Attractiveness Judgments and Discrimination of Mommies and Grandmas:

Perceptual Tuning for Young Adult Faces

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Abstract

Adults are more accurate in detecting deviations from normality in young than older adult faces, despite exhibiting comparable accuracy in discriminating both face ages. This deficit in judging the normality of older faces may be due to reliance on a face space optimized for the dimensions of young adult faces, perhaps because of early and continuous experience with young adult faces. Here we examined the emergence of this young adult face bias by testing 3- and 7-year-old children on a child-friendly version of the task used to test adults. In an attractiveness judgment task, children viewed young and older adult face pairs; each pair consisted of an unaltered and a distorted face of the same identity. Children pointed to the prettiest face, which served as a measure of their sensitivity to the dimensions on which faces vary relative to a norm. To examine whether biases in the attractiveness task were specific to deficits in referencing a norm or extended to impaired discrimination, we tested children on a simultaneous match-to-sample task with the same stimuli. Both age groups were more accurate in judging the attractiveness of young relative to older faces; however, unlike adults, the young adult face bias extended to the match-to-sample task. These results suggest that by 3 years of age, children's perceptual system is more finely tuned for young than older adult faces, which may support past findings of superior recognition for young adult faces.

Keywords: young adult face bias; norm-based coding; discrimination; face space

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Adults' ability to recognize faces is limited by experience. For example, they recognize own-race faces more accurately than other-race faces, presumably because they have more experience with own- than other-race faces (for a review, see Meissner & Brigham, 2001). The advantage for own-race faces emerges during infancy (Kelly et al., 2007), has been found in children as young as 3 years of age (Macchi Cassia, Luo, Pisacane, Li, & Lee, 2014b; Sangrigoli & de Schonen, 2004), and is thought to reflect a process of perceptual tuning (e.g., Kelly et al., 2005; Kelly et al., 2007; Scott, Pascalis, & Nelson, 2007) similar to that observed in music (Hannon & Trehub, 2005) and speech perception (Kuhl, Tsao, & Liu, 2003; Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; Maurer & Werker, 2014; Werker & Tees, 1984).

Face age also influences recognition accuracy; however, the developmental pattern is more complex, perhaps because one's own age (unlike race) continuously changes, as does the age of faces to which one is primarily exposed. Some studies report enhanced recognition for own- relative to other-age faces across all participant ages (e.g., Anastasi & Rhodes, 2005; Perfect & Harris, 2003; Rhodes & Anastasi, 2012), a pattern of results that suggests that recent life experience exerts significant influence on recognition abilities (see Wiese, Komes, & Schweinberger, 2012 for a demonstration of an own-age bias among older adults with high experience with other older adults but not among older adults with low experience with other older adults). In contrast, other studies report comparable or even superior recognition for young adult faces relative to own-age faces even in children and older adults (e.g., Fulton & Bartlett, 1991; Macchi Cassia, Pisacane, & Gava, 2012; Wallis, Lipp, & Vanman, 2012; Wiese, Schweinberger, & Hansen, 2008; Wolff, Wiese, & Schweinberger, 2012); this pattern of results

is consistent with the view that young adult faces are the most frequently encountered (Rennels & Davis, 2008) and socially relevant (Scherf & Scott, 2012) face age category early in life, which sets up a life-long perceptual bias for young adult faces (Macchi Cassia, 2011). Consistent with this argument, Macchi Cassia, Bulf, Quadrelli, and Proietti (2014a) recently reported evidence of a perceptual processing advantage for young adult relative to infant faces in 9- but not 3-month-old infants. Here we investigate the development of a perceptual bias during childhood for young compared to older adult faces, a bias that may underlie superior recognition of young faces among young and, in many cases, older adults.

