (d'), hit rates, false alarm rates, and response bias (C) to young, middle aged and older adult faces in each group in Experiment 2

	d'	Hits	False Alarms	*C*
Young				
Group YO	0.92(0.69)	.53(.22)	.21(.17)	0.34(0.70)

Group YM	0.92(0.83)	.50(.24)	.19(.18)	0.45(0.80)
Middle				
Group YM	0.82(0.69)	.55(.22)	.25(.17)	0.21(0.79)
Group MO	0.93(0.63)	.52(.22)	.21(.19)	0.36(0.79)
Old				
Group YO	0.65(0.69)	.57(.23)	.34(.21)	0.03(0.80)
Group MO	0.71(0.66)	.59(.24)	.34(.23)	-0.02(0.91)

Note: Standard deviations are reported in brackets.

Discussion

The results of Experiment 2 replicate the findings of Experiments 1a and 1b that *d'* performance for middle aged faces does not change depending on the age of the accompanying stimuli. However, the finding that response bias differs was not replicated, with no difference in response bias found for middle aged faces, though the Bayesian statistics did not provide evidence beyond anecdotal in favour of the null finding. Additionally, unlike in Experiment 1b, a relative OAB was found for those in the middle-old group.

The current finding that sensitivity does not differ between conditions may reflect on perceptual-expertise mechanisms underlying the OAB, with no involvement from social-cognition. However, it is also possible that our manipulation of context was not suitable. Our manipulation aimed to induce own-age categorisation for middle aged faces by presenting them alongside older adult faces. We expected that this would produce better performance for middle aged faces compared to when they were presented alongside young adult own-age faces as they would now be the age group most similar to the participants' age in-group. However, because we did not find an OAB between young and middle aged face recognition to begin with, it is not surprising that we do not find an improvement in middle aged face recognition when they were positioned as the relative own-age faces. Categorisation of middle aged faces as own-age may happen spontaneously when they are seen alongside young adult faces and as such our comparison of middle aged faces across conditions may not be appropriate. To further explore the influence of context, Experiment 3 used an age categorisation task during encoding to see if performance for middle aged faces could be reduced by inducing stronger social categorisation for these faces in a task using young adult and middle aged faces.

Experiment 3

Method

Participants. Data from 85 participants were analysed (38 male, 47 female; M_{age}=26.00, SD_{age}=3.02, range=19-31) with 10 additional participants excluded as they did not meet demographic requirements (6 participants) or experienced experimental sequencing or completion errors (4 participants).

Stimuli. As per Experiment 1a.

Procedure. As per Experiment 1a, only that during encoding, instead of pressing the spacebar as soon as faces disappeared from the screen, participants were tasked with categorising each face as 'young' or 'old' using the 'e' and 'i' keys (response-mapping counterbalanced between-participants). They were instructed to do so as quickly and as accurately as they could. Response time was recorded and faces remained on screen for the predetermined exposure duration (1500ms or 1000ms) before the experiment proceeded to the next trial.

Data Analysis. As per Experiment 1a with the addition of reaction time and categorisation data analysis. Reaction times (RT) for young and middle aged faces were computed for each participant as the average reaction time for trials of that face age. Trials of <100ms, +/-3 *SD* from the sample mean, or trials that timed-out were removed. Cases with fewer than 9 valid trials were removed from the RT analysis. Accuracy in categorisation was also computed with correct responses being the categorisation of young stimuli as 'young' and middle aged stimuli as 'old'.

Results

Participants reported higher social identification with young (M=6.14, SD=1.18) than middle aged adults (M=3.36, SD=1.66; $t(84)=10.72$, $p<.001$, $d_{av}=2.00$, $BF_{10}=2.77\times10^{14}$). They reported equal amounts of contact, however, with young (M=1.95, SD=1.26) and middle aged adults, though Bayesian analysis provided only anecdotal evidence to support this (M=2.18, SD=1.11; $t(83)=1.53$, $p=.130$, $d_{av}=0.19$,

BF_{10}=0.37). Correlation analyses between reported contact and social identification, and *d'* for each age were non-significant (all r^2<.035, all *p*>.085).

A paired samples t-test revealed there was no difference between young and middle aged face sensitivity ($t(84)=1.04$, $p=.300$, $d_{av}=0.11$, $BF_{10}=0.20$; see Figure 4). There was however, a difference in criterion with a more conservative bias found for young than middle aged faces ($t(84)=3.29$, $p=.001$, $d_{av}=0.28$, $BF_{10}=16.19$; see Table 4). This was such that there were more false alarms to middle aged than young faces ($t(84)=2.25$, $p=.027$, $d_{av}=0.19$, $BF_{10}=1.25$). There was no difference between hit rates for young and middle aged faces ($t(84)=1.62$, $p=.110$, $d_{av}=0.16$, $BF_{10}=0.42$) but hit rates were higher for faces categorised as old than young ($t(84)=2.12$, $p=.037$, $d_{av}=0.21$, $BF_{10}=0.99$). The results from the Bayesian analyses of hit and false alarm rates, however, provided only anecdotal evidence and these results should be interpreted cautiously.

Analysis of categorisation data showed high accuracy in categorising young faces as young ($M=.87$, $SD=.15$) and middle aged faces as old ($M=.92$, $SD=.13$). Analysis of the reaction time data with a paired samples t-test revealed an other-age categorisation advantage such that middle aged faces ($M=810.80$, $SD=221.72$) were categorised faster than young adult faces, though Bayesian analyses did not support this ($M=843.71$, $SD=235.76$; $t(83)=2.03$, $p=.046$, $d_{av}=0.14$, $BF_{10}=0.84$).

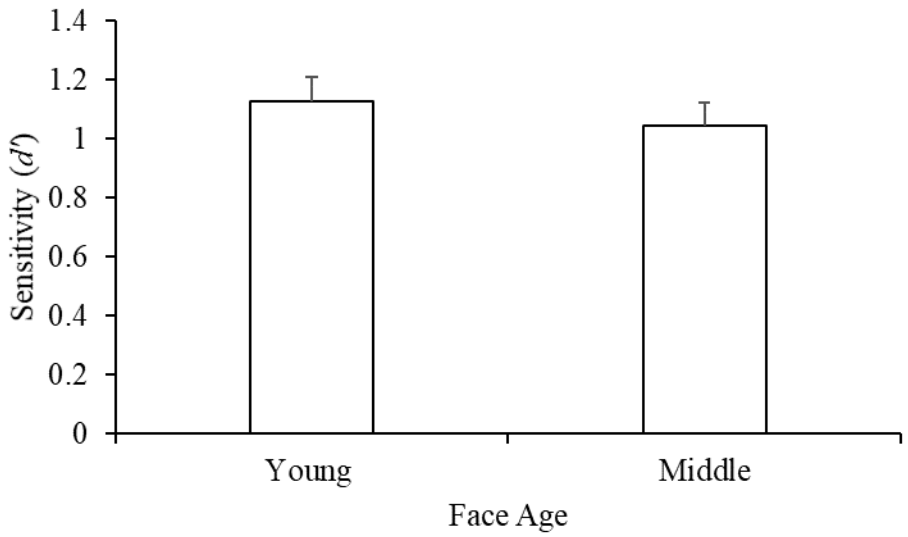

Figure 4. Sensitivity to faces varying in age as measured by *d'* in Experiment 3. Error bars are 1 standard error of the mean.

Table 4

Mean sensitivity (d'), hit rates, false alarm rates, and response bias (C) to stimulus categories in Experiment 3

	d'	Hits	Hits (category)	False Alarms	*C*
Young	1.13(0.76)	.57(.21)	.57(.22)	.19(.20)	0.37(0.51)
Middle	1.05(0.72)	.60(.20)		.22(.17)	0.24(0.42)
Old			.61(.19)		

Note: Standard deviations are reported in brackets. "Hits" compare stimuli based on actual young/middle age categories, "Hits (category)" compare stimuli based on participants' young/old categorisation responses.

General Discussion

The aim of this study was to explore the influence of social-cognition, specifically categorisation, on the OAB by manipulating context to highlight middle aged other-age faces as relatively more or less similar to the young adult own-age group. We predicted that, if social-cognitive mechanisms are involved in the production of the OAB, then positioning middle aged faces as similar to the own-age group would result in better recognition performance than when positioning them as similar to the other-age group. Across four experiments that positioned middle aged faces as other-age (Experiments 1a, 2, 3) and relative own-age faces (Experiments 1b, 2), recognition performance did not differ in the predicted ways. In all cases, performance for middle aged faces was not different when faces were presented as other-age or relative own-age faces. Additional exploration of response bias suggested that differences across conditions may emerge here. However, the findings from the combined analysis of Experiment 1a and 1b, suggesting that response bias differed across conditions, did not replicate in Experiment 2.

In addition to our main finding that middle aged recognition performance did not differ across conditions we also found no OAB between young adult and middle aged faces. Despite reported contact and social identification being significantly higher to young adult than middle aged people, recognition performance was not different for each face age group. There were, however, differences in response bias that are consistent with an OAB (Rhodes & Anastasi, 2012). This was such that, even though recognition performance did not differ, young adult faces were responded to more conservatively than middle aged faces.

These results are not consistent with a social-cognitive account of the OAB. A social-cognitive account would predict that manipulations of context targeted at changing perceptions of group membership and positioning faces as more or similar to the age in-group or out-group should change recognition performance. For the middle aged faces, when positioned as more similar to the out-group we expected encoding with less emphasis on individuating information, while when positioned as more similar to the in-group we expected encoding with more emphasis on individuating information. We did not, however, find evidence of this process as subsequent recognition performance did not differ for middle aged faces between any of our conditions. There was some evidence of different responding to middle aged faces as a function of context in response bias data. Participants responded to middle aged faces more conservatively in Experiment 1b when they were positioned as relative own-age faces, than Experiment 1a when they were positioned as other-age faces (though this did not confer an advantage to recognition accuracy). This is consistent with the finding that own-age faces are responded to more conservatively than other-age faces (Rhodes & Anastasi, 2012), however, the effect was not replicated in Experiment 2. It is possible that this finding is more reflective of differences in samples than an effect of our manipulation.

It is possible that our manipulation of middle age categorisation was unsuccessful. Social category activation is a fast and spontaneous process suggested to be influenced by contextual factors (Brewer, 1988; Macrae & Bodenhausen, 2000). Our manipulation aimed to change category activation by using different stimulus set compositions and through use of a categorisation task. Such manipulations have been successfully applied in the ORB field where racial group cues have been used to create ORBs in racially ambiguous or mixed race face sets (e.g., MacLin & Malpass, 2001; Pauker et al., 2013). It is possible that in Experiments 1-2, where only stimulus set composition was changed, our participants' category activations were not changed and that middle aged faces were processed the same way regardless of the other faces they were encountered with.

The use of a categorisation task in Experiment 3 allowed us to better infer category activation, however, this manipulation did not change recognition performance. We observed that participants were able to accurately categorise young and middle aged faces as ‘young’ and ‘old’, respectively. We also found some support for an other-age categorisation advantage. This suggests that there were differences in category activation between young and middle aged faces. Recognition performance, however, did not reflect this difference with no OAB observed. A difference did emerge when comparing hit rates on the basis of how participants categorised faces. Hit rates were higher for faces categorised as ‘old’ than for faces categorised as ‘young’. This was in contrast to our prediction that performance would be lower for the ‘old’ than ‘young’ faces. The improvement for other-age faces might instead reflect an overall less conservative response bias, however, we cannot confirm this as only hit rates can be examined this way (as participants only categorised faces in encoding, participants’ categorization of the ‘new’ faces is not known). Additionally, as participants reported similar levels of contact with both young and middle aged faces, and several Bayesian analyses for this experiment provided only anecdotal support, we are limited in how we can interpret these results. There may be an effect of categorisation, however, it is not strong enough to influence overall recognition performance.

One factor that may explain our lack of OAB in recognition performance between young and middle aged faces is that there are perceptual similarities between young and middle aged faces (not shared with older adult faces) that may have contributed to high middle aged face recognition. Our study used young adult faces 19-31 years old and middle aged faces 39-55 years old. Given that craniofacial growth is largely unchanged after 20 years of age (Albert & Wright, 2016), and signs of aging (such as marked wrinkling of the skin) are arguably not yet prominent in middle age, young adult and middle aged faces are not as distinct from each other as they are from faces from other age groups (i.e., children and older adults). As a result, any perceptual-expertise gained in processing and recognising one of these two age groups may also confer a benefit to the processing and recognition of the other.

Wolff et al. (2012) conducted a study which supports this notion of a recognition benefit from perceptual similarity. They examined the OAB between young (18-29 years old), young-middle aged (30-44 years old) and old-middle aged (45-59 years old) faces in young adult observers and found the OAB was present between young and old-middle but not young and young-middle aged faces. Wolff et al. speculated that the young faces were more perceptually similar to the young-middle aged faces than the old-middle aged faces, and that expertise for young adult faces enabled young-middle aged faces to be encoded better for later recognition. The stimuli we used in our study were aged in between Wolff et al.'s young-middle and old-middle categories and so it is possible that perceptual similarities between young and middle aged stimuli contributed to high recognition performance for middle aged faces and that these prevented the OAB, or moderation of it, from being observed.

It is also possible that our results are best explained by a purely perceptual-expertise account. We did not find an effect of our social-cognitive manipulation and our lack of OAB between young and middle aged faces could be explained parsimoniously by perceptual-expertise processes. In addition to shared perceptual-expertise between young and middle aged faces due to perceptual similarities, reported contact with middle aged people, while tending to be less than with young adults, may have been sufficient for middle aged expertise and prevented the OAB.

Overall, the results of this study suggest that manipulating the context that middle aged faces are encountered in to position them as own- or other-age does not impact the OAB. The current results are consistent with a perceptual-expertise account of the OAB and do not provide support for a social-cognitive account. Our conclusions are, however, limited by the lack of OAB between young adult and middle aged faces in our experiments. Further exploration of social-cognitive manipulations of category activation is required under conditions where an OAB is observed to understand the generality of our findings.

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CHAPTER 4 - AN OWN-AGE BIAS IN MIXED- AND PURE-LIST PRESENTATIONS: NO EVIDENCE FOR THE SOCIAL-COGNITIVE ACCOUNT[3]

Abstract

The own-age bias (OAB) is suggested to be caused by perceptual-expertise and/or social-cognitive mechanisms. Bryce and Dodson (2013, *Psychology and Aging*, *28*, 87, Exp 2) provided support for the social-cognitive account, demonstrating an OAB for participants who encountered a mixed-list of own- and other-age faces, but not for participants who encountered a pure-list of only own- or other-age faces. They proposed that own-age/other-age categorisation, and the resulting OAB, only emerge when age is made salient in the mixed-list condition. Our study aimed to replicate this finding using methods typically used to investigate the OAB to examine their robustness and contribution to our understanding of how the OAB forms. Across three experiments that removed theoretically unimportant components of the original paradigm, varied face sex, and included background scenes, the OAB emerged under both mixed-list and pure-list conditions. These results are more consistent with a perceptual-expertise than social-cognitive account of the OAB, but may suggest that manipulating age salience using mixed-list and pure-list presentations is not sufficient to alter categorisation processes.

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Our ability to recognise people we have encountered before is an important social skill. The ability to correctly recognise unfamiliar faces is, however, prone to error and subject to biases (Hancock, Bruce, & Burton, 2000; Hugenberg, Wilson, See, & Young, 2013). One such bias is the own-age bias (OAB) which is characterised by better recognition memory for own-age relative to other-age faces (Wiese, Komes, & Schweinberger, 2013). The OAB occurs to varying degrees across the lifespan, with the strongest bias seen in young adult observers when the other-age faces are older adults (see Wiese, Komes, et al., 2013 for a review, and Rhodes & Anastasi, 2012 for a meta-analysis). Attempts to explain the cause of the OAB have largely drawn on social-cognitive and perceptual-expertise mechanisms proposed in the related own-race bias field (ORB; Wiese, Komes, et al., 2013).

The social-cognitive account holds that 'own-group' biases, like the ORB and OAB, are caused by differential evaluations of, and attention to, own- versus other-group faces. When we view a face we make judgements and evaluations that are suggested to influence the way we remember that face (Rodin, 1987; Sporer, 2001). Judgments relating to in-group/out-group membership, relevance, and motivation can bias us to merely categorise the face and encode category level information, or further individuate it and encode identity level information (Hugenberg, Young, Bernstein, & Sacco, 2010; Levin, 2000). In the case of the OAB, age is a social cue that prompts evaluations about group membership. Within this account, own-age faces are processed with a focus on individuating information, making their identities easier to recognise, and other-age faces are processed with a focus on category information, making their identities more difficult to recognise (Hugenberg et al., 2010; Levin, 2000).

The perceptual-expertise account holds that own-group biases occur due to differential experience with in-group and out-group people (Wiese, Komes, et al., 2013). Generally, we have more exposure to faces from our in-group compared to out-groups, and as a result we are afforded more opportunities to practice recognising these people, and to gain expertise in in-group face processing. In the case of the OAB, this expertise is said to improve our perceptual processing of own-age faces, enhancing encoding of information useful for recognising identities, and organising our mental representations of identities such that differences are maximised and discrimination is facilitated between different own-age faces (Wiese, Komes, et al., 2013; Valentine, 1991). Other-age faces alternately, do not benefit from expertise and the information encoded from a face is less optimised for identity recognition (Wiese, Komes, et al., 2013). The mental representations of these faces will also be stored in a system optimised to represent differences between own-age faces, resulting in difficulties distinguishing between similar other-age faces (Valentine, 1991). Considering that what is own- and other-age changes as people age, perceptual-expertise accounts often suggest that as new expertise is accumulated, former expertise tends to wane or become dormant and mental representations are adjusted to best represent what is now the new own-age group (see Hills, 2012 for a discussion).

The categorisation-individuation model (CIM) proposed by Hugenberg et al. (2010) integrates components of both the perceptual-expertise and social-cognitive accounts. It suggests that categorisation, motivation, and individuation experience can all influence our encoding of faces. The two former components are social-cognitive factors and the latter is a perceptual-expertise factor. This model has been used to describe how recognition can be influenced by both perceptual-expertise and social-cognition, and how these processes interact. An example of this can be seen in Young and Hugenberg's (2012) study on the influence of individuation instructions on the ORB. They hypothesised that instructing participants to pay attention to how other-race faces differed from one another would increase their motivation to remember them and in turn they would become less biased. Results supported this prediction. However, Young and Hugenberg also measured interracial contact and found that the instruction effect was only present when participants had high levels of interracial experience. They argued that bias reduction caused by motivation to remember other-race faces (a social-cognitive factor) was only effective when there was pre-existing individuation experience (a perceptual-expertise factor) to draw on. This study and the CIM highlight that both perceptual-expertise and social-cognitive factors together can be important to face identity recognition.

Research that has specifically evaluated the mechanism underlying the OAB has yielded mixed results, with evidence emerging for both social-cognitive and perceptual expertise mechanisms. Most of the research has evaluated the perceptual-expertise account. These studies have demonstrated that groups of people who have higher levels of contact with other-age people (e.g., trainee teachers, preschool teachers, geriatric nurses) tend to have a smaller OAB compared to the average person who has low levels of contact with people from other age groups (Harrison & Hole, 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Wiese, Wolff, Steffens, & Schweinberger, 2013), and that other-age contact levels correlate with OAB such that as contact increases, the OAB decreases (Ebner & Johnson, 2009; He, Ebner, & Johnson, 2011). Additionally, more efficient holistic processing, a hallmark of expertise, can be seen for own-age relative to other-age faces and has been shown to vary with reported contact (Kuefner, Macchi Cassia, Picozzi & Bricolo, 2008; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009). However, it is unclear if contact or expertise directly cause the OAB. It is likely that contact also co-varies with other more social factors such as positive feelings towards the relevant age out-groups which may explain the results.

Research evaluating the social-cognitive account has been much more limited. Most of the research employs manipulations of individuation, often adapted from studies in the ORB field, in an attempt to improve recognition performance of other-age faces. Individuation has been manipulated using instructions, tasks and stimuli, and these studies have produced mixed support for the role of social-cognition in the OAB. In one study, participants were instructed to individuate, by paying attention to how the other-age faces differed from each other (Craig & Thorne, 2019). Although these instructions have been shown to reduce the ORB (Young & Hugenberg, 2012), they did not reduce the OAB. Another study had participants view faces in pairs and tasked them with deciding if the photos were of the same person (Proietti, Laurence, Matthews, Zhou, & Mondloch, 2018). The authors suggested that this task would necessitate individuation of the faces and found that the OAB was eliminated in a subsequent recognition test.

Studies using emotional expressions have also produced mixed findings. Emotional expressions convey more important and interesting information relative to neutral faces and are hypothesised to improve face recognition memory (Ackerman et al., 2006; D’Argembeau, Van der Linden, Comblain & Etienne, 2003). Where out-group faces may be the subject of cognitive disregard and processed at a categorical level, emotional information can act to increase their relevance to the observer. This in turn increases motivation to remember the face and prompts processing of the face at the individual level. One study examining the effect of emotional expressions on the OAB presented participants with faces posing neutral and emotional expressions (angry, sad or happy; Cronin, Craig & Lipp, 2019). Emotional expressions reduced the OAB seen for faces with neutral expressions by improving the recognition of other-age faces. However, similar experiments have found no effect of emotional expression on the OAB (Ebner & Johnson, 2009), or only marginal effects (Denkinger & Kinn, 2018).

Only one study that we are aware of employs a manipulation targeting categorisation to assess the social-cognitive account of the OAB. Bryce and Dodson (2013, Exp 2) aimed to manipulate age group salience by presenting young adult participants either with a mixed stimulus set ("mixed-list") of young and older adult faces, or a pure set ("pure-list") of only young or older adult faces. They found that the OAB emerged in the mixed-list but not the pure-list condition. This was due to worse recognition performance for young faces in the pure-list compared to the mixed-list condition. They argued that when age was made salient in the mixed-list condition, own-age/other-age categorisation was induced, causing own-age face processing to be enhanced and facilitating an OAB. In the pure-list condition, where age was not salient, no OAB was observed. Young faces were not categorised as own-age, and as such did not benefit from individuation encoding that would produce an OAB.

A similar approach has been taken in the ORB field, also finding support for the role of social-cognition albeit through a different pattern of results. Young, Hugenberg, Bernstein and Sacco (2009) explored whether increasing race category salience would prompt changes in recognition performance for white own-race faces across two studies. Using a task order manipulation, participants completed two old/new recognition tasks, one with only own-race white faces, and one with only other-race black faces. They found that recognition performance was reduced for own-race faces when this block followed after the other-race face block, while other-race face recognition performance did not differ between conditions. They replicated this change in own-race recognition, with a single white or black face preceding the own-age memory block. They argued that when other-race faces were seen first, they highlighted race as a category, drawing more attention to category-diagnostic facial features in the own-race faces that followed, reducing recognition performance for those faces. This stands in contrast to Bryce and Dodson's (2013) suggestion that category salience should improve own-group recognition through highlighting the relevance of own-group faces.

Bryce and Dodson's (2013) study is one of the few pieces of evidence published that evaluates effects of social cognition in the OAB and is also the only one that attempts to manipulate categorisation processes. In comparison to the Young et al. (2009) study that examines a similar question for the ORB, the implications for theory are different. While both studies suggest evidence for social-cognitive processes, the type of process proposed differs. Bryce and Dodson suggest that age category salience highlights in-group membership of own-age faces, providing a signal of personal relevance that motivates more individuation style processing of these faces and improves recognition performance. In contrast, Young et al. (2009) suggest that age category salience enhances categorisation of own-race faces, increasing attention to category-diagnostic features of the faces, which in turn reduces recognition performance, though not to the level of the other-race faces. The implication of Bryce and Dodson's study, beyond the role of social cognition in the OAB, is that the different aspects of social cognition may be stronger in the case of age than race, and vice versa. This is consistent with other more recent evidence examining identity recognition and perceived distinctiveness for faces varying in both age and race which suggested some independence between the OAB and ORB, and proposed that the OAB may be based on differences in motivation to deeply encode while the ORB may be based on differences in individuation (Mukudi & Hills, 2019).

There are many components of the Bryce and Dodson (2013) design that differ from typical old/new face recognition studies in the own-group recognition bias field. A basic old/new face recognition paradigm will typically include one encoding phase where participants view faces one at a time. This is followed by a delay period often including an unrelated filler task. Finally, participants complete a recognition test where previously viewed and new faces are presented one at a time for participants to indicate whether they were seen before or not (e.g. Ackerman et al., 2006, Anastasi & Rhodes, 2005; Hills and Lewis, 2011; Young, Bernstein & Hugenberg, 2010). In Bryce and Dodson's study, young adult participants (age range unspecified) completed three encoding-test sessions with 5 min filler tasks separating the sessions rather than the encoding and test phases. In each encoding phase 24 faces were viewed one at a time for 5s on a variety of background scenes. Participants were asked to remember the face-background pairs. Two additional filler faces that were not later tested were added to the beginning and end of this encoding phase. Immediately afterward, a recognition test was conducted where 24 studied faces were viewed, and an additional 8 new faces were presented in a randomised order, one at a time. Participants indicated if they had seen the face before and rated their confidence in this judgement on a six-point scale. If they reported seeing the face, they were also asked to identify the background it was presented on. Participants either saw a pure-list of young faces or old faces, or a mixed-list of both young and old faces throughout the experiment. Faces were of male and female Caucasians with neutral expressions and background stimuli were a hospital room, basketball court and plain white. Backgrounds were chosen to be age-stereotypical (young-basketball, old-hospital) and hypothesised to differentially influence source memory for young and older adult faces (though they did not). Some of these components were included to test related questions (e.g., background scenes were included to test source memory) and others likely to solve methodological issues (e.g., multiple testing blocks to give sufficient trial numbers to test source memory questions while not overloading memory). Given these idiosyncrasies and complexities in design, a replication using a more typical old/new recognition paradigm would provide further evidence to support the robustness of Bryce and Dodson's results beyond the specifics of their design, and support their generalisability and implications for our understanding of the mechanism underlying the OAB.

The aim of the current series of experiments was to replicate Bryce and Dodson's (2013) finding that the OAB is present under mixed-list but not pure-list conditions, and to examine the robustness of the finding in an alternate paradigm where theoretically unimportant components are removed. Theoretically unimportant components are components that do not affect the conditions of encoding where the theories of the OAB suggest the OAB is produced. In three experiments, young adult participants were presented with one set of faces to remember followed by a filler task and then a recognition test. Participants viewed a mixed-list of faces (young and older adults), or a pure-list of faces (young or older adults). Relative recognition performance between young and older adult faces was examined. Experiment 1 tested the effect using only male Caucasian faces, Experiment 2 explored the influence of face sex by including male and female faces, and Experiment 3 explored the influence of stereotypical backgrounds. Based on Bryce and Dodson's finding we expect to find an OAB in the mixed- but not the pure-list condition. This would support the notion of social-cognitive processes in the OAB whereby the OAB emerges only when age categorisation is prompted by viewing faces from more than one age category. Alternately, if a perceptual-expertise mechanism underlies the OAB, we expect to see similar OABs in both list conditions.

Experiment 1

Method

Participants. Given the modified ANOVA analysis (see Data Analysis below) used in the Bryce and Dodson (2013, Exp 2) study, a power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was conducted using an effect size estimate from a previous study investigating the OAB (paired samples t-test: d_{av} = 0.64, Cronin et al., 2018). This suggested that 32 participants would be required to have an 80% chance of finding the OAB in a mixed-list design. Considering this, along with Bryce and Dodson's (2013, Exp 2) sample of 24 participants per list-type, counterbalancing needs, and potential participant attrition, we aimed to recruit 64 participants per list-type.

One-hundred and sixty eight participants' data were analysed (94 male, 73 female, 1 undisclosed; M_{age}=26.33, SD_{age}=3.07, range=18-31). Demographic requirements for this experiment were that participants be aged between 18 and 31 years old and Caucasian. This was so that participants' age and race matched the characteristics of the 'young' stimuli used in the experiments. Participants were sourced from Amazon Mechanical Turk and compensated USD2.80 for their time. There were 56 participants in each list-type group (mixed, pure-young, and pure-old). Additional participants were removed prior to analyses because they did not fit age and race demographic requirements (10 participants), completed the experimental sequence incorrectly (4 participants), or needed to be removed so that group numbers were equal and the required analysis method could be conducted (15 participants - 11 from the pure-young condition, 4 from the pure-old condition; see Data Analysis for further detail). Ethics approval was obtained from an Australian university.

Stimuli. Ninety-six images of Caucasian male young and older adult faces with neutral expressions were used in this experiment. Half were sourced from the CAL/PAL database (Minear & Park, 2004; the database used in the Bryce & Dodson, 2013 study) and half from the FACES database (Ebner, Riediger, & Lindenberger, 2010). Young adult posers were between the ages of 18 and 31 years, and older adult posers were 69 years and older. A total of 48 young adult and 48 older adult posers were used. Images were in colour and 335 × 419 pixels in size. To maintain consistency across stimulus sets, backgrounds were removed with faces cropped around the face and hair outline.

Procedure. A previously used intentional learning old/new recognition paradigm was employed (Cronin et al., 2019). Participants were randomly assigned to one of three stimulus list-types; mixed, pure-young or pure-old. In the pure conditions, participants only saw faces of one age group throughout the experiment (young or old, respectively). In the mixed condition age was varied within participants with half of the faces viewed at each stage of the experiment young, and half old.

Participants first viewed 24 faces one at a time in an exposure phase, and were instructed to "pay attention to the faces as you will be asked to remember them later". Those in the mixed-list condition saw 12 young and 12 older adult faces. Those in the pure-young condition saw 24 young faces, and those in the pure-old condition saw 24 older adult faces. In line with previous experiments investigating the OAB with online participants (Cronin et al., 2019), a secondary response time (RT) task was included to ensure participants were paying attention to the faces. To facilitate this, half of the faces were presented for 1000ms and half for 1500ms, with an inter-stimulus interval of 1500ms. The presentation duration of each poser was counterbalanced between-participants and in the mixed-list condition an equal number of young and older adult faces were presented for each duration. Participants were instructed to press the spacebar when the face disappeared from the screen as quickly as possible. Text prompts to "remember the face" and "press spacebar after it disappears" were presented at the bottom of the screen on each trial.

Next, participants completed a filler task. This was an irrelevant task designed to remove the faces from working memory and allow the recognition test to be a test of long term memory. The task involved eight word puzzles in which participants had 30 seconds to generate the longest word from a grid of nine letters in which the centre letter had to be included. Including reading of instructions, word generating, and responding, the task took approximately five minutes to complete.

Following the filler task, participants completed a recognition test. They were presented with 48 images, 24 that they saw at the beginning of the experiment and 24 new faces. Posers that were studied in exposure, and posers that were new at test were counterbalanced between-participants. Participants saw faces of the same ages in the exposure and test phases (i.e. participants in the mixed-list condition saw young and old, participants in the pure-young condition saw only young, and participants in the pure-old condition saw only old). Participants were instructed to press ‘e’ if they had ‘seen’ the face before, and ‘i’ if they had ‘not seen’ the face before (response mapping was counterbalanced between-participants). If they indicated they had seen the face before, a follow-up remember/know/guess question was included to probe memory strength. Participants were instructed to respond ‘remember’ if they recalled seeing the face, ‘know’ if they could not recall it specifically but it was familiar, and ‘guess’ if they were guessing (Gardiner & Richardson-Klavehn, 2000). Although this measure in the Cronin et al. (2019) paradigm is not a necessary feature as it appears post-encoding, we retained it to keep this alternate paradigm consistent with its past use.

At the end of the experiment a brief survey collected demographics (age, race, sex), and measures of age group contact and age group social identification. The contact measure asks two questions per age group: “*How often do you have personal (i.e., face-to-face) contact with young adults/older adults (approx. between 18 to 30 years of age/approx. 65 years of age and older)?*” and “*How often do you have other types of contact (e.g., phone, e-mail, letter) with young adults/older adults (approx. between 18 to 30 years of age/approx. 65 years of age and older)?*”. Responses were taken on a 1-8 scale from *“daily”* to *“less than once a year”* and averaged to form a single contact score in line with previous research (Ebner & Johnson, 2009). The identification measure asks one question per age group: *“I identify with older adults (65 years+)”* and *“I identify with young adults (18-30 years)”* on a 1-7 Likert scale from *“strongly disagree”* to *“strongly agree”* (Postmes, Haslam, & Jans, 2013; Reysen, Katzarska-Miller, Nesbit, & Pierce, 2013).

Data analysis. The design of this study includes an independent variable (face age) that is manipulated both within and between participants. In order to analyse such data, Erlebacher's (1977) modified ANOVA method was employed. This method was also used by Bryce and Dodson (2013) and is a method that was created specifically to test if the effect of an independent variable changes depending on whether the design is within- or between-participants. Error degrees of freedom in the method are estimated for each effect using Satterthwaite's (1946) method. For more details refer to Erlebacher (1977) and Satterthwaite (1946). The analysis was conducted using R (version 3.4.3; R Core Team, 2017) and code from Merritt, Cook, and Wang (2014). In order for the analysis to be completed, all groups (mixed, pure-young, and pure-old) need to have an equal number of participants. As mentioned above, some participants' data was removed prior to analysis (those who had participated last were removed first).

To supplement the main analysis, data were analysed using Bayesian generalised linear mixed models and the *brm* function from the BRMS R package (Bürkner, 2018) with model likelihoods compared. In this analysis, scores were modelled as a normally distributed variable using a Gaussian family function, the priors were set as a Cauchy distribution using a non-informative prior (0.707), and the number of iterations was set to 4000.

Corrected recognition scores (P_r), hit rates, false alarm rates, and response bias (B_r) were calculated as dependent variables (Snodgrass & Corwin, 1988). P_r is calculated by subtracting the false alarm rate from the hit rate. B_r is calculated by dividing the false alarm rate by 1 minus P_r. Scores above 0.5 indicate a tendency to respond 'seen' (liberal response bias) and scores below 0.5 indicate a tendency to respond 'not seen' (conservative response bias). Hit rates represent the proportion of test trials in which the participant correctly responded 'seen' to a face that was seen before. False alarm rates represent the proportion of test trials in which the participant incorrectly responded 'seen' to a face that had not been seen before. Loglinear adjustments were applied to P_r and B_r calculations, in line with recommendations by Snodgrass and Corwin (1988). This is such that before hit and false alarm rates are calculated 0.5 is added to the raw counts of hits and of false alarms, and 1 is added to the number of trials with seen faces and to the number of trials with new faces. Where hit and false alarm rates are reported below, these are the unadjusted rates.

Sensitivity (*d'*) was also calculated and produced the same pattern of results as P_r throughout the experiments in this paper and is reported in the Supplement (Appendix C). Remember/know/guess analyses did not contribute meaningfully to the interpretation of results of these experiments and can be found in the Supplement (Appendix C).

Results

One-way ANOVAs were conducted on the group contact data (young contact and old contact) with a between-groups factor of list-type (mixed, pure-young, and pure-old). Results indicate that the list-type groups did not differ on amount of contact with young adults ($F(2, 164)=1.47$, $p=.234$, $\eta^2=.02$) but there was a marginal difference in the amount of contact with older adults ($F(2, 163)=2.97$, $p=.054$, $\eta^2=.04$). This marginal difference emerged as those in the pure-young group reported slightly less contact with older adults than those in the pure-old group ($t(108)=2.29$, $p=.024$, $d_s=0.44$). Given that those in the pure-young group did not view any older adult faces we do not believe this to be problematic. Paired samples t-tests also confirm that our sample had higher levels of contact with young than older adults ($t(165)=16.11$, $p<.001$, $d_{av}=1.74$) and greater social identification with young than older adults ($t(165)=24.92$, $p<.001$, $d_{av}=3.08$).

An analysis of the P_r data using Erlebacher's (1977) method with a face age (young, old) factor and a design (mixed [within-participants], pure [between-participants]) factor was conducted (see Figure 1). There was a main effect of face age such that the OAB was present overall ($F(1, 160)=12.13$, $p<.001$, $\eta^2=.04$). There was, however, no effect of design ($F(1, 119)=0.95$, $p=.333$, $\eta^2=.01$), nor an interaction between face age and design ($F(1, 160)=0.56$, $p=.457$, $\eta^2<.01$). Bayesian analyses were conducted to compare the likelihood of our pattern of results (main effect of age only) to the pattern Bryce and Dodson (2013) found (main effect of age and an interaction between age and design). We found that a model containing only the age effect was 410.75 times more likely than a model containing the age and interaction effects given the observed data.

Analysis of the hit rates produced no significant effects of face age (*F*(1, 146)<0.01, *p*=.955, η^2<.01), design (*F*(1, 128)=1.18, *p*=.280, η^2=.01), nor an interaction between the two (*F*(1, 146)=0.03, *p*=.865, η^2<.01). An analysis of the false alarm rates produced a main effect of face age (*F*(1, 136)=11.98, *p*<.001, η^2=.05) such that fewer false alarms were made to young adult faces than older adult faces (see Table 1). There was no main effect of design (*F*(1, 131)=0.03, *p*=.858, η^2<.01) nor an interaction between face age and design (*F*(1, 136)=0.79, *p*=.377, η^2<.01) for false alarms. Analysis of B_r produced a main effect of age (*F*(1, 137)=4.29, *p*=.040, η^2=.02) such that responding was more conservative for young than older adult faces. There was no effect of design (*F*(1, 136)=0.38, *p*=.538, η^2<.01), nor an interaction between age and design (*F*(1, 137)=0.26, *p*=.609, η^2<.01) in the B_r data.

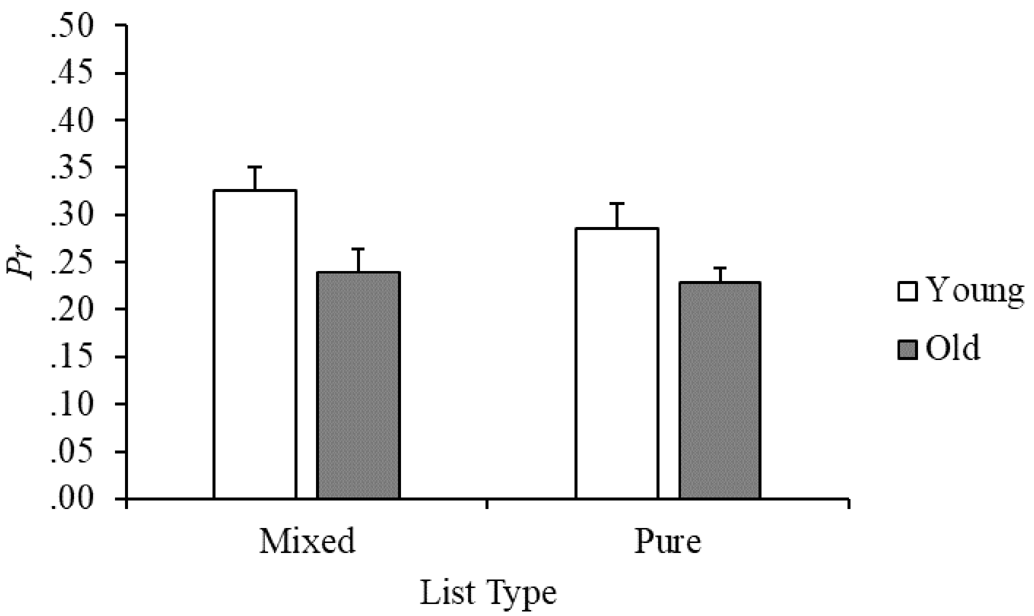

Figure 1. Corrected recognition scores (P_r) to young and older adult faces as a function of list type in Experiment 1. Error bars are the standard error of each mean.

Table 1

Hit rates, false alarm rates, and response bias for young and older adult faces in each list type group in Experiment 1

	Hits		False Alarms		Response Bias (B_r)	
	Young	Old	Young	Old	Young	Old
Mixed	.55(.21)	.55(.22)	.19(.16)	.29(.20)	.34(.21)	.41(.22)
Pure-Young	.52(.20)	-	.22(.16)	-	.33(.19)	-
Pure-Old	-	.51(.18)	-	.28(.16)	-	.38(.21)

Note. Standard deviations are reported in brackets.

Discussion

These results do not replicate the finding by Bryce and Dodson (2013) that the OAB varies as a function of stimulus set composition. We observed the standard OAB overall, and this did not vary as a function of whether participants saw one age group or two. Bryce and Dodson argue that pure-list conditions should produce comparable recognition performance for differently aged faces because age is not salient and therefore age categorisation processes are not engaged. If this underlying social-cognitive mechanism of categorisation is responsible for the OAB it may be that some of the differences between our paradigm and Bryce and Dodson's influenced this mechanism and may explain why we find our results. One difference that may have influenced performance is that we did not vary face sex. The faces used in Experiment 1 were restricted to male faces while in the Bryce and Dodson study both male and female faces were used. We used only male faces to remove variation in the potential in-group/out-group cue of face sex. It may be, however, that varying sex allows the salience of age to be reduced in the pure-list conditions because there is another cue to categorise by. To explore this possibility, Experiment 2 included both male and female faces in all conditions. If face sex variation aids in the reduction of age salience and categorisation, consistent with the findings of Bryce and Dodson, we expect to find an OAB in the mixed-, but not in the pure-list condition. Alternately, if a perceptual-expertise mechanism underlies the OAB, we expect to see similar OABs in both list conditions, replicating Experiment 1.

Experiment 2

Method

Participants. One-hundred and seventy seven participants' data were analysed (92 male, 85 female; M_{age}=26.11, SD_{age}=3.04, range=18-31). Participants were sourced from Amazon Mechanical Turk and compensated USD2.80 for their time. There were 59 participants in each list-type group (mixed, pure-young, and pure-old). Additional participants were removed prior to analyses because they did not fit demographic requirements (7 participants), completed the experimental sequence incorrectly (9 participants), or needed to be removed so that group numbers were equal and the required analysis method could be used (9 participants - 5 pure-young, 4 pure-old).

Stimuli. The same stimuli as Experiment 1 were included, with an additional ninety-six Caucasian female faces with neutral expressions (48 young and 48 older adult posers) taken from the same databases. Visible jewellery was digitally removed. While the age of faces that participants saw varied based on the list-type they were allocated to, all participants saw both male and female faces throughout the experiment.

Procedure and data analysis. As per Experiment 1 with the following differences. Of the faces presented during encoding and during test, half were male and half were female. For participants in the mixed-list condition, there were an equal number of faces of each sex for each age condition. Presentation time counterbalancing in exposure was also such that an equal number of male and female faces were presented for each duration. Given the now larger stimulus set, the subset of faces chosen for each participant was counterbalanced between-participants.

Results

One-way ANOVAs on the group contact data (young contact and old contact) with a between-groups factor of list-type (pure-young, pure-old, mixed) show that our groups did not differ in the amount of contact reported with young (F(2, 173)=1.00, p=.370, η^2=.01) or older adults (F(2, 172)=1.84, p=.162, η^2=.02). Paired-samples t-tests confirmed that our sample had higher contact with young than older adults (t(173)=15.64, p<.001, d_{av}=1.65), and identified more with young than older adults (t(175)=23.64, p<.001, d_{av}=3.00).

Analysis of the P_r data using Erlebacher's (1977) method with factors of face age (young, old) and design (mixed, pure) was conducted (see Figure 2). There was a main effect of face age such that the OAB was present overall ($F(1, 141)=9.83$, $p=.002$, $\eta^2=.04$). There was, however, no effect of design ($F(1, 131)=0.08$, $p=.774$, $\eta^2<.01$) nor an interaction between face age and design ($F(1, 141)=0.63$, $p=.427$, $\eta^2<.01$). Bayesian analyses found that a model containing only the age main effect was 423.18 times more likely than a model containing the age and interaction effects to explain the data. Stimulus sex effects were not significant in the data and are not reported further.

An analysis of the hit rates produced no significant effect of face age ($F(1, 125)=0.21$, $p=.650$, $\eta^2<.01$), design ($F(1, 104)=1.28$, $p=.261$, $\eta^2=.01$), nor an interaction between the two ($F(1, 125)=0.63$, $p=.428$, $\eta^2<.01$). An analysis of the false alarm rates produced a main effect of face age ($F(1, 149)=16.94$, $p<.001$, $\eta^2=.06$) such that fewer false alarms were made to young adult faces than older adult faces (see Table 2). There was no main effect of design ($F(1, 119)=0.23$, $p=.632$, $\eta^2<.01$), nor an interaction between face age and design ($F(1, 149)<0.01$, $p=.961$, $\eta^2<.01$) for false alarms. Analysis of B_r produced a significant effect of age ($F(1, 143)=7.58$, $p=.007$, $\eta^2=.03$) such that responding to young faces was more conservative than to older adult faces. There was no effect of design ($F(1, 118)=1.87$, $p=.174$, $\eta^2<.01$), nor an interaction between the age and design ($F(1, 143)=0.02$, $p=.895$, $\eta^2<.01$) for the B_r data.

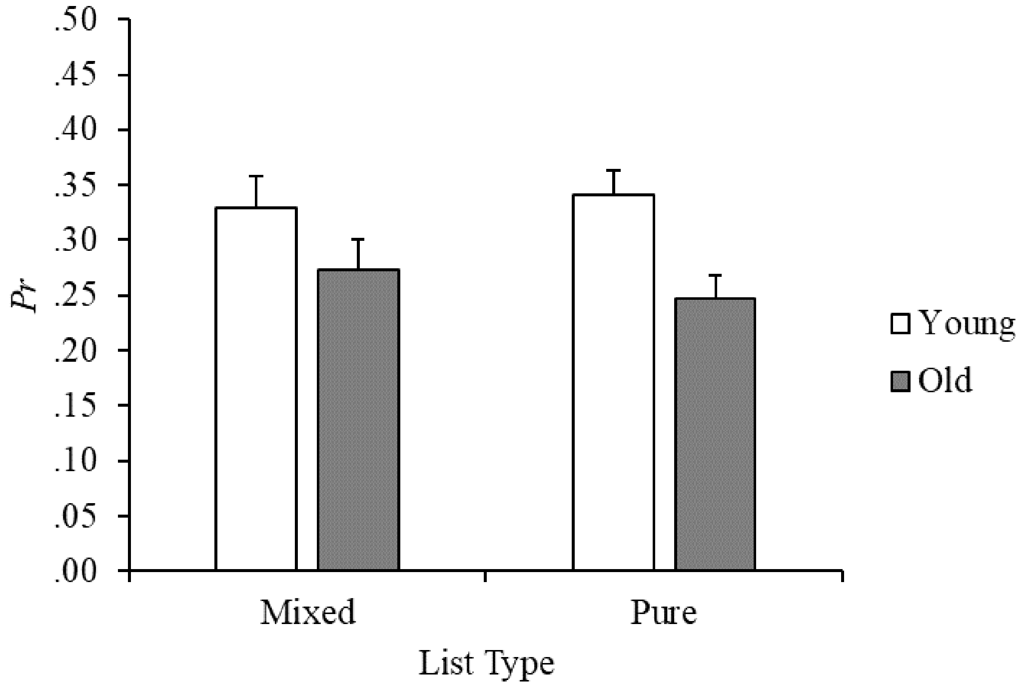

Figure 2. Corrected recognition scores (P_r) to young and older adult faces as a function of list type in Experiment 2. Error bars are the standard error of each mean.

Table 2

Hit rates, false alarm rates, and response bias for young and older adult faces in each list type group in Experiment 2

	Hits		False Alarms		Response Bias (B_r)	
	Young	Old	Young	Old	Young	Old
Mixed	.56(.24)	.59(.24)	.21(.18)	.30(.23)	.35(.22)	.42(.24)
Pure-Young	.55(.16)	-	.20(.12)	-	.31(.16)	-
Pure-Old	-	.54(.17)	-	.29(.18)	-	.38(.19)

Note. Standard deviations are reported in brackets.

Discussion

The results of this experiment replicate those of Experiment 1 where an OAB was observed, which did not differ between the mixed-list and pure-list conditions. Again, these results are in contrast to Bryce and Dodson's (2013) findings. The inclusion of female faces did not influence the pattern of results. Another feature of

Bryce and Dodson's procedure that might influence categorisation processes was the inclusion of a source memory task using age stereotypical backgrounds. Rather than placing all faces on a neutral background, Bryce and Dodson presented faces on one of three backgrounds; a white rectangle, a basketball court or a hospital room. The first served as a neutral control and the latter two were suggested to be stereotypic of age groups (young and old, respectively). However, the backgrounds may also be stereotypic of sex (male and female, respectively). In the pure-list conditions where age does not vary, the salience of face sex may be enhanced by the sex stereotypes associated with the backgrounds. Additionally, asking participants to remember the faces and the backgrounds they are presented on may influence the way in which faces are encoded. To examine if the inclusion of these background stimuli influences the pattern of results, the source memory task was included in Experiment 3. If the inclusion of stereotypical backgrounds aids in the reduction of age salience and categorisation we expect to see an OAB in the mixed- but not in the pure-list condition. Alternately, if a perceptual-expertise mechanism underlies the OAB, we expect to see similar OABs in both list conditions, replicating Experiment 1 and 2.

Experiment 3

Method

Participants. One-hundred and fifty six participants' data were analysed (70 male, 86 female; M_{age}=25.75, SD_{age}=3.00, range=18-30). Participants were sourced from Amazon Mechanical Turk and compensated USD3.70 for their time. There were 52 participants in each list-type group (mixed, pure-young, and pure-old). Additional participants were removed prior to analyses because they did not fit demographic requirements (24 participants), completed the experimental sequence incorrectly (16 participants), or needed to be removed so that group numbers were equal and the required analysis method could be used (13 participants - 4 mixed, 9 pure-old).

Stimuli. The same stimuli as in Experiment 2 were used, with the addition of background stimuli. Background stimuli in exposure were a picture of a hospital room, a basketball court, and a white rectangle outlined in black. In the test phase, the background was a grey rectangle. These stimuli were 636 × 478 pixels in size.

Procedure and data analysis. As per Experiment 1 with the following differences. Faces were presented overlayed on a background and participants were instructed to remember the face-background pairings. The possible backgrounds were the white rectangle, hospital room, and basketball court. An equal number of young and old, and male and female faces were presented on each background. Presentation time was also extended to 5000ms and 5500ms so that participants had sufficient time to remember the face-background pairs. On test trials, all faces were presented on the grey background. Where participants indicated that they had seen a face, they were prompted with the remember/know/guess question and then an additional source memory question. The source memory question presented the three backgrounds seen in the exposure phase on-screen and asked participants to select the background that the face had been presented on. As participants were instructed to remember the backgrounds, this source memory question was included, however, these data are not reported as they were not central to our predictions and too few trials were available for analysis.

Results

One-way ANOVAs on the group contact data (young contact and old contact) with a between-groups factor of list-type (pure-young, pure-old, mixed) show that our groups did not differ in the amount of contact reported with young (F(2, 152)=0.49, p=.614, η^2=.01) or older adults (F(2, 152)=0.22, p=.804, η^2<.01). Paired-samples t-tests confirmed that our sample had higher contact with young than older adults (t(153)=15.05, p<.001, d_{av}=1.74), and identified more with young than older adults (t(153)=21.56, p<.001, d_{av}=2.91).

Analysis of the P_r data using Erlebacher's (1977) method with factors of face age (young, old) and design (mixed, pure) was conducted (see Figure 3). There was a main effect of face age such that the OAB was present overall (F(1, 151)=6.41, p=.012, η^2=.03). There was, however, no effect of design (F(1, 145)=1.85, p=.175, η^2=.01), nor an interaction between face age and design (F(1, 151)=0.89, p=.347, η^2<.01). Bayesian analyses found that a model containing only the age main effect was 102.74 times more likely than a model containing the age and interaction effects to explain the data.

An analysis of the hit rates produced no significant effect of age (F(1, 119)=0.48, p=.491, η^2<.01), design (F(1, 139)=0.09, p=.761, η^2<.01), nor an interaction between the two (F(1, 119)=0.29, p=.594, η^2<.01). An analysis of the false alarm rates produced a main effect of face age (F(1, 131)=14.21, p<.001, η^2=.05) such that fewer false alarms were made to young adult faces (see Table 3). There was also a main effect of design (F(1, 139)=8.51, p=.004, η^2=.05), such that there were higher false alarm rates in the pure-list conditions. There was no interaction between face age and design (F(1, 131)=0.68, p=.411, η^2<.01). Analysis of B_r produced a significant effect of age (F(1, 153)=6.01, p=.151, η^2=.02) such that responding to young faces was more conservative than to older adult faces. There was also a significant effect of design (F(1, 141)=4.36, p=.039, η^2=.02) such that responding was more conservative in the mixed than in the pure-list condition. There was no interaction between age and design (F(1, 153)=0.63, p=.428, η^2<.01) for the B_r data.

Supplementary analysis. A supplementary analysis examined the relationship between self-reported contact with older adults and OAB magnitude (young P_r - old P_r). Bias scores could only be calculated in a meaningful way for participants in the mixed-list condition of each experiment so a combined analysis including data from all three experiments was conducted (findings were the same when each experiment was analysed individually). No relationship was found between self-reported contact with older adults and OAB magnitude (r(166) = .004, p = .956).

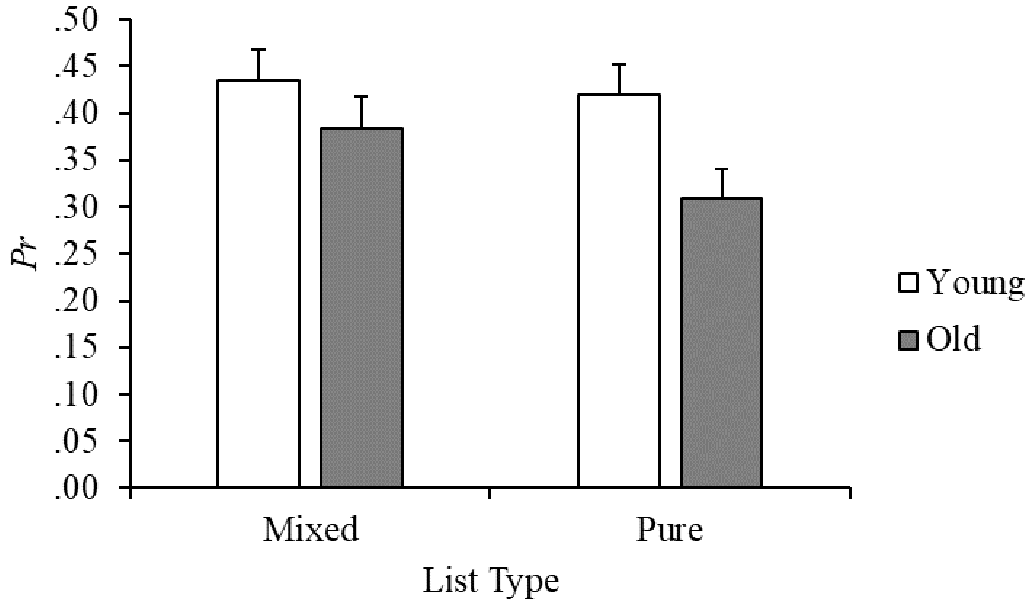

Figure 3. Corrected recognition scores (P_r) to young and older adult faces as a function of list type in Experiment 3. Error bars are the standard error of each mean.

Table 3

Hit rates, false alarm rates, and response bias for young and older adult faces in each list type group in Experiment 3

	Hits		False Alarms		Response Bias (B_r)	
	Young	Old	Young	Old	Young	Old
Mixed	.57(.23)	.57(.21)	.11(.11)	.16(.16)	.25(.16)	.29(.19)
Pure-Young	.60(.20)	-	.16(.14)	-	.29(.18)	-
Pure-Old	-	.56(.19)	-	.24(.17)	-	.37(.22)

Note. Standard deviations are reported in brackets.

General Discussion

The aim of this study was to replicate Bryce and Dodson's (2013) finding that the OAB emerges in young adult participants presented with a mixed- but not with a pure-list of young and older adult faces, and to further our understanding of the mechanism/s underlying the OAB. We predicted that the results would replicate and be robust when removing theoretically unimportant components of the Bryce and Dodson old/new recognition paradigm. Across three experiments that removed components of the original paradigm (Experiment 1) and included components replicating the encoding conditions (Experiment 2 and 3), the finding that the OAB only occurs in a mixed-list was not replicated. In each of the three experiments, the OAB was evident regardless of list-type.

Our results deviate from Bryce and Dodson's (2013) finding that suggests social-cognitive mechanisms influence the OAB. Bryce and Dodson argued that when participants view only one age group of faces, they do not engage in the age categorisation that is necessary to produce the OAB. They suggest that age group variance in a mixed-list context acts as a situational cue to make age salient and prompt age categorisation. Our results instead show that encountering a list of age mixed faces (or not) does not change performance. Additionally, these results indicate that the disparate pattern of results seen in comparison to results noted in the ORB field (where category salience reduces own-group recognition performance rather than enhances it; Young et al., 2009) may not be reliable. This tempers the implication from Bryce and Dodson's study that the OAB and ORB are distinct social-cognitive phenomena, and instead suggests that social cognition may play a more important role for remembering differently raced faces, than differently aged faces.

Our results overall, are more consistent with a perceptual-expertise account. A perceptual-expertise account predicts that manipulations of category salience will have no influence on the OAB. Instead, the OAB should be driven by participants having more contact with own- than other-age people. Our results support these predictions, with the list-type manipulation having no effect on the OAB, and our participants reporting higher contact with young adults than older adults. However, unlike in previous studies of the OAB (Ebner & Johnson, 2009; He, Ebner, & Johnson, 2011), we did not find that participants' level of other-age contact was associated with their OAB. As only participants in the mixed-list had scores for both young and older adult recognition we were unable to determine if this pattern was the same for other participants. Additionally, while we used the same measure as the above mentioned studies, these are the only two cases we are aware of where this evidence has been produced. Most of the evidence supporting the role of experience in the OAB instead comes from group comparisons where participants with distinct experience profiles are compared (e.g., trainee teachers with high contact with children, versus young adult participants with no contact with children; Harrison & Hole, 2009).

The failure to replicate Bryce and Dodson's (2013) results in our paradigm may indicate that the perceptual-expertise account best explains the OAB, but it might also indicate that the use of mixed- versus pure-list conditions did not successfully manipulate social categorisation or face age salience in the context of the current experiments. The social categorisation literature suggests that category activation is fast and spontaneous (Brewer, 1988). Determining which categories are activated and under which conditions has been the topic of much research (Macrae & Bodenhausen, 2000). Factors such as category salience, stereotype salience, beliefs and prejudices, motivations, and processing capacity have all been suggested to influence whether, and if so, which category is activated (Macrae & Bodenhausen, 2000). While our manipulation aimed to target category salience, other factors may have prevented the effectiveness of the manipulation. Perhaps for our participants, age categorisation occurred automatically regardless of the condition the faces were encountered in.

There remain methodological differences between the studies that may also account for the different patterns of results observed (see Table 4 for a summary). Some notable differences are that Bryce and Dodson's (2013) study included a single passive encoding task (versus our additional RT task), fewer new faces than studied faces at test (versus our equal number of new and studied faces), no delay between encoding and test (versus our 5 min delay), confidence ratings on all trials (versus our remember/know/guess question on "seen" response trials), and three encoding-test sessions (versus our one session). We did not examine the influence of these features as the RT task was designed to assist encoding in an online setting by requiring attention to the faces, and the remaining differences occur post-encoding and should not have influenced the OAB which is suggested to be created during the encoding phase (Wiese, Komes, et al., 2013; Young, Bernstein & Hugenberg, 2010). We would argue that even though there remain possible boundary conditions to the influence of using a mixed- versus pure-list on the OAB, these conditions are not theoretically relevant to the predictions made by social-cognitive models like the CIM (Hugenberg et al., 2010). If presenting a mixed- versus pure-list of faces is sufficient to manipulate social categorisation, and the OAB is partly a product of social categorisation, the influence of the manipulation should be seen regardless of the remaining untested methodological differences. If these methodological differences are responsible for producing different patterns of results, this is likely indicative of their influence on other processes such as response bias or working memory rather than on the encoding processes that are thought to produce the OAB.

Table 4

Summary of methodological features and differences in Bryce and Dodson's (Exp 2, 2013) and the current study's experiments

Feature	Difference	Bryce and Dodson (Exp 2, 2013)	Current Study
Sample	Sample larger in the current study	N = 72 Young adults	Exp 1: N = 168 Exp 2: N = 177 Exp 3: N = 156 18-31 years old
Participation Setting	In-person vs. online	In-person	Online
Stimuli	1 vs. 2 face databases	Male and female faces (CAL/PAL database) Background scenes (basketball court, hospital room)	Male and female (Exp 1 male only) faces (CAL/PAL and FACES databases) Background scenes (Exp 3: basketball court, hospital room)
Experimental sequence	3 vs. 1 old/new recognition tasks	Encoding 1, Test 1, Filler 1, Encoding 2, Test 2, Filler 2, Encoding 3, Test 3	Encoding, Filler, Test
Encoding Phase	1 vs. 2 tasks	Intentional encoding of 26 face-background pairs	Intentional encoding of 24 faces (Exp 3: 24 face-background pairs), RT task

		5s presentations	1-1.5s (Exp 1, 2) and 5-5.5s (Exp 3) presentations
Filler Task	Maze task vs. word puzzles	Maze task	Word puzzles
	Between vs. within the old/new recognition tasks	Between each old/new recognition task sequence	Between encoding and test
Encoding-Test Transition	Immediate vs. delayed	Immediate transition	Filler task between encoding and test
Test Phase	3:1 vs. 1:1 ratio of studied and new faces	24 studied faces, 8 new faces	24 studied faces, 24 new faces
	Confidence vs. Remember/Know/Guess question	Old/New judgement, confidence rating (after all trials), background selection	Seen/Not Seen judgement, remember/know/guess question (after 'seen' trials), background selection (Exp3)

Even when considering these differences, it is difficult to conceive how they may have produced Bryce and Dodson's (2013) results. The inclusion of an RT task in encoding could be argued to influence depth of encoding with shallower encoding seen in our experiments than in Bryce and Dodson's suggested by the overall poorer recognition performance in our study (corrected recognition ranged from approximately .20-.45 across our experiments versus .60-.85 in Bryce and Dodson's). However, the observation of the OAB in all conditions, suggests that encoding of the face stimuli was sufficiently deep to enable the categorisation and individuation processes that are said to be required for the emergence of the OAB. The inclusion of fewer new faces at recognition may influence response bias, making 'seen' responses more frequent. However, given there were equal numbers of new own- and other-age faces, this response bias shift should be the same across face age types, maintaining the relative difference in performance. We can also see in our data a response bias OAB consistent to that reported in the Rhodes and Anastasi (2012) meta-analysis which indicated that young adult participants respond more conservatively to young than older adult faces. There was a significant effect of design in Experiment 3, however, this was not present in Experiment 1 or 2 and likely reflects differences in the participant groups. Similarly, the benefit conferred by faces being retained in working memory due to a lack of delay between encoding and test should be equal among the list-type conditions. The inclusion of confidence ratings and multiple testing rounds might produce learning effects whereby participants perform differently over time based on confidence or lack thereof in their performance. However, we would still assume that the first encoding-test session should yield a pattern of results that would match our own. Assuming that it did, this would require that improvements in subsequent encoding-test sessions differed across list-types and face age (i.e., larger improvement for old faces in the pure list condition only) in order to yield the pattern of results reported by Bryce and Dodson. Such a selective improvement seems rather unlikely and is inconsistent with Bryce and Dodson's notion that performance should not differ across age in the pure-list condition.

Overall, the findings of this study do not replicate Bryce and Dodson's (2013) and do not provide support for the social-cognitive account of the OAB. While there remain methodological differences in the approach that we and Bryce and Dodson took, we are confident that the findings we have presented across three separate experiments reflect the effect of mixed- and pure-lists on the production of the OAB. These results are more consistent with the perceptual-expertise account but further research is required to fully assess the influence of categorisation on the OAB. The literature would benefit from research that more strongly manipulates and measures categorisation. Ambiguity manipulations such as those used in the ORB and own-sex bias literature where cues are used to indicate group membership of ambiguous faces (MacLin & Malpass, 2001; Huart, Corneille & Becquart, 2005) may be one such approach, although creating ambiguity would be much harder for age than it is for race or sex.

Our results qualify evidence in favour of a distinct social-cognitive account of the OAB. Beyond their implications to our understanding of the OAB and its differences and similarities to the broader own-group bias literature, our results are important for a field that almost exclusively uses designs with mixed-lists of own- and other-age faces during encoding. Our results indicate that the biases we are examining exist outside of these stimulus set composition constraints and are not a product of our experimental procedures. In real life we can encounter heterogeneous or homogenous groups, or interact with a single person. Our results indicate that regardless of the nature of these encounters, an age-based recognition bias will be present.

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CHAPTER 5 - INDIVIDUATION TRAINING IMPROVES OLDER ADULT FACE RECOGNITION IN YOUNG ADULTS

Abstract

Our ability to recognise faces of our own-age group is superior to our ability to recognise faces of other-age groups. This own-age bias is thought to be caused in part by perceptual-expertise mechanisms. The current evidence to support the role of perceptual-expertise has, however, been derived from studies that have examined and compared populations with pre-existing differences in contact with other-age people. In this study we instead examined the effect of an experimental manipulation of perceptual-expertise on other-age face recognition. Young adult participants completed two old/new recognition memory tests before and after completing five training sessions. In the training sessions participants learned to individuate older adult (or child) faces, and categorise child (or older adult) faces. We found that participants who received individuation training for older adult faces were able to improve their recognition of novel older adult faces. These result provide support for perceptual-expertise and individuation experience as having a casual role in the own-age bias.

Face identity recognition in unfamiliar face processing is biased. Own-group recognition biases have been described where our ability to recognise people we have seen briefly before is biased by the social cues in their faces (Herlitz & Loven, 2013; Meissner & Brigham, 2001; Scott & Fava, 2013; Wiese, Komes, & Schweinberger, 2013). This is such that cues that denote in-group membership often result in better identity recognition, relative to cues of out-group membership. One such bias is the own-age bias (OAB) where recognition is better for own-age faces compared to other-age faces (Wiese, Komes, et al., 2013). Research into this effect has found that the OAB is strongest in young adults, but can also be seen in children and older adults (for a review see Wiese, Komes, et al., 2013; for a meta-analysis see M. G. Rhodes & Anastasi, 2012). Theories of the underlying mechanism of the OAB have been drawn from accounts attempting to explain the related own-race bias (ORB) where recognition is better for own-race compared to other-race faces (Wiese, Komes, et al., 2013). The most prominent accounts of this bias are the perceptual-expertise accounts and social-cognitive accounts.

The perceptual expertise accounts suggests that our processing of own- and other-age faces is different due to our experience with those types of faces (Wiese, Komes, et al., 2013). We tend to be exposed to more faces from our in-group than out-group and, as a result, get more practice processing them. Our processing is thus, optimised for representing uniqueness in these faces. Additionally, the way we store representations is said to be optimised for faces we see most often, generally in-group faces, such that it is easier to discriminate among those types of faces than among others (Valentine, 1991). This means when we encounter new faces, we are better at encoding the individuating aspects of a face that will help us recognise and distinguish it from other similar faces when it is an in-group face compared to an out-group face.

The social-cognitive accounts on the other hand suggest that judgements made about faces drive encoding differences. These judgements can bias us in the amount of effort we put into encoding a face or in what we capture from it (Rodin, 1987; Sporer, 2001). Usually this is discussed in terms of encoding strategies being biased towards capturing individuating information or categorising information (e.g., Hugenberg, Young, Bernstein, & Sacco, 2010; Levin, 2000; Sporer, 2001). For instance, when faces are judged as belonging to in-group members, we are biased to an individuation style of processing where information useful for identifying that specific person is captured (Hugenberg et al., 2010; Levin, 2000). However, when faces are judged to belong to out-group members we are biased towards a categorisation style of processing where information more useful for categorisation and less useful for individuation is captured (Hugenberg et al., 2010; Levin, 2000). As a result, we are better able to recognise in-group faces than out-group faces.

An integrative account, the categorisation-individuation model (CIM), has also been proposed that posits both perceptual-expertise and social-cognition are involved in the production of own-group biases. The CIM (Hugenberg et al., 2010) was initially developed to explain the ORB and has since been applied more broadly to other own-group biases (Hugenberg, Wilson, See, & Young, 2013). In this model the authors suggest that face encoding captures categorical or individual information, and that categorisation, motivation, and individuation experience influence which encoding style is employed. Category cues, like race, can prompt in-group/out-group categorisations that result in categorical encoding of out-group faces and individuated encoding of in-group faces. Situational cues can motivate perceivers to attend to categorising or individuating information in the face by highlighting which has more utility. For example, angry faces may enhance attention to identity so that threats may be tracked (Ackerman et al., 2006). Individuation experience is suggested to further influence these processes where capacity to extract individuating information may be constrained by experience and expertise in doing so.

Evidence evaluating the social-cognitive account of the OAB has been mixed. Studies investigating emotional expressions, suggested to influence the perceived social relevance of faces, have demonstrated that facial expressions can lead to bias reduction (Cronin, Craig, & Lipp, 2019a), produce only marginal effects on memory (Denkinger & Kinn, 2018), or not influence the bias (Ebner & Johnson, 2009). Manipulations of motivation to attend to individuating features have also produced mixed findings, with one study that instructed participants to individuate other-age faces finding no effect on the OAB (Craig & Thorne, 2019), and another that used a task requiring individuation of faces finding a bias reduction (Proietti, Laurence, Matthews, Zhou, & Mondloch, 2018). Finally, attempts to manipulate categorisation have had limited success with one study finding that the OAB occurs where age salience is high but not low (Bryce & Dodson, 2013), and another which could not replicate the effect (Cronin, Craig, & Lipp, 2019b).

Research in the OAB field has largely evaluated and found support for the perceptual-expertise account. Studies have shown that individuals with high levels of other-age contact, such as geriatric nurses, trainee teachers, and pre-school teachers, have smaller OABs when compared to individuals with limited other-age contact (Harrison & Hole, 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Wiese, Wolff, Steffens, & Schweinberger, 2013). Additionally, correlations between other-age contact and OAB magnitude have been observed where increased contact is associated with decreased bias (Ebner & Johnson, 2009; He, Ebner, & Johnson, 2011). Other investigations have produced evidence for mental representational differences with more efficient holistic processing present in own-age than other-age processing, indicative of more expertise in own-age face processing (Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008; Macchi Cassia et al., 2009).

The specific nature of the perceptual-expertise account however remains unclear. Inconsistencies in some of the findings reviewed above have suggested a more nuanced understanding of contact and experience with other-age faces may be required. For instance, reported correlations between other-age contact and own-age contact are not always replicated (e.g., Cronin et al., 2019a, 2019b). Additionally, while geriatric nurses have been shown to have reduced OABs (Wiese, Wolff, et al., 2013), neonatal nurses have not (Yovel et al., 2012). Despite viewing massive numbers of faces, mere exposure seems insufficient to improve neonatal nurses' recognition of infants. There is also the problem of causation in examining pre-existing levels of other-age contact and we cannot be sure if these patterns of results in recognition are a product of expertise per se, or another factor, such as attitudes or interaction motives. It may be that positive feelings towards a group, or motivations to learn individual identities enhance expertise learning.

In the case of the ORB, perceptual training regimes have been employed to determine if they can change the bias. Early work had participants learn to discriminate between other-race faces, finding reductions in the ORB (Elliott, Wills, & Goldstein, 1973; Lavrakas, Buri, & Mayzner, 1976; Malpass, Lavigueur, & Weldon, 1973). Later work has examined both the role of individuation training and categorisation training finding success in subordinate individuation training improving other-race face recognition (Lebrecht, Pierce, Tarr, & Tanaka, 2009; Tanaka & Pierce, 2009). Additionally, developmental work with infant populations has shown that exposure to other-race face videos at 8-10 months of age can eliminate the ORB (Anzures et al., 2012) while exposure to photographs of other-race faces between 3 and 6 months of age can prevent its emergence (Heron-Delaney et al., 2011).

The aim of this study is to examine the role of individuation training on other-age face recognition in young adults and to determine if there is a causal link between individuation experience and the OAB. To do so, we have adapted Tanaka and Pierce's (2009) paradigm. Tanaka and Pierce conducted a study exploring the influence of individuation and categorisation training on recognition performance and ERP responses to two other-race face categories. Twenty-four participants completed two old/new recognition tests with African American and Hispanic faces while undergoing EEG, with the tests separated by five training sessions. In each training session, participants were trained to differentiate faces of one race by learning their unique letter labels, and categorise faces of the other race by learning a shared letter label. They found that recognition accuracy improved overall for both races post-training, but that there was a greater improvement in performance seen for the race that was individuated than for the race that was categorised. The ERP data also showed an enhanced activation of the N250 component for individuated faces, suggesting better identity specific representations of these faces. Tanaka and Pierce argued that individuation training induced a more fine grained perceptual analysis with more focus on unique properties of the face than did categorisation training, resulting in more improved recognition for faces of the race that were individuated than categorised.

In addition to examining recognition memory, affective priming tasks will be conducted to explore potential co-occurring changes in attitudes with training. Priming tasks have been suggested to be useful in investigating an observer's implicit attitudes towards a category (Fazio, Jackson, Dunton, & Williams, 1995; Fazio & Olsen, 2003) and have been used in the study of the own-race bias (e.g., Lebrecht et al., 2009). Current correlational studies of the OAB suggest that differences in the amount of contact an observer has with a group influences how well they can recognise faces from that group. However, if increased contact with a group also causes attitudes (positive and negative evaluations) about that group to change, this social factor could instead be responsible for changes in recognition. If attitudes towards each age group are constant, we can be sure that any changes in recognition performance to faces from those age groups are due to changes in expertise. In an affective priming task, participants categorise target words as positive and negative (Fazio et al., 1995). By preceding each target with a prime stimulus and examining differences in response time to positive and negative targets, attitudes to the prime can be inferred. Where evaluations of the prime and target are congruent, responding is facilitated. Where evaluations of the prime and target are incongruent, responding is hindered. As such, we can infer whether participants' attitudes towards the primes are relatively more positive or negative.

In our study young adult participants' recognition performance and implicit attitudes for young adult, older adult, and child faces will be examined before and after a training regime in which they learn to individuate and categorise older adult and child faces. We predict that if individuation experience is in part responsible for the manifestation of the OAB, then recognition performance will improve for the age group that receives individuation training. In turn this should reduce the OAB between young faces and individuated faces. We expect no change, or a smaller change, for faces that receive categorisation training, and no changes in implicit attitudes for either group.

Method

Participants

The total sample included 133 participants (35 male, 96 female, 2 other/undisclosed; $n_{\text{old-individuation}}$=68, $n_{\text{child-individuation}}$=65). Participants were aged between 17 and 47 years old (*M*=21.46, *SD*=3.97), with 125 identifying as Caucasian, five as mixed race, and three as Asian. A pre-registration of the study (https://osf.io/mw9nf; Appendix D) stated inclusion criteria for participants to be Caucasian, between the ages of 17 and 31 years old, and to complete all five unique training sessions of the study. The subset of the total sample that met the inclusion criteria comprised 109 participants (27 male, 80 female, 2 other/undisclosed; $n_{\text{old-individuation}}$=54, $n_{\text{child-individuation}}$=55). Their ages ranged from 17 to 29 years old

(*M*=21.06, *SD*=2.86). All participants were sourced from an undergraduate university population who participated for course credit, and volunteers who were compensated $30 for their time. Ethics approval was obtained from Curtin University.

Sample size was informed by previous research using an individuation manipulation that yielded significant results in the ORB field (*N*=120; Experiment 2; G. Rhodes, Locke, Ewing, & Evangelista, 2009). Given that the OAB is smaller than the ORB, we aimed to oversample and based our sample size on G. Rhodes et al.'s (2009) study rather than Tanaka & Pierce's (2009, *N*=24). We aimed to collect a sample of 120 participants meeting the inclusion criteria, however, due to restrictions on face-to-face testing during the 2020 COVID-19 pandemic we were unable to do so. To increase power we have conducted our analyses on the total sample. Demographic inclusion criteria were used to highlight in-group membership with young adult, own-age stimuli, consistent with our previous research. However, given that our manipulation targeted processing of out-group faces, including slightly older participants (who are not older adults) and other-race participants is not problematic. Additionally, of the 15 participants who did not complete five unique training sessions, 11 completed four. To supplement our main analysis we have also reported an analysis of the restricted sample.

Stimuli

Thirty-two images of young adult, and seventy-two images of older adult faces were sourced from the FACES (Ebner, Riediger, & Lindenberger, 2010) and CAL/PAL (Minear & Park, 2004) databases. Seventy-two images of children's faces were sourced from the CAFÉ (LoBue & Thrasher, 2015) and DEFSS (Meuwissen, Anderson, & Zelazo, 2017) databases. Faces were cropped around the face and hair outline to remove background information. All faces were Caucasian and both male and female posers were used. Young adult posers were 18-31 years old, older adult posers were 69 years and older, and children were 2-13 years old. Images were in colour and centred on 335 × 419 pixel canvases. For training sessions, additional stimuli were created with face outlines equated by placing oval masks over the images.

Procedure

The experiment was completed over five days. On Day 1 participants completed an old/new recognition test, an affective priming task, a questionnaire, and a training session in the laboratory. On Days 2, 3 and 4, participants completed one training task online per day. On Day 5 participants returned to the laboratory and completed a training task, followed by an old/new recognition test, an affective priming task, and a questionnaire.

Old/New recognition test. This task consisted of three phases: encoding, filler task, and recognition test. In the encoding phase participants were presented with 24 faces, one at a time (8 young adult, 8 child, 8 older adult; half of each face age were male posers and half female). Learning was intentional, with participants instructed to remember the faces as they would be asked to recognise them later. Participants were additionally asked to press the spacebar as quickly as they could after the face disappeared from the screen. This task was included to ensure participants were paying attention to the screen during the short presentation times and has been used in previous studies (Cronin et al., 2019a, 2019b). To facilitate this task, faces were presented on screen for 1000ms or 1500ms each with a 1500ms inter-stimulus interval. Presentation time of each poser was counterbalanced between-participants and varied equally between face ages and face sexes. Text reminders to “remember the face” and “press spacebar when it disappears” were presented on screen during each trial.

Participants completed a filler task following the encoding phase. The purpose of this task was to create a time delay between encoding and test to ensure our test was of long term memory and not working memory. In this task, which took approximately five minutes, they were presented with eight word puzzles. Each puzzle was allotted 30 seconds of viewing time before participants were permitted to make their response. The puzzles were grids of 9 letters in which participants had to generate the longest word they could that included the centre letter and any other letters in the grid.

In the recognition test, participants were presented with a set of 48 faces. These were a mix of the 24 faces they had previously seen in encoding and 24 new faces (with an equal number of each face age and sex type). The faces were presented one at a time and participants were instructed to indicate if they had seen the face earlier by responding ‘seen’ or ‘unseen’ using keyboard responses (‘e’ and ‘i’, with response mapping counterbalanced between participants). Faces seen in the old/new recognition test on Day 1 and Day 5 were different, and counterbalanced between participants, as were faces seen during encoding as learnt faces, and faces seen during test as new lure faces.

Affective priming task. An affective priming task was included to explore the effect of the training protocol on attitudes as this may give us insights into the changes taking place during training. The affective priming task consisted of a speeded word categorisation task (Fazio et al., 1995). On each trial, a picture of a face prime preceded a target word and participants were instructed to categorise the word as positive or negative as quickly and as accurately as they could. Twelve pictures of faces and twelve words were included. The faces were a selection taken from the just completed old/new recognition task (4 young, 4 child, 4 older adult), the words were taken from Hu, Gawronski, and Balas’ (2017) study. The positive words were: *pleasant*, *good*, *outstanding*, *beautiful*, *magnificent*, and *marvellous*. The negative words were: *unpleasant*, *bad*, *horrible*, *miserable*, *hideous*, and *dreadful*. Each trial started with a fixation cross for 500ms, followed by a face prime for 200ms, and then the target word that remained onscreen until a response was made. Trials were separated by a 500ms inter-stimulus interval. Feedback was provided where responses were incorrect such that a red ‘X’ would appear on screen for 500ms. Participants initially completed a practice task with 12 trials to familiarise themselves with the task and stimuli. The full task that followed included 144 trials consisting of all combinations of face and word stimuli.

Questionnaire. A questionnaire was completed on Day 1 and Day 5. Items differed slightly between sessions with questions pertaining to demographics (age, sex, race, number of children, and language spoken at home), contact, group identification and group attitudes included on Day 1, but only questions pertaining to group identification and group attitudes repeated on Day 5.

Contact was measured with four questions for each age group. One questions asked participants to report the number of people they know: “*Approximately how many young adults/older adults/children do you know who are not related to you?*” Another two asked about the frequency of interactions, *“How often do you interact* *with young adults/older adults/children?"* and *"How often do you meet new people who are young adults/older adults/children?"*, with responses taken on a 1-8 scale from *"daily"* to *"less than once per year"*. A final question asked about the quality of the interactions, *"How would you rate the quality of interactions you have with young adults/older adults/children?"*, with responses taken on a 1-5 Likert scale from *"very shallow/superficial"* to *"very deep/intense"*.

The group identification measure asked one question per age group, *"I identify with young adults/older adults/children (18-30 years/65 years+/13 years and younger)"*, with responses taken on a 1-7 Likert scale *from "strongly disagree"* to *"strongly agree"* (Postmes, Haslam, & Jans, 2013; Reysen, Katzarska-Miller, Nesbit, & Pierce, 2013). The attitude measure asked one question per age group, *"What is your attitude towards young adults (18-30 years)/older adults (65+ years)/children? (13 years and younger)"*, with responses taken on a 1-7 Likert scale from *"strongly like"* to *"strongly dislike"*.

Training task. This task was based on Tanaka and Peirce's (2009) paradigm in which participants learned 16 face-label pairs per session. Eight child and eight older adult faces were paired with a letter and participants were instructed to learn which letter was paired with which face. One age group of faces was learnt in an individuation condition, the other in a categorisation condition. Faces in the categorisation condition were always paired with the same letter (P), faces in the individuation condition were presented with unique letters (Q, W, E, R, T, Y, U, I). A different set of faces were learnt each day (and these were different faces to those used in the old/new recognition test and affective priming task). Training was progressive with seven learning-test block pairs where participants initially learnt four face-label pairs (an equal number of older adult and child faces were learnt in each block), and each successive learning block added two new faces to the set until all 16 had been learnt. When all 16 face-label pairs had been learnt, a speeded test concluded the training.

Learning. In the learning blocks, participants viewed each face-label pair one at a time for 3 seconds with a 1500ms inter-stimulus interval. The stimuli were presented in randomised order with an oval mask obscuring the face outline. This was done so as to draw attention to internal features, which has been suggested to improve recognition (Paterson et al., 2017), and to provide some image variance between learning and test. The paired letter was presented below the face. For faces in the individuation condition, the letter paired with a particular face was counterbalanced between participants.

Test. Following the learning phase, participants immediately entered a test where they viewed the faces again without their labels or oval masks. Participants were instructed to label the face by using the keyboard to indicate which letter was paired with the face. If they made an incorrect response the text 'INCORRECT' was displayed on screen, along with the correct answer (i.e. the correct letter). If participants made an incorrect response during the test, they immediately repeated the test. Participants needed to respond correctly on all trials to move on to the next learning block, or attempt the test three times.

Speeded test. After all 16 face-label pairs had been learnt, participants completed a final speeded test. The test was the same as above, with the exception that responses had to be made within three seconds. If they were not the text 'TOO SLOW' would appear on screen and the trial was considered incorrect.

Data Analysis

Old/New recognition test. To assess recognition memory performance the signal detection measure of sensitivity (*d'*) was calculated for young adult, child, and older adult faces. To calculate *d'* the difference between z-transformed hit and false alarm rates is taken. Hits denote responses where a participant correctly identified a face as 'seen' when it was seen before. False alarms denote responses where a participant incorrectly identified a face as 'seen' when it was new. Larger positive scores indicate better discrimination between seen and unseen faces and hence more accurate recognition. Loglinear adjustments were applied to deal with extreme hit and false alarm rates (0 and 1) where z-transformations are not possible (Snodgrass & Corwin, 1988). This is such that when calculating hit and false alarm rates, 0.5 is added to the raw count of each, and 1 is added to the number of signal and of noise trials.

Affective priming task. Priming scores were calculated for each face age in accordance with Weisbuch and Ambady (2008). This was such that the average RT was first calculated for each face age (young, old, child) – word valence (pleasant, unpleasant) pair. Priming scores were calculated by subtracting the sum of the unpleasant RTs from the pleasant RTs for each face age. Scores are interpreted in a relative sense, where the more positive score indicates more positive affect and the more negative score indicates more negative affect. Data was excluded from incorrect trials and trials with response times of >1000ms or <300ms. Entire cases were removed where excluded trials were equal to or greater than 25% of all trials.

Training task. To assess effects of training, we calculated individuation error rates for each session completed. The rates reflected the proportion of individuation test trials (both test and speeded tests) that participants responded to incorrectly.

Results

Recognition Memory

A mixed ANOVA with within-participant factors of face age (young, child, old) and time (pre-test [Day 1], post-test [Day 5]) and a between-groups factor of group (old-individuation, child-individuation) was conducted on the *d'* data (see Figure 1 and Table 1). There was a main effect of face age ($F(2,130)=12.27$, $p<.001$, $\eta_p^2=.159$) and a marginally significant interaction between face age and group ($F(2,130)=2.68$, $p=.073$, $\eta_p^2=.040$). These were subsumed by a significant three way interaction between time, face age and group ($F(2,130)=5.18$, $p=.007$, $\eta_p^2=.074$). The remaining effects were non-significant (all $F<2.43$, all $p>.121$).

Follow-ups of the three-way interaction revealed that *d'* increased for older adult faces from pre- to post-test in the old-individuation group ($F(1,131)=4.60$, $p=.034$, $\eta_p^2=.034$). Performance for child faces in the child-individuation group, however, did not change ($F(1,131)=0.47$, $p=.494$, $\eta_p^2=.004$). We also observed, that young adult faces in the child-individuation group were recognised better at post-test than at pre-test ($F(1,131)=5.32$, $p=.023$, $\eta_p^2=.039$). There was no change in performance from pre- to post- test for the remaining comparisons (all $F<0.67$, all $p>.413$).

We further explored the improved recognition of older adult faces post old-individuation training and found that the OAB that was present between young and older adult faces at pre-test ($t(67)=4.07$, $p<.001$, $d_{av}=0.55$) was eliminated by post-test ($t(67)=1.40$, $p=.167$, $d_{av}=0.18$). Additionally, the improvement in older adult face recognition could be traced back to a reduction in false alarm rates ($t(67)=2.52$,

p=.014, d_{av}=0.37) rather than an increase in hit rates (t(67)=0.28, p=.784, d_{av}=0.03). This in turn resulted in marginally more conservative responding to older adult faces at post-test compared to pre-test (t(67)=1.95, p=.055, d_{av}=0.25). The increase also meant that the response bias OAB seen at pre-test where young faces were responded to more conservatively than older adult faces (t(67)=4.04 p<.001, d_{av}=0.60) was eliminated at post-test (t(67)=0.06, p=.953, d_{av}=0.01), though this was in part driven by more liberal responding to young adult faces at post-test (t(67)=2.22, p=.030, d_{av}=0.34).

While we found an overall OAB in *d'* between young and older adult faces at pre-test in our sample (t(132)=13.19, p=.002, d_{av}=0.32), we did not find one between young and child faces (t(132)=0.57, p=.567, d_{av}=0.06). In the child-individuation group specifically, we did not find either a young-old (t(64)=0.64, p=.522, d_{av}=0.09) or young-child OAB (t(64)=0.85, p=.398, d_{av}=0.12). Given the lack of baseline OAB, we have not followed up the findings of this group any further.

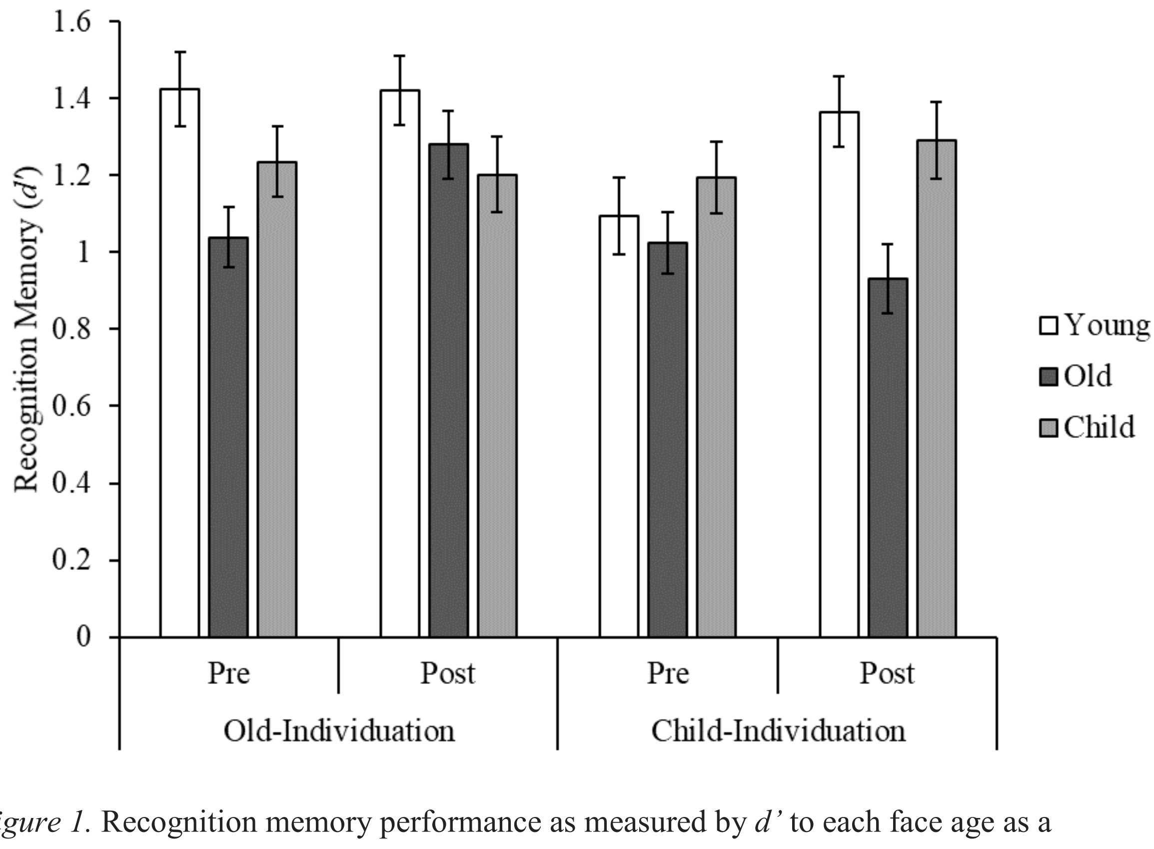

Figure 1. Recognition memory performance as measured by *d'* to each face age as a function of time and group in the total sample. Error bars are one standard error of the mean.

Analysis of restricted sample. The mixed ANOVA analysis conducted on the pre-registered sample produced a marginally significant three way interaction between time, face age and group (see Figure 2 and Table 1; $F(2,106)=2.70$, $p=.072$, $\eta_p^2=.048$). There was also a significant main effect of face age ($F(2,106)=8.92$, $p<.001$, $\eta_p^2=.144$) and the other effects remained non-significant (all $F<2.76$, all $p>.100$). While the pattern of results in this smaller sample was comparable, exploratory follow-up of the three-way interaction found that the significant change over time for older adult faces in the old-individuation group did not reach significance ($F(1,107)=2.18$, $p=.143$, $\eta_p^2=.020$). The interaction was instead driven by the significant change over time for young adult faces in the child-individuation group ($F(1,107)=7.54$, $p=.007$, $\eta_p^2=.066$). The change over time for child faces in the child-individuation group remained non-significant ($F(1,107)=0.62$, $p=.434$, $\eta_p^2=.006$) as did the remaining comparisons (all $F<0.38$, all $p>.538$).

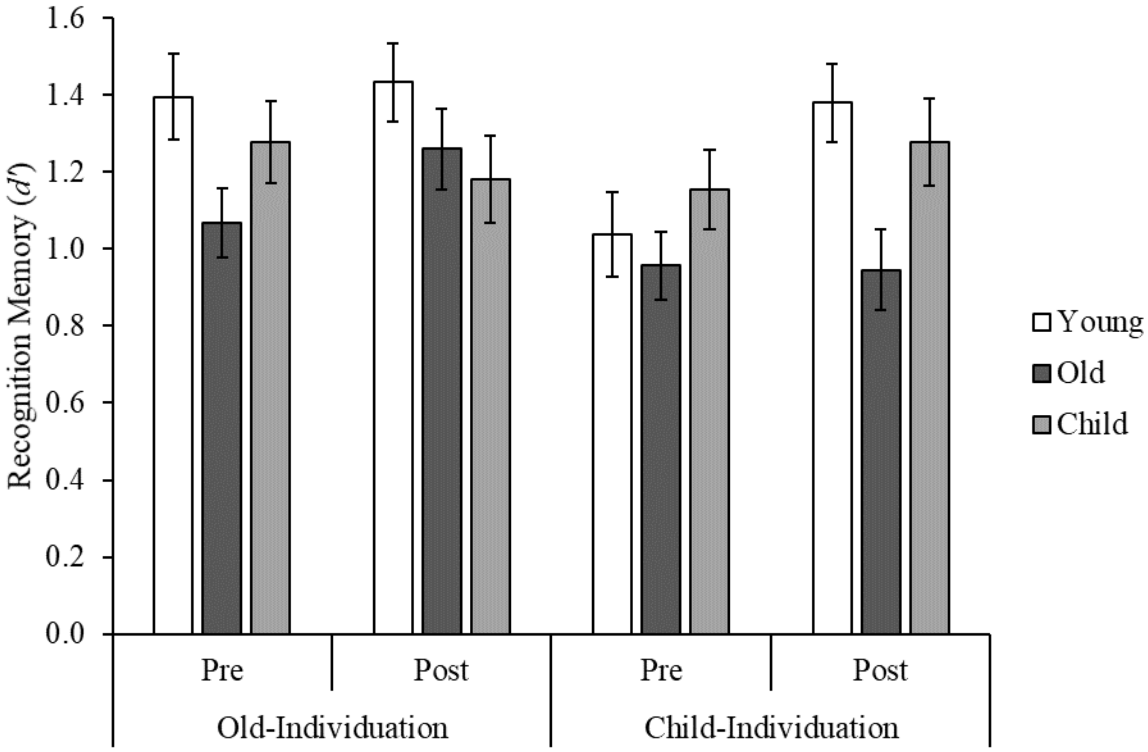

Figure 2. Recognition memory performance as measured by *d'* to each face age as a function of time and group in the restricted sample. Error bars are one standard error of the mean.

Table 1.

Recognition memory performance as measured by d' to each face age as a function of time and group in both the total and restricted samples.

Time	Total Sample			Restricted Sample		
	Child	Young Adult	Older Adult	Child	Young Adult	Older Adult
			Old-Individuation			
Pre	1.24(0.66)	1.43(0.80)	1.04(0.61)	1.28(0.67)	1.40(0.83)	1.07(0.62)
Post	1.20(0.88)	1.42(0.76)	1.28(0.82)	1.18(0.93)	1.43(0.76)	1.26(0.87)
			Child-Individuation			
Pre	1.20(0.85)	1.09(0.80)	1.03(0.69)	1.16(0.87)	1.04(0.81)	0.96(0.71)
Post	1.29(0.73)	1.37(0.71)	0.93(0.62)	1.28(0.73)	1.34(0.74)	0.95(0.66)

Note. Standard deviations are reported in brackets.

Affective Priming

A mixed ANOVA with within-participant factors of time (pre-test, post-test) and prime (young, child, old) and a between-groups factor of group (old-individuation, child-individuation) was conducted on the prime score data (see Figure 3). There was a significant main effect of time ($F(1,131)=4.57$, $p=.034$, $\eta_p^2=.034$) such that priming scores increased from pre- to post-test. There was also a main effect of prime ($F(1,130)=15.07$, $p<.001$, $\eta_p^2=.188$) such that scores were lower for old primes than young ($t(132)=5.17$, $p<.001$, $d_{av}=0.53$) and child primes ($t(132)=4.63$, $p<.001$, $d_{av}=0.48$). Young and child prime scores did not differ ($t(132)=0.58$ $p=.561$, $d_{av}=0.05$).

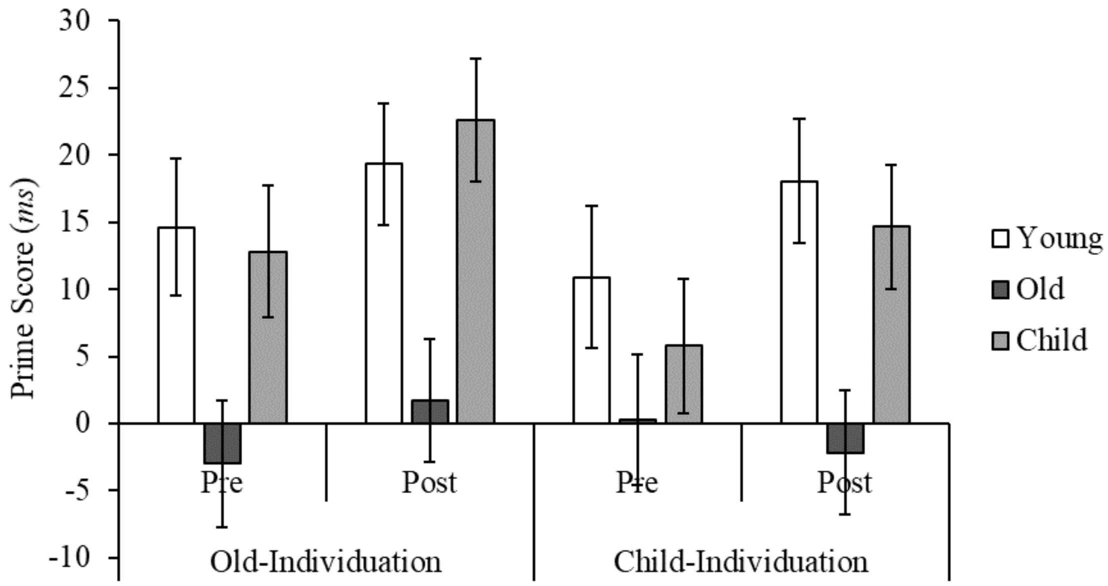

Figure 3. Priming scores to young, old and middle aged faces measured in milliseconds as a function of time and individuation group. Error bars are one standard error of the mean.

Training Errors

A paired samples t-test was conducted on the error rates from the first and last session of training participants completed and found that error rates decreased over the training period for each group (old-individuation: $t(67)=4.88$, $p<.001$, $d_{av}=0.56$; child-individuation: $t(64)=7.95$, $p<.001$, $d_{av}=1.13$). Error rates were also examined for participants who had completed all five unique training sessions ($n_{\text{old-individuation}}=57$, $n_{\text{child-individuation}}=61$). Error rates from these participants were subjected to a mixed ANOVA (see Figure 4) with a within-participant factor of session number (1, 2, 3, 4, 5) and a between-groups factor of group (old-individuation, child-individuation). The results revealed a main effect of session number ($F(4,113)=21.74$, $p<.001$, $\eta_p^2=.435$) and an interaction between session number and group ($F(4,113)=4.00$, $p=.005$, $\eta_p^2=.124$). The main effect of group was not significant ($F(1,116)=0.02$, $p=.901$, $\eta_p^2<.001$). Tests of within-subject contrasts showed a significant interaction between group and the linear trend for session ($F(1,116)=11.49$, $p=.001$, $\eta_p^2=.090$). This was such that there were significant linear trends in both groups, and that error rates reduced faster in the child-individuation group (old-individuation: $F(1,56)=14.85$, $p<.001$, $\eta_p^2=.210$; child-individuation: $F(1,60)=61.32$, $p<.001$, $\eta_p^2=.505$).

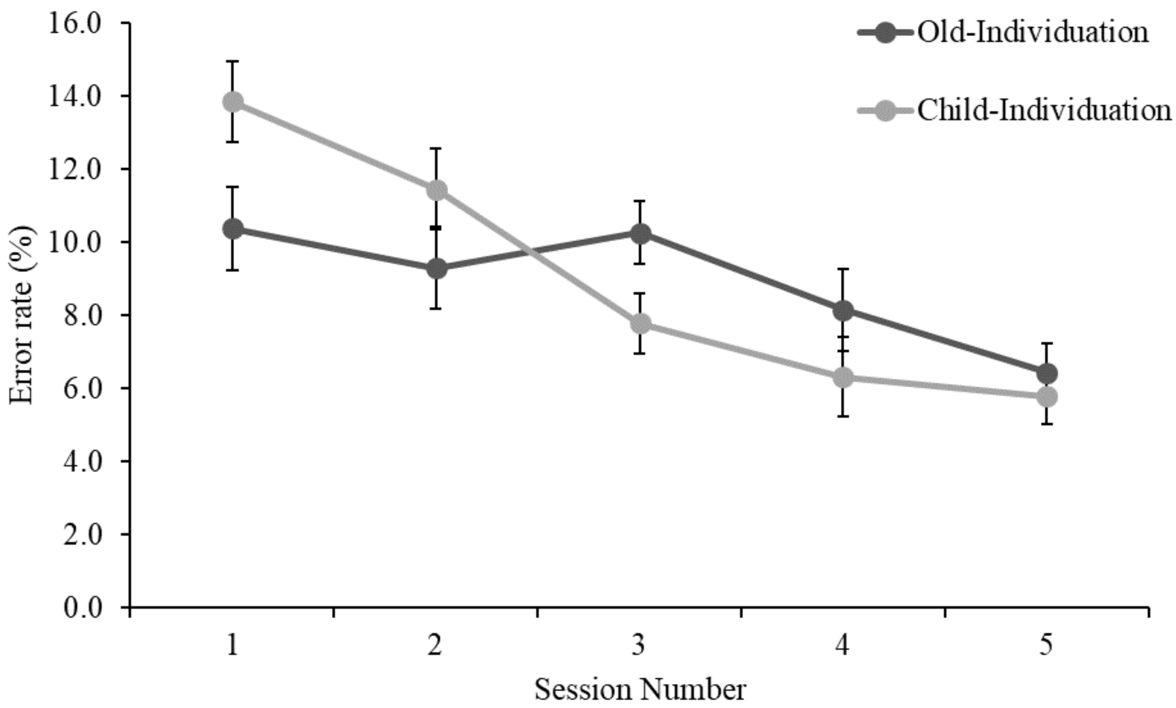

Figure 4. Error rate (proportion) to individuated faces in each training session as a function of group. Error bars are one standard error of the mean.

Questionnaire Measures

Analysis of questionnaire responses showed that amount of contact, positive attitude and social identification strength measures reported at pre-test were greater for young adults than for older adults or children (all t>3.37, all p<.002) and groups did not differ on any of these measures (all t<1.37, all p>.174). Further exploration found that participants reported higher quality of interaction with older adults compared to children ($t(132)=5.84$, $p<.001$, $d_{av}=0.60$), that they liked older adults more than children ($t(132)=2.63$, $p=.010$, $d_{av}=0.29$), and that they identified with older adults marginally more than with children ($t(132)=1.89$, $p=.062$, $d_{av}=0.18$). There was no difference, however, in the number of people known, frequency of interaction, or frequency of meeting new people who were older adults or children (all t<1.30, all p>.199).

Exploration of correlation between contact measures and recognition memory was conducted. No correlations were found between reported contact with older adults and pre-test *d'* for older adult faces (all r^2<.029, all p>.226). Similarly, no correlation was found between reported contact with children and pre-test *d'* for child faces (all r^2<.006, all *p*>.382).

Discussion

In the current study we aimed to evaluate the causal role of individuation experience in other-age face recognition. We hypothesised that individuation training, where participants actively practiced extracting identity information, would improve subsequent recognition of novel faces. Our results supported this, with old individuation training improving recognition of older adult faces.

Consistent with Tanaka and Pierce's (2009) findings, our analysis of recognition memory found individuation training improved recognition of other-group faces. After old-individuation training, participants were better able to recognise novel older adult faces. Further exploration of this finding showed that participants did this by reducing the number of false alarms they were making. Both the OAB in recognition memory, and in response bias that were present at pre-test were absent at post-test.

While we found an effect of individuation training on recognition performance we did not find any effect of categorisation training. This suggests that individuation experience, rather than mere exposure or other types of face processing, is necessary to change recognition memory. This is consistent with existing evidence showing that passive exposure to infant faces does not improve recognition memory of neonatal nurses (Yovel et al., 2012).

In addition to the recognition memory results, the data also indicate that implicit attitudes were not affected by training. Scores did increase overall, but this was not dependent on the type of training received. This suggests that recognition performance changes were not a result of co-occurring changes in implicit attitudes. This supports other OAB studies of pre-existing differences in contact that conclude support for a perceptual-expertise account of the bias (Ebner & Johnson, 2009; Harrison & Hole, 2009; He et al., 2011; Macchi Cassia et al., 2009; Wiese, Wolff, et al., 2013). It also suggests that individuation experience with other-age faces without corresponding changes in implicit attitudes is sufficient to result in better recognition memory performance. It does, however, diverge from findings in the ORB field where effects of individuation training have been observed on implicit bias (Lebrecht et al., 2009), potentially suggesting distinctions between the ORB and OAB.

While the findings for the old-individuation group support a causal role of individuation experience in the OAB, data from participants in the child-individuation group do not. Here, we found no change in recognition memory post individuation-training. Pre-test recognition performance for child faces was already high, indicating our sample could already recognise these types of faces well. Given this, the size of improvement in recognition possible for child faces may have been too small to observe with statistical significance in this sample.

In the analysis of training errors, participants who individuated child faces displayed a faster reduction in training errors in comparison to those who individuated older adult faces. This might suggest that the task was easier to do with child faces than older adult faces and the quality of individuation training may have been insufficient to change memory performance. One reason this might have occurred is due to the stimuli examined. In order to have a sufficient number of stimuli and identities for participants to be trained and tested on, faces were selected from multiple databases. Constraints on these stimulus sets meant that only one image was available for each identity and as such, participants might have been learning to discriminate some faces through image cues (e.g., particular quality of lighting in the photo) rather than identity cues (e.g., shape of the eyes). Child face stimuli came from different databases than the young and older adult faces, and this database might have had more image cues that aided recognition of the faces. Future research could aim to use more varied image sets with multiple images for each identity to encourage individuation of identities rather than images.

There was also an unexpected finding that recognition of young adult faces improved from pre-test to post-test in the child-individuation group. No training intervention was provided for these faces and so it is unclear why this change occurred. Recognition performance appears unusually low in the pre-test for the child-individuation group, suggesting that the difference may be driven by something that happened at pre-test, and not an improvement seen over time. Future replication of this study and follow-up research is required to determine if this is a chance anomaly or caused by another factor.

Another caveat to these results is provided by the restricted sample analysis results. While in the total sample old individuation significantly improved old face recognition, it did not in the restricted sample. The restricted sample was smaller than our pre-registered sample but excluded participants who were other-race, older than 31, or did not complete all training sessions. For reasons outlined in our methods we do not believe that including these participants in the sample conferred any benefit other than increased power. As such, the lack of a significant effect in the restricted sample speaks to the small-medium size of the effect yielded from this current amount of training and this particular training task.

Our results show that mere exposure, or categorisation of faces is insufficient to gain expertise useful in recognising face identity. What is necessary is practice in processing faces with a focus on identity specific information. While our current results cannot tell us exactly how this training modifies encoding behaviour, we agree with Tanaka and Pierce's (2009) suggestion that attention is trained towards identity diagnostic information. Participants have a short amount of time in which to capture important information from faces and training likely provides the opportunity to learn where to strategically direct their attention. Future research to confirm and explore this could use eye tracking during training to determine whether and how gaze patterns are altered.

Overall, our results are consistent with a perceptual-expertise account of the OAB. Specifically, those stipulating a role of individuation experience. These results, however, do not necessarily preclude a role for social-cognition in the OAB, with integrative accounts such as the CIM (Hugenberg et al., 2010) accounting for individuation experience. However, they suggest that changes in expertise need not co-occur with changes in implicit bias and that individuation experience is sufficient to change recognition memory.

These data provide the first evidence that experimentally manipulated individuation experience can improve other-age face recognition and demonstrate that improvements in memory for older adult faces can be achieved over a relatively short period of training. These findings contribute to our understanding of the mechanisms underlying the OAB and can assist in the development of interventions to reduce bias. Future research could delve deeper into understanding how individuation training improves recognition, for example using eye tracking to determine if patterns of viewing or attention change in response to training to better focus on identity-diagnostic information in face. Future research could also aim to optimise training. Follow-up studies could determine how long training effects last and how many sessions of training are necessary to produce lasting changes in performance. Additional exploration of the training task itself could also be undertaken to find tasks and training regimes that improve the speed of learning.

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CHAPTER 6 - GENERAL DISCUSSION

The aim of this thesis was to explore the contribution of social-cognition, as conceptualised in the categorisation-individuation model (CIM), to the own-age bias (OAB; Hugenberg, Young, Bernstein, & Sacco, 2010). Previous studies of the OAB have largely investigated the role of perceptual-expertise with limited research evaluating the role of social-cognition. Across four studies this thesis investigated the three components of the CIM; motivation, categorisation and individuation experience, on the OAB.

Summary of Findings

In Chapter 2, the role of motivation in the OAB was explored using emotional expressions. Emotional expressions communicate important social information that can inform observers about the importance of remembering a person, and motivate greater individuation of faces (Ackerman et al., 2006). Three emotional expressions were explored; angry, happy, and sad. Each communicates slightly different information to the observer. Angry faces provide a threat signal while happy faces provide an affiliative signal. Sad faces in contrast signal neither risk nor reward. As such, it was hypothesised that angry and happy emotional expressions would reduce the OAB, while sad emotional expressions would not. Across two experiments, we observed that the OAB, observed when faces were neutral, was absent when faces had emotional expressions, regardless of which emotional expression was examined. Further exploration found recognition performance was higher for other-age faces with emotional expressions than neutral expressions. While it was predicted that the effects of emotional expressions would differ from one another, it is likely that all emotional expressions are engaging and socially meaningful, and prompt individuation of other-age faces. As such, the findings of Chapter 2 support the role of motivation in the OAB.

In Chapter 3 and Chapter 4, the role of categorisation in the OAB was examined using manipulations of category activation. When a category is more strongly activated it draws attention to category cues, resulting in the encoding of more category-diagnostic information from a face that is not useful for identity recognition (Levin, 2000). In Chapter 3, middle age faces were presented alongside either young adult or older adult faces for young adult participants to remember. The design aimed to manipulate the strength of other-age category activation of middle aged faces. It was hypothesised that when presented alongside young adult own-age faces that other-age categorisation would be stronger for middle aged faces than when they were presented alongside more own-age dissimilar older adult faces. However, across four studies, middle aged face recognition did not change and support was not found for a role of categorisation in the OAB.

In Chapter 4, a manipulation that aimed to supress category activation was explored. Recognition of young and older adult faces was tested when they were presented together mixed in the same task (within-participants), or separately in pure age tasks (between-groups). The manipulation aimed to alter age salience, and hence category activation. It was hypothesised that when age salience was high in the mixed condition, that the OAB would be present, and that when age salience was low in the pure age conditions that it would be smaller or absent. Despite having been shown to successfully alter recognition performance in another study (Bryce & Dodson, 2013), Chapter 4 found that across three variations of the paradigm, the age salience manipulation did not moderate the size or presence of the OAB. As with Chapter 3, Chapter 4 does not support a role of categorisation in the OAB.

Lastly, Chapter 5 explored the role of individuation experience in the OAB. This factor represents the perceptual-expertise component of the CIM that proposes expertise comes from motivated learning in which observers practice identity recognition (Hugenberg et al., 2010). To explore whether individuation experience has a causal role in the OAB, a pre/post training study was conducted where the effect of individuation training on novel other-age face recognition was examined. Young adult participants completed two memory tasks separated by five training sessions. During training, participants viewed faces of older adults and children and were trained to learn individual identities for one age group (individuation training), and learn to categorise the faces of the other age group (categorisation training). It was hypothesised that individuation training would improve novel face recognition, while categorisation training would not. This prediction was partially supported, with individuation training improving novel older adult face recognition. The findings of Chapter 5 support a role for individuation experience in the OAB.

Together, the findings of this thesis suggest that social-cognition plays a role in the OAB. Specifically, motivation can moderate the OAB. When participants are provided with socially relevant other-age faces (with emotional expressions) and are motivated to learn to recognise other-age faces (with individuation training), then the OAB can be reduced. Additionally the findings support two components of the CIM; motivation and individuation experience. No evidence was found for the role of categorisation processes in the OAB. This may be because categorisation is not involved in the OAB, or could suggest that the manipulations explored in this thesis were not sufficient to change age categorisation processes.

Motivation to Individuate

The finding that motivation is important in the OAB is consistent with emerging evidence in the literature. A study by Proietti, Laurence, Matthews, Zhou, and Mondloch (2018) explored the role of social cognition in the OAB and own-race bias (ORB). Experiment 1 examined the OAB and had young adult participants complete an old/new recognition memory test. During encoding, participants were presented young and older adult faces in either a passive viewing task, or an identity matching task. In the identity matching task, participants viewed images two at a time and were tasked with deciding if they were images of the same person or of different people. This task manipulation was designed to motivate participants to attend to individuating features on the faces. The OAB that was present in the passive encoding condition was absent in the identity matching condition. Proietti et al. concluded from this that social-cognition has a role in the OAB and that observers can be motivated to attend to individuating face features.

Another study concluding that there is a role of motivation in the OAB was conducted by Mukudi and Hills (2019). The study aimed to examine whether the OAB, ORB, and own-sex bias (OSB) are based on the same mechanism. To do so they had participants complete an old/new recognition memory test with faces that varied in age (young, older adult), race (white, black), and sex (male, female). During encoding, participants rated the distinctiveness of each face. Mukudi and Hills hypothesised that biases with the same underlying mechanisms should display additive effects where recognition is worse when more out-group features are present on a face. Biases with different underlying mechanisms, in contrast, should remain independent. The memory results supported an additive effect between the OAB and

OSB such that recognition performance was poorest when both other-age and other-sex cues were present. However, the ORB was stable with neither of the other-group cues influencing the size of the bias, suggesting a different underlying mechanism. Examination of the distinctiveness ratings provided during encoding further supported this with an ORB, but no OAB or OSB found, suggesting that individuation processes are disrupted by other-race category cues, but not by other-age nor other-sex cues. Taken together, Mukudi and Hills concluded that motivation processes are more important for the OAB and OSB, while categorisation processes are more important for the ORB.

One study that did not find support for a role of motivation in the OAB examined individuation instructions. Craig and Thorne (2019) aimed to motivate participants to individuate other-age faces by providing them with instructions on how to do so. Young adult participants completed an old/new recognition test with young and older adult faces. At the beginning of encoding they were provided information about what the OAB is, and asked to try to avoid the OAB by paying close attention to what differentiates one face from another of the same age (see Craig & Thorne for verbatim instructions). These instructions were modified from studies of the ORB that have successfully shown that individuation instructions reduce the ORB (e.g., Hugenberg et al., 2007; Young & Hugenberg, 2012). However, the instruction manipulation did not moderate the OAB and no support was found for the role of motivation in the OAB.

There are differences between the studies of this thesis and Craig and Thorne's (2019) study, and alternative explanations which might explain why different conclusions regarding the role of motivation were reached. Firstly, Craig and Thorne explored the manipulation of a perceiver cue to motivation using individuation instructions while Chapter 2 explored a target cue using emotional expressions. It may be that target cues more successfully manipulate motivation to individuate other-age faces than perceiver cues do. Secondly, research from the ORB field suggests that a certain amount of other-age individuation experience may be necessary for social-cognitive manipulations to be successful. When Young and Hugenberg (2012) examined the effect of individuation instructions on the ORB, they found that, for participants who were instructed to individuate, the size of their ORB correlated with their interracial experience such that those with higher experience had a smaller bias. In the case of Craig and Thorne's study, participants' other-individuation experience may have been too low for individuation instructions to have an observable effect on recognition memory. Lastly, in Chapter 5, instructing participants to individuate older adult other-age faces during training in conjunction with practice and feedback on performance improved novel older adult face recognition. It may be the case that instructions to individuate other-age faces are only successful in combination with individuation experience or in a task that necessitates individuation (e.g., Proietti et al., 2018) rather than one that just provides instructions to pay attention to what differentiates one face from another.

Categorisation in the OAB

Neither Chapter 3 nor Chapter 4 found evidence for the role of categorisation in the OAB. While the CIM predicts category activation to play a role in producing own-group biases, there are reasons that it may not in the case of the OAB. Unlike in other own-group biases where physiognomic facial cues to group membership are present, the OAB is based on cues that are not stable over the lifetime. Race and sex rarely change while age is always changing. As a result, what was once an observer's age in-group will in time become their age out-group, and vice versa. For this reason many perceptual-expertise models of the OAB specify that expertise is restricted to recent experiences (see Hills, 2012 for a discussion).

It is the case, however, that faces from different age groups look different and will be automatically categorised, and that young adult observers, who were the focus of this thesis, do not yet have experience with older age in-groups. As such, categorisation is occurring, and theories explaining the OAB will need to account for why categorisation does not impact the bias. One way in which this could be accounted for is in considering the importance and salience of age group membership.

The diversity of experience observers have over the lifespan with faces from different age groups could have the effect of making own-age and other-age groups less oppositional. Without a strong 'us' versus 'them' mentality, age groups may be less salient and categorisation processes may have less influence on face encoding. A study by Harrison, Hole, and Habibi (2020) explored group salience in their UK study of own-group biases. They examined face recognition in a paradigm where participants were provided group membership information (university affiliation) about a set of Caucasian young adult male faces. Unlike in similar studies conducted in the USA (e.g., Bernstein, Young, & Hugenberg, 2007), they did not find that providing information about whether each face belonged to the participant's university or a rival university caused an own-group bias to emerge. University rivalries are not as salient in the UK as they are in the USA, so Harrison et al. conducted the same study with BREXIT stance as the group membership cue instead. In this experiment they did find the own-group bias for 'remain' voters and argued that the salience of the category and importance of group membership to these participants produced the bias. It may be then that categorisation is less important to the OAB because age is a less divisive and less salient category than say, race.

In contrast to the conclusions of Chapter 3 and Chapter 4, a recent study conducted by Rollins, Olsen, and Evans (2020) has suggested that categorisation does play a role in the OAB. They conducted a study of the OAB in which young adult participants completed an old/new recognition test with young adult and child faces. During encoding, participants were tasked with categorising either the age or sex of the faces. The resulting OAB was larger when participants categorised faces by age than by sex. Rollins et al. concluded from this that categorisation matters for the OAB. Neither Chapter 3 nor Chapter 4 found evidence for a role of categorisation in the OAB, however, the encoding task was passive in all but one case, Chapter 3 Experiment 3, where faces were categorised only by age. The manipulations also only targeted activation of age categories and did not explore manipulations targeting the activation of other categories like sex. Even though the methods of Chapter 3 and Chapter 4 used a variety of stimuli and paradigms it remains possible that categorisation has an effect on the OAB. What the findings do suggest though, is that the effects of categorisation on the OAB are likely smaller or more restricted than they are on other biases like the ORB. Further exploration of the conditions under which categorisation matters is required.

Perceptual Expertise as an Alternative Explanation

The results of this thesis support the role of motivation in the OAB and hence for a role of social-cognition. However, as discussed in individual Chapter General Discussions, there remains the possibility that findings can be explained most parsimoniously by perceptual-expertise processes. For instance, the lack of moderation of the OAB by categorisation manipulations observed in Chapter 3 and 4 is, when considered alone, most parsimoniously explained by perceptual-expertise and a lack of social-cognition in the OAB.

In the case of Chapter 2, where emotional expressions were found to eliminate the OAB, there remains a limit on interpretations we can make about these data. Only young adult participants were tested and so, own-age faces were always young adult faces, and other-age faces were always older adult faces. It could be that there is some perceptual facet of emotional older adult faces that makes them easier to recognise than neutral older adult faces. Mileva and Burton (2018), for instance, found that in an unfamiliar face matching task, smiling faces result in higher accuracy than neutral faces. They determined that this was likely because when smiling, idiosyncratic information in faces is highlighted making them more distinctive. If something similar happens to older adult faces with emotional expressions, they may also become more distinctive. According to a multidimensional face space model account (Valentine, 1991) this enhanced distinctiveness would result in the encoding of a face representation that is more easily recognised. However, Chapter 2 tested three different emotional expressions that distort faces in different ways and no difference in recognition performance was noted between them. There were also no changes in performance when young adult faces were neutral versus emotional in expression.

In order to exclude a perceptual-expertise explanation of the Chapter 2 results, future research should aim to replicate the study with older adult participants. By keeping the stimuli constant, and only changing the participant age group (and hence which faces are own-age and which other-age), social-cognitive effects based on group membership, and perceptual-expertise effects based on stimulus differences can be separated. If emotional expressions increase motivation to individuate other-age faces as we have argued in Chapter 2, then the particular age of the face will not matter. When other-age faces are young adults (instead of older adults), we should observe better recognition of these faces with emotional compared to neutral expressions. In contrast, if emotional expressions increase the perceptual distinctiveness of older adult faces we should observe the same pattern of results as seen in Chapter 2 with recognition of older adult faces better when displaying emotional versus neutral expressions.

In the case of the results of Chapter 5, individuation experience was found to improve novel other-age face recognition. While consistent with the CIM, this is also consistent with a contact based perceptual-expertise account of the OAB. Contact based expertise accounts suggest that greater contact with a particular group of people affords more opportunity to practice recognising them, in turn improving future encoding and recognition. This description is very similar to the CIM description of individuation experience, though in the CIM, the influence of individuation experience is said to be impacted by the co-occurring influences of motivation and categorisation. As such, while Chapter 5 demonstrates the causal effect of individuation experience (but not mere exposure to faces) on other-age face recognition, future research that examines how this relationship is influenced by motivation is necessary to distinguish this factor from contact based perceptual-expertise accounts.

Implications for Theory

The results of this thesis provide some support for the role of social-cognition to the OAB, but they also inform our understanding of the suitability of the CIM as a model of the OAB. The CIM predicts that motivation, categorisation, and individuation experience will all contribute to the OAB. However, this thesis has produced support for only motivation and individuation experience, and not categorisation. As such, this model may not be suitable to describe the OAB.

Since the proposal of the CIM, research has emerged to describe a range of other own-group biases not based on physiognomic facial features, for instance, those based on university affiliations, sexual orientation and personality type groups (e.g., Bernstein, Young, & Hugenberg, 2007; Rule, Ambady, Adams, & Macrae, 2007; Hehman, Mania, & Gaertner, 2010). In response to this, Hugenberg, Wilson, See and Young (2013) proposed an extended CIM to account for all own-group biases. In this model they suggested that individuation motivation and individuation experience contribute to own-group biases. The categorisation component that was discussed as a distinct component in the original model has instead been incorporated into the other factors of the extended model. This is such that category activation is something that can influence observers' motivation to individuate. This allows the model to better account for own-group biases that are not based on physiognomic facial features, but also means that it can better account for biases where categorisation is less salient.

The current thesis used the CIM model to explore the OAB as cues to the age category are endogenous to the face. Given the findings of Chapter 3 and 4 relating to categorisation, the extended CIM model may be more suitable to describe the OAB. However, given that categorisation is still occurring in many of the cases where facial cues to group membership are present, a model that specifies a category salience component, rather than a general categorisation component, may be better suited to describing the OAB.

Future Directions

This thesis has explored individuation and categorisation processes in the OAB providing evidence for a role of social-cognition. While focussing on the OAB, the conclusion that motivation but not categorisation is important for identity recognition diverges from conclusions in the literature regarding the ORB. As alluded to in earlier sections of this chapter, the underlying mechanisms and relative contribution of different types of social-cognition may be different for the OAB than the ORB. For instance, Proietti et al. (2018) found that the OAB could be eliminated by using an identity matching task during encoding to manipulate perceiver motivation. However, when in a second experiment they varied face race instead of age, they found that motivation did not moderate the ORB. Mukudi and Hills (2019) also concluded a difference between the OAB and ORB in their study of multiple out-group cues suggesting that the OAB relies on motivation, while the ORB relies on categorisation. Further evidence to support a role of categorisation in the ORB can also be seen in studies manipulating interracial contexts (Young, Hugenberg, Bernstein, & Sacco, 2009) and group distinctiveness threat (Wilson & Hugenberg, 2010).

Future research could aim to further compare the OAB and ORB to determine whether underlying mechanisms are shared or distinct. For instance, the paradigm of Chapter 4, where own-age and other-age faces were presented in the same task or separate tasks, could be used to explore category activation in the ORB. Mukudi and Hills' (2019) paradigm where multiple group cues were varied could also be used to explore the effect of social-cognition under conditions where different types of, and different numbers of out-groups cues are present. Understanding whether the OAB and ORB are the same type of phenomenon would inform discussions about whether own-group biases in general have shared mechanisms. This is useful to know for the development of interventions to reduce identity recognition biases and for understanding whether different interventions are needed for different types of biases.

Further to this, future research could apply the findings of this thesis to the development of training interventions to reduce the OAB. In workforces where other-age recognition is important, such as in the aged care sector, improving identity learning could improve service quality. Aged care workers in residential nursing homes are increasingly being asked to care for more clients and are given less time to do so. Development of training protocols such as those in Chapter 5 could prove useful in improving workers' ability to learn the identities of those they care for, resulting in a higher quality care for their clients and a reduction of the negative consequences of recognition errors.

Future research could explore how to make this training more efficient and long lasting. Factors such as individuation difficulty, number of faces to individuate, and number of training sessions could all be explored to optimise an individuation training program. The inclusion of motivational factors to assist in individuation experience acquisition could also be explored, such as examining the inclusions of emotional expressions or ways to make the task more engaging. A recent study by Bate, Adams, and Bennetts (2020) has demonstrated that a gamified discrimination training task is successful in improving face recognition in children. While it did not specifically explore whether the training was more successful because of the game format, this type of task could be examined in adult populations to increase motivation and improve learning.

Conclusions

Across four studies this thesis has found support for the role of social-cognition in the OAB. Motivation to individuate (with emotional expressions) and motivated expertise learning (with individuation training) were both demonstrated to influence the OAB. No evidence was found for categorisation, though future exploration is required to further understand the role of this factor. Future research can use this new knowledge to explore the potential similarities and differences in mechanisms underlying the OAB and other own-group biases, like the ORB, and to develop interventions to reduce bias.

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APPENDIX A: CHAPTER 2 SUPPLEMENTARY ANALYSES

Experiment 1

Age Group Contact

A score for young adult and for older adult contact was calculated by taking the average of the responses made to the two young adult and two older adult contact questions. When the data were subjected to a paired samples t-test, participants were found to have significantly higher contact with young than older adults ($t(63) = 8.33$, $p<.001$, $d_{av}=1.11$).

To examine the association between this measure and the magnitude of the OAB, correlations were conducted. An OAB score was calculated by taking the difference between *d'* scores for the young and the older adult faces. Results indicated that neither young adult contact ($r_s(62) = -.210$, $p=.096$) nor older adult contact ($r_s(62) = -.183$, $p=.148$) correlated with OAB score.

Remember/Know/Guess

Remember/know/guess trials followed test trials that participants responded 'seen' to. As such, each participant received as many trials as they made 'seen' responses. In line with another study investigating the effect of emotional expression on face recognition (Chen et al., 2015), proportion scores were calculated and data examined separately for each response type. Scores were calculated representing the proportion of the time a particular response (remember/know/guess) was made for a particular aged face (young/old). For example, a score of 0.33 for young faces in the 'remember' response type indicates that 33% of the responses to young 'seen' faces were 'remember'. Paired sample t-tests were conducted separately for each response type comparing scores for young and older adult faces. Results indicate participants responded 'remember' the same proportion of time when the face was young compared when it was old ($t(63) = 0.93$, $p=.356$, $d_{av}=0.10$), and that this pattern held for both 'know' ($t(63) = 0.33$, $p=.742$, $d_{av}=0.04$) and 'guess' responses ($t(63) = 0.70$, $p=.484$, $d_{av}=0.08$).

Experiment 2

Age Group Contact and Social Identification

Group contact data were subject to a paired samples t-test (two participants were excluded due to missing data) and results indicate participants had significantly higher contact with young than older adults ($t(69) = 7.69$, $p<.001$, $d_{av}=1.26$).

Social group identification results were subjected to a paired samples t-test which indicated that participants identified significantly more with young adults than older adults ($t(71) = 11.10$, $p<.001$, $d_{av}=2.09$).

Correlations were conducted between young adult contact, older adult contact, young adult identification and older adult identification, and an OAB score calculated from the young and older adult neutral faces (young neutral *d'* – old neutral *d'*). The OAB score did not correlate with young adult contact ($r_s(68)= -.069$, $p=.573$), older adult contact ($r_s(68) = -.126$, $p=.298$), young adult identification ($r_s(70) = -.107$, $p=.370$), or older adult identification ($r_s(70) = .167$, $p=.161$).

Remember/Know/Guess

For each participant, scores were calculated representing the proportion of the time a particular response was made for that aged face (young/old) with that particular emotional expression (neutral/angry). A 2 (face age: young, old) × 2 (face emotion: neutral, angry) repeated measures ANOVA was conducted for each response type. No significant results were found although the main effect of face emotion in the 'know' and 'guess' data trended towards significance as well as the main effect of face age in the 'guess' data.

Full results are reported in Tables 1-3 and Figure 1.

Table 1

Experiment 2 ANOVA results for 'remember' responses

Effect	F	$df_{hypothesis}$	df_{error}	p	η_p^2
Face Age	1.00	1	71	.322	.014
Face Emotion	0.05	1	71	.817	.001
Face Age x Face Emotion	1.44	1	71	.234	.020

Table 2

Experiment 2 ANOVA results for 'know' responses

Effect	F	$df_{hypothesis}$	df_{error}	p	η_p^2
Face Age	0.01	1	71	.909	.000
Face Emotion	3.11	1	71	.082	.042
Face Age x Face Emotion	0.15	1	71	.697	.002

Table 3

Experiment 2 ANOVA results for 'guess' responses

Effect	F	$df_{hypothesis}$	df_{error}	p	η_p^2
Face Age	3.44	1	71	.068	.046
Face Emotion	3.73	1	71	.058	.050
Face Age x Face Emotion	1.46	1	71	.231	.020

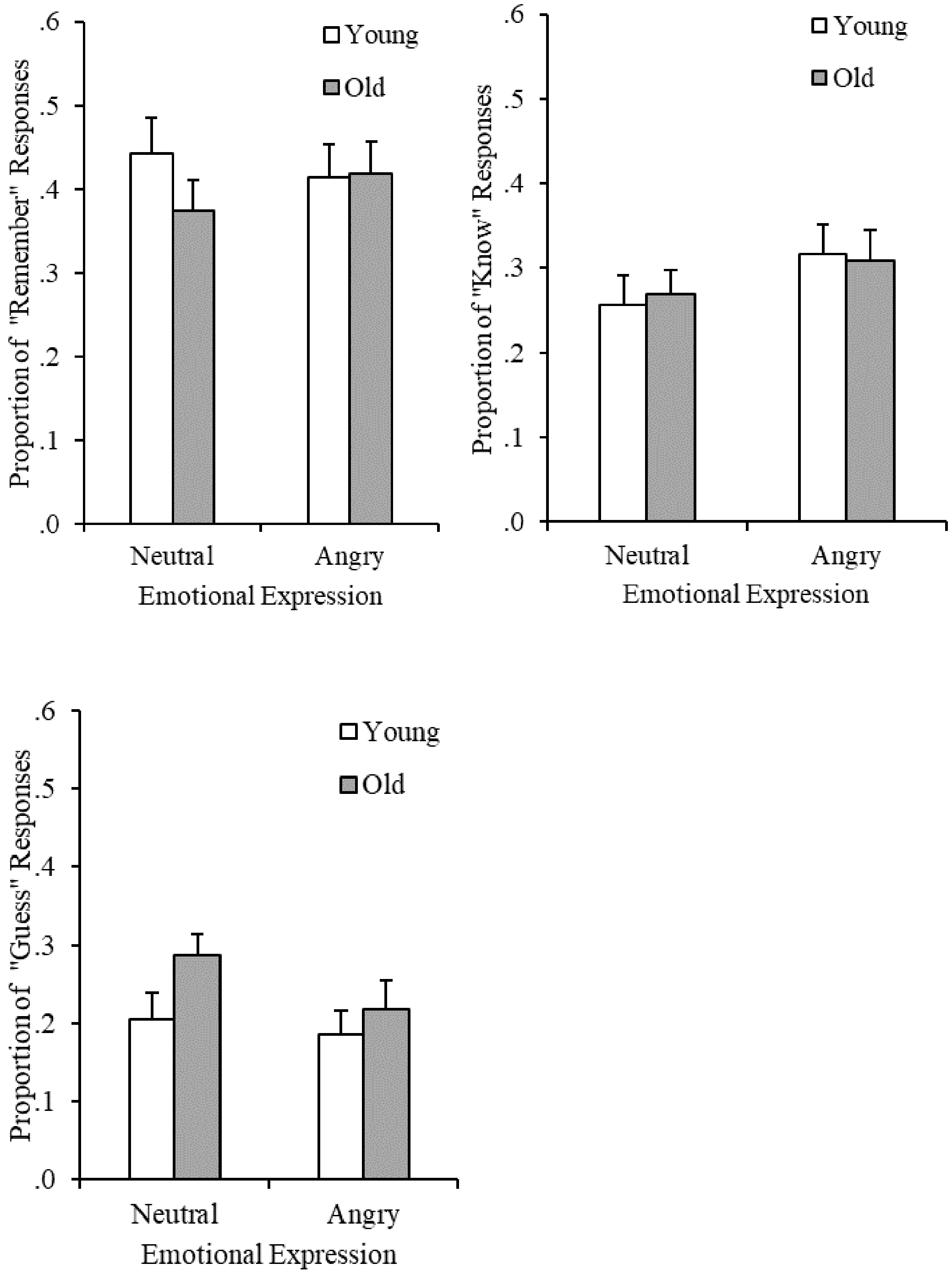


Figure 1. Proportion of 'remember' (top left), 'know' (top right) and 'guess' (bottom) responses for young and older adult faces as a function of emotional expression. Error bars are 1 standard error of the mean.

Experiment 3

Age Group Contact and Social Identification

Group contact data were subjected to a paired samples t-test (one participant was excluded due to missing data) and results indicate participants had significantly higher contact with young than older adults ($t(178) = 12.18$, $p<.001$, $d_{av}=1.25$).

Social identification data were subjected to a paired samples t-test (one participant was excluded due to missing data) that indicated that participants identified significantly more with young than older adults ($t(178) = 26.78$, $p<.001$, $d_{av}=2.95$).

Correlations were conducted between young adult contact, older adult contact, young adult identification, and older adult identification, and an OAB score calculated from the young and older adult neutral faces. The OAB score did not correlate with young adult contact ($r_s(178) = -.045$, $p=.544$), older adult contact ($r_s(177) = .109$, $p=.148$), young adult identification ($r_s(177) = .041$, $p=.584$), or older adult identification ($r_s(178) = -.034$, $p=.655$).

Remember/Know/Guess

For each participant, scores were calculated representing the proportion of the time a particular response was made for that aged face (young/old) with that particular emotional expression (neutral/emotional). A 2 (face age: young, old) × 2 (face emotion: neutral, angry) × 2 (emotion type: sad, happy) mixed ANOVA was conducted for each response type. There was a main effect of face age for each response type. 'Remember' responses represented a greater proportion of the responses to young faces than older adult faces. However, the relationship was reversed for 'know' and 'guess' responses with these representing a greater proportion of the responses to older adult than young faces. There was a main effect of face emotion for 'know' responses such that they represented a greater proportion of responses made to emotional than neutral faces. There was also a Face Age x Face Emotion interaction for 'know' responses such that there was a higher proportion of 'know' responses made to older adult emotional faces, than young emotional faces, but no difference among young and older adult neutral faces.

Full results are reported in Tables 4-6 and Figure 2.

Table 4

Experiment 3 ANOVA results for 'remember' responses

Effect	F	$df_{hypothesis}$	df_{error}	p	η_p^2
Face Age	4.54	1	178	.034	.025
Face Age x Emotion Type	0.18	1	178	.674	.001
Face Emotion	0.09	1	178	.760	.001
Face Emotion x Emotion Type	0.66	1	178	.417	.004
Face Age x Face Emotion	1.01	1	178	.316	.006
Face Age x Face Emotion x Emotion Type	0.05	1	178	.816	.000
Emotion Type	0.62	1	178	.433	.003

Table 5

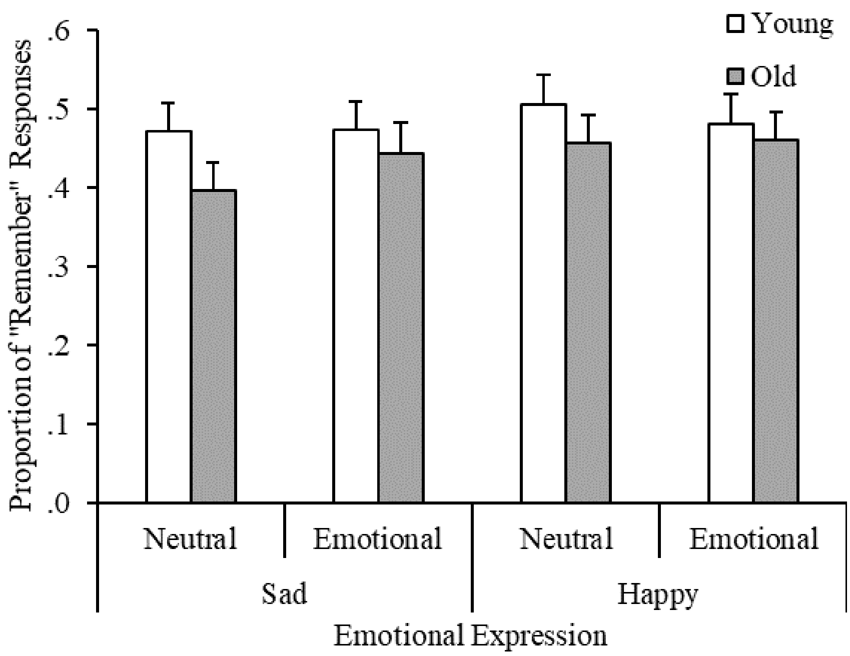
Experiment 3 ANOVA results for 'know' responses

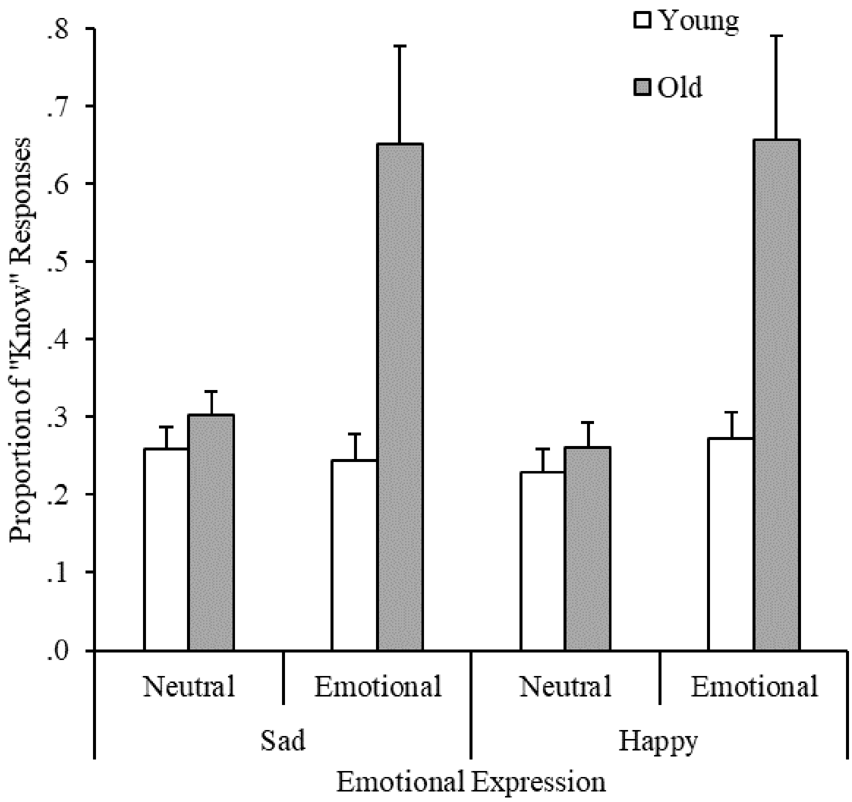
Effect	F	$df_{hypothesis}$	df_{error}	p	η_p^2
Face Age	23.32	1	178	.000	.116
Face Age x Emotion Type	0.03	1	178	.858	.000
Face Emotion	15.78	1	178	.000	.081
Face Emotion x Emotion Type	0.29	1	178	.589	.002
Face Age x Face Emotion	15.80	1	178	.000	.082
Simple Effects of Face Age					
Neutral	2.20	1	178	.140	.012
Emotional	20.97	1	178	.000	.105
Face Age x Face Emotion x Emotion Type	0.01	1	178	.967	.000
Emotion Type	0.02	1	178	.877	.000

Table 6

Experiment 3 ANOVA results for ‘guess’ responses

Effect	*F*	$df_{hypothesis}$	df_{error}	*p*	η_p^2
Face Age	8.12	1	178	.005	.044
Face Age x Emotion Type	3.55	1	178	.061	.020
Face Emotion	0.02	1	178	.890	.000
Face Emotion x Emotion Type	0.08	1	178	.785	.000
Face Age x Face Emotion	0.13	1	178	.716	.001
Face Age x Face Emotion x Emotion Type	0.13	1	178	.720	.001
Emotion Type	0.55	1	178	.458	.003





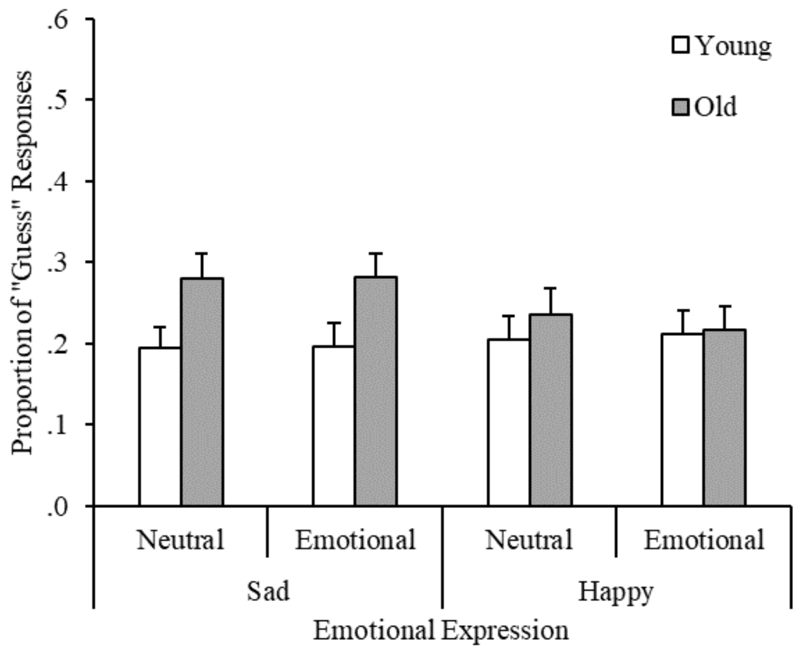


Figure 2. Proportion of 'remember' (previous page), 'know' (top) and 'guess' (bottom) responses for young and older adult faces as a function of emotional expression and expressions type. Error bars are 1 standard error of the mean.

References

Chen, W., Liu, C. H., Li, H., Tong, K., Ren, N., & Fu, X. (2015). Facial expression at retrieval affects recognition of facial identity. *Frontiers in Psychology, 6*, 780. doi: 10.3389/fpsyg.2015.00780

APPENDIX B: CHAPTER 3 SUPPLEMENTARY ANALYSES

Experiment 1

Remember, know and guess scores were calculated for each face age such that they represented the proportion of trials for which that response was selected. For example, a score of 0.5 for remember in the middle aged face condition indicates that 50% of the responses made to remember/know/guess follow ups for middle aged faces were 'remember'. In Experiment 1a (see Table 1), paired-samples t-tests comparing scores for young and middle age faces for each response type found no difference in 'remember' ($t(89)=0.58$, $p=.564$, $d_{av}=0.06$), 'know' ($t(89)=1.11$, $p=.268$, $d_{av}=0.11$), or 'guess' responses ($t(89)=0.08$, $p=.938$, $d_{av}=0.01$). In Experiment 1b (Table 2), paired samples t-tests comparing scores for middle aged and older adult faces for each response type found no difference in 'remember' ($t(91)=0.55$, $p=.584$, $d_{av}=0.06$), 'know' ($t(91)=1.06$, $p=.288$, $d_{av}=0.12$), or 'guess' responses ($t(91)=1.45$, $p=.150$, $d_{av}=0.19$).

Table 1

Proportion scores for remember, know and guess responses for young and middle aged faces in Experiment 1a

	Remember	Know	Guess
Young	.42(0.25)	.30(.22)	.26(.23)
Middle	.40(0.25)	.33(.24)	.26(.22)

Note. Standard deviation are reported in brackets.

Table 2

Proportion scores for remember, know and guess responses for middle aged and older adult faces in Experiment 1b

	Remember	Know	Guess
Middle	.43(0.26)	.34(.24)	.22(.22)
Old	.42(0.25)	.31(.24)	.26(.23)

Note. Standard deviation are reported in brackets.

Experiment 2

In Experiment 2 (see Table 3) there were three groups with participants viewing faces of different ages in each. Group YO saw young and older adult faces, Group YM saw young and middle aged faces, and Group MO saw middle aged and older adult faces. Paired-samples t-tests compared scores for remember, know, and guess responses between the two face ages viewed by each group. A trend towards a higher proportion of 'guess' responses to older adult than middle aged faces was found in Group MO ($t(88)=1.91$, $p=.060$, $d_{av}=0.17$). No other significant differences were found in the paired-samples t-test analysis (all $t<1.47$, all $p>.146$). Independent samples t-tests were conducted to compare proportion scores for the same face age between groups. A significant difference was found between scores for the proportion of 'know' responses made to young adult faces such that the proportion was higher in Group YO than Group YM ($t(181)=2.15$, $p=.033$, $d_s=0.32$). All other comparisons were non-significant (all $t<1.54$, all $p>.127$).

Table 3

Proportion scores for remember, know and guess responses for young, middle aged, and older adult faces as a function of group in Experiment 2

	Remember	Know	Guess
Young			
Group YO	.41(.25)	.35(.25)	.23(.22)
Group YM	.41(.28)	.27(.24)	.29(.28)
Middle			
Group YM	.43(.24)	.30(.23)	.26(.23)
Group MO	.44(.28)	.29(.20)	.25(.23)
Old			
Group YO	.41(.24)	.33(.23)	.24(.20)
Group MO	.40(.24)	.33(.22)	.24(.19)

Note. Standard deviation are reported in brackets

Experiment 3

In Experiment 3 (see Table 4) paired-samples t-tests comparing scores for young and middle age faces for each response type found no difference in 'remember' ($t(88)=1.41$, $p=.163$, $d_{av}=0.12$), 'know' ($t(88)=0.78$, $p=.435$, $d_{av}=0.07$), or 'guess' responses ($t(88)=0.52$, $p=.608$, $d_{av}=0.05$).

Table 4

Proportion scores for remember, know and guess responses for young and middle aged faces in Experiment 3

	Remember	Know	Guess
Young	.48(0.30)	.30(.28)	.20(.21)
Middle	.45(0.29)	.32(.29)	.21(.20)

Note. Standard deviation are reported in brackets

APPENDIX C: CHAPTER 4 SUPPLEMENTARY ANALYSES

Experiment 1

Sensitivity

An analysis of the *d'* data using Erlebacher's (1977) method showed there was a main effect of face age such that the OAB was present overall ($F(1, 161)=14.51$, $p<.001$, $\eta^2=.047$). There was no effect of design ($F(1, 118)=0.96$, $p=.330$, $\eta^2=.005$) nor an interaction between face age and design ($F(1, 161)=0.71$, $p=.401$, $\eta^2=.002$). Means for each condition are reported in Table 1.

Table 1

Sensitivity for young and older adult faces in each list type group in Experiment 1

	Young d'	Old d'
Mixed	1.01(0.58)	0.72(0.58)
Pure-Young	0.88(0.62)	-
Pure-Old	-	0.69(0.33)

Note. Standard deviations are reported in brackets.

Remember/Know/Guess

Scores were calculated for each participant, representing the proportion of trials a particular response (remember, know, or guess) was made for a particular face age (young, old). For example, a score of 0.5 for remember-young would be indicative of half of the responses to young faces being 'remember'. Data were analysed separately for each response type using Erlebacher's (1977) ANOVA method with face age (young, old) and design (within, between) as factors. All analyses were non-significant ($F<1.83$). Means for each condition are reported in Table 2.

Table 2

Proportion of response types chosen for young and older adult faces in Experiment 1

	Remember		Know		Guess	
	Young	Old	Young	Old	Young	Old
Mixed	.48(.28)	.45(.26)	.26(.23)	.31(.27)	.25(.24)	.23(.20)
Pure-Young	.45(.23)	-	.29(.20)	-	.25(.19)	-
Pure-Old	-	.40(.24)	-	.26(.19)	-	.26(.19)

Note. Standard deviations are reported in brackets.

Experiment 2

Sensitivity

An analysis of the *d'* data using Erlebacher's (1977) method showed there was a main effect of face age such that the OAB was present overall, $F(1, 140)=11.20$, $p=.001$, $\eta^2=.045$. There was no effect of design ($F(1, 134)=0.20$, $p=.651$, $\eta^2<.001$) nor an interaction between face age and design ($F(1, 140)=0.65$, $p=.420$, $\eta^2=.003$). Means for each condition are reported in Table 3.

Table 3

Sensitivity for young and older adult faces in each list type group in Experiment 2

	Young d'	Old d'
Mixed	1.01(0.71)	0.81(0.65)
Pure-Young	1.04(0.55)	-
Pure-Old	-	0.71(0.49)

Note. Standard deviations are reported in brackets.

Remember/Know/Guess

Analysis of the Remember/Know/Guess data using Erlebacher's (1977) method yielded no significant results for Remember or Guess data ($F<1.83$). Analysis of Know data showed a marginally significant main effect of face age, such that 'know' responses represented a greater proportion of the responses to young than older adult faces (F(1, 159)=3.61, p=.059, η^2=.016). The main effect of design (F(1, 171)=1.18, p=.280, η^2=.005) and the interaction between face age and design (F(1, 159)=0.06, p=.801, η^2<.001) were non-significant. Means for each condition are reported in Table 4.

Table 4

Proportion of response types chosen for young and older adult faces in Experiment 2

	Remember		Know		Guess	
	Young	Old	Young	Old	Young	Old
Mixed	.47(.26)	.50(.27)	.31(.20)	.26(.19)	.22(.21)	.24(.26)
Pure-Young	.46(.24)	-	.34(.22)	-	.18(.16)	-
Pure-Old	-	.47(.22)	-	.28(.21)	-	.24(.20)

Note. Standard deviations are reported in brackets.

Experiment 3

Sensitivity

An analysis of the *d'* data using Erlebacher's (1977) method showed there was a main effect of face age such that the OAB was present overall (F(1, 152)=6.71, p=.011, η^2=.028). There was no effect of design (F(1, 140)=1.79, p=.183, η^2=.009) nor an interaction between face age and design (F(1, 152)=0.98, p=.324, η^2=.004). Means for each condition are reported in Table 5.

Table 5

Sensitivity for young and older adult faces in each list type group in Experiment 3

	Young d'	Old d'
Mixed	1.43(0.84)	1.25(0.84)
Pure-Young	1.37(0.87)	-
Pure-Old	-	0.98(0.77)

Note. Standard deviations are reported in brackets.

Remember/Know/Guess

Analysis of the Remember data using Erlebacher's (1977) method produced no significant effects (all F<0.65). Analysis of the Know data showed a main effect of design such that there were a higher proportion of 'know' responses in the pure-list than mixed-list design ($F(1, 137)=7.50$, $p=.007$, $\eta^2=.035$). There was no main effect of face age ($F(1, 136)=1.63$, $p=.204$, $\eta^2=.008$) nor an interaction between face age and design ($F(1, 136)=0.92$, $p=.340$, $\eta^2=.004$). Analysis of the Guess data showed a main effect of design such that there was a higher proportion of 'guess' responses in the mixed-list than pure-list design ($F(1, 134)=6.20$, $p=.014$, $\eta^2=.024$). There was no main effect of face age ($F(1, 105)=0.08$, $p=.784$, $\eta^2<.001$) nor an interaction between face age and design ($F(1, 105)=1.50$, $p=.223$, $\eta^2=.008$). Means for each condition are reported in Table 6.

Table 6

Proportion of response types chosen for young and older adult faces in Experiment 3

	Remember		Know		Guess	
	Young	Old	Young	Old	Young	Old
Mixed	.51(.27)	.48(.24)	.26(.20)	.27(.21)	.22(.18)	.24(.21)
Pure-Young	.47(.28)	-	.31(.22)	-	.19(.17)	-
Pure-Old	-	.47(.24)	-	.38(.20)	-	.15(.15)

Note. Standard deviations are reported in brackets.

APPENDIX D: CHAPTER 5 PRE-REGISTRATION

Study Information

Title

The effect of individuation training on the own-age bias

Authors

Sophie Cronin, Belinda Craig, and Ottmar V. Lipp

Date Registered

March 20, 2019

Registered from

osf.io/7b5fp

Description

The own-age bias is suggested to be caused in part by perceptual-expertise processes. Studies have demonstrated that people who have increased contact with, and practice remembering individuals from other-age groups have a smaller own-age bias. This study aims to investigate if the process of learning to individuate other-age faces improves recognition memory for novel other-age faces, and in turn reduces the own-age bias.

Hypotheses

1. Recognition memory performance will increase from time 1 to time 2 for other-age faces that receive individuation training
2. Recognition memory performance will not increase from time 1 to time 2 for other-age faces that receive categorisation training

Design Plan

Study type

Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

Blinding

For studies that involve human subjects, they will not know the treatment group to which they have been assigned.

Is there any additional blinding in this study?

No response

Study design

This study has a 3 (face age: young, child, old) x 2 (individuation age: child/old, old/child) x 2 (time: 1, 2) design. The face age and the time factors are manipulated within-participants, the individuation age factor is manipulated between-participants. DVs measured are recognition memory performance for young, old and children's faces in an old/new recognition task, and the own-age bias between young-old and young-child; affective priming scores between young-old and young-child; and rate of learning in training sessions. Participation will involve 5 sessions. In the first and last session participants will complete an old/new recognition task and an affective priming task with young, old, and children's faces. In each of the sessions participants will also complete a training task where they will be asked to learn the labels (a letter) paired with each face (old or child faces). Letter labels will be unique for the individuated face age, and shared for the categorised face age. The first and last sessions will be held in the laboratory. The second, third and fourth session will be completed online.

No files selected

Randomization

Participants will be randomly allocated to an individuation condition (individuation age: old, child) when they arrive to participate.

Sampling Plan

Existing Data

Registration prior to creation of data

Explanation of existing data

No response

Data collection procedures

Participants will be university students or community members recruited through a university student/community research participation platform. They will be compensated with course credit and/or money for participation. Value of monetary compensation will be at the rate of $15/hr of time expected for completion (or above any time compensated with course credit). Inclusion criteria will be to be between the ages of 17 and 31, and Caucasian. These criteria will serve to highlight in-group membership with the own-age faces (which are Caucasian 18-31yr olds).
No files selected

Sample size

120-160 people (60-80 per individuation condition)

Sample size rationale

The sample size was based on a previous study employing an individuation manipulation that successfully reduced the own-race bias (Rhodes, Locke, Ewing & Evangelista, 2009, Perception; N=120). As such, we aim for a minimum sample of 120. Given the manipulation is different and may have a smaller effect, if time permits (if there is time remaining in the semester for student participants to continue to participate) we will aim to collect a sample of 160. No analyses will be conducted before sampling is completed.

Stopping rule

No response

Variables

Manipulated variables

The design of this study is 3 (face age: young, child, old) x 2 (individuation age: child, old) x 2 (time: 1, 2). The first and third factor are manipulated within-participants, the second between-participants. The study will manipulate which other-age faces are individuated and which categorised in the training task. Individuation involves learning a unique label for each face of that age – requiring participants to learn at the individual level. Categorisation involves learning a shared label for faces of that age – not requiring participants to learn at the individual level.
No files selected

Measured variables

1 (Primary). Recognition performance for young, child and older adult faces in the old/new recognition test, pre- and post-training (hit rate, false alarm rate, *d'*)
2. Affective priming scores pre- and post-training (RTs for each face age-target valence condition)
3. Training task performance (how many errors made in a session, how many blocks required to finish the session)
4. Response bias in the old/new recognition test pre- and post- training (*C*)
5. Demographic information (age, sex, race, how many children, what language spoken at home)
6. Contact information with each age group

a. Q: "Approximately how many young adults/children/older adults do you know who are not related to you?" A: open-ended integer

b. Q: "How often do you interact with young adults/children/older adults?" A: 1-8 scale from daily to less than once per year

c. Q: "How often do you meet new people who are young adults/children/older adults?" A: 1-8 scale from "daily" to "less than once per year"

d. Q: "How would you rate the quality of interaction you have with young adults/children/older adults?" A: 1-5 scale from "very shallow/superficial" to "very deep/intense"

7. Attitudes to each age group

a. Q: "What is your attitude towards young adults/children/older adults?" A: 1-7 scale from "strongly dislike" to "strongly like"

8. Social Identification with each age group

a. Q: "How much do you agree with the following statement?: I identify with young adults/children/older adults." A: 1-7 scale from "strongly disagree" to "strongly agree"

No files selected

Indices

Recognition performance will be used to create OAB scores (d' difference scores) for young-old and young-child. Priming reaction times will be combined to create priming scores for young-old and young-child.

No files selected

Analysis Plan

Statistical models

Mixed ANOVA to examine changes in recognition performance: factors: face age (young, child, old), time (1, 2), individuation age (old, child), dv: *d'*.

No files selected

Data exclusion

All data will be excluded from a participants where they don't meet inclusion requirements or did not complete the experiment correctly (i.e. did not complete all parts, did not make responses, or experienced programming issues that meant they didn't complete the experiment in the correct order). Data will be excluded from the affective priming task on a trial level where responses are less than 300ms or greater than 1000ms. All of a participant's data will be excluded from the affective priming task if they made less than 25% errors (errors are when responses were too fast, too slow or incorrect).

Missing data

No response

Exploratory analysis

Further/exploratory analyses will use a mixed ANOVA to examine changes in implicit attitudes: factors: other-age face (child, old), time (1, 2), individuation age (old, child), dv: priming score.

Further/exploratory analyses will use correlations to explore associations between the OAB score and its reduction, and the contact measures, attitude measure, priming scores, social identification measure and training speed.