One explanation for superior recognition for faces from highly familiar categories (including own-age or young adult faces) is norm-based coding, a process by which individual faces are coded relative to a face prototype that represents the average of all faces previously encountered (Valentine, 1991). Within this multidimensional face space, individual faces are represented as distinct points; the farther a face is from the prototype, the less attractive and more distinctive it appears (Rhodes & Tremewan, 1996; Valentine, Darling, & Donnelly, 2004). Norm-based coding is thought to facilitate discrimination around the norm (Armann, Jeffery, Calder, & Rhodes, 2011; Wilson, Loffler, & Wilkinson, 2002). Because face space is optimized for differentiating individual faces within frequently encountered categories, faces from other categories are recognized less accurately (Valentine & Endo, 1992). Differences in how faces from various age categories (e.g., own age, young adult) are represented in face space may account for how well individual faces from those categories are differentiated and recognized.

Short and Mondloch (2013) recently reported that both young and older adults are more sensitive to how young adult faces, compared to older adult faces, deviate from an undistorted face. Parallel results for both age groups (i.e., the lack of a reversal in older adults) suggest that

early and continuous experience with young adult faces tunes the perceptual system to the

dimensions of young adult faces, with later experience having less impact. In the current study,

we tested the hypothesis that children as young as 3 years of age would show a similar advantage

for young adult faces compared to older adult faces, as would be expected if early experience

tunes the perceptual system.

Short and Mondloch (2013) showed participants young and older adult face pairs in

which one member of each pair was undistorted and the other had compressed (-10%, -20%, -

30%) or expanded (+10%, +20%, +30%) features. In the normality task, participants indicated

which member of each pair was more normal, and in the discrimination task, participants

indicated which member of each pair was more expanded. Both age groups were more accurate

when tested with young compared to older faces—but only when judging normality. The

presence of a young adult face advantage in the normality but not the discrimination task was

attributed to differences in the perceptual processing strategies required by the two tasks.

Whereas the identification of a normal-looking face requires reliance on perceptual expertise

(e.g., use of a well-defined norm), the identification of the expanded face in a pair only requires

participants to be able to tell the two faces apart, which they can largely do using a feature-based

approach (e.g., determine which face has the larger nose) or by attending to large differences in

feature spacing (e.g., determine which face has more space between the eyes). Such a processing

strategy does not require the use of norm-based coding and requires less perceptual expertise

than the normality task, as demonstrated by the finding that inversion reduces accuracy of

normality judgments but not accuracy of discrimination (Short & Mondloch, 2013, Experiment

2). To further illustrate the differences between the two tasks, imagine participants are shown

pairs of coffee mugs; in each pair, one mug is undistorted while the other mug is expanded or

compressed. Participants could easily identify the expanded mug by determining which mug has the largest handle. However, identifying the more normal looking mug in each pair would be significantly more difficult, unless the participant had received ample experience in examining mugs of different shapes and sizes. In this same way, adults are fully capable of identifying expanded young and older faces but appear to lack the expertise and sensitivity required to judge the normality of older relative to young adult faces. Short and Mondloch thus attributed the deficit for older faces in the normality task to decreased reliance on a well-refined norm for older faces.

In the current study, we examined the emergence of this pattern of results in childhood by creating a child-friendly version of the normality and discrimination task. We tested 3- and 7-year-old children on both an attractiveness judgment and a match-to-sample (discrimination) task. In the attractiveness task, children viewed young and older adult face pairs; one member of each pair was undistorted and the other had features that were compressed towards the center of the face or expanded outward. Children were asked to point to the prettiest face, which served as a measure of their sensitivity to the dimensions on which faces vary relative to a norm. We elected to use attractiveness judgments rather than normality judgments because past studies examining children's use of a norm have relied on ratings (Anzures, Mondloch, & Lackner, 2009) and judgments of attractiveness (Short, Hatry, & Mondloch, 2011; Short, Lee, Fu, & Mondloch, 2014), and because adults show similar sensitivity to facial distortions whether they are asked to judge normality or attractiveness (Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003). Although many factors influence perceived attractiveness (e.g., symmetry, sexual dimorphism; see Rhodes, 2006), with some deviations from average making a face especially attractive (e.g., increased eye size; Geldart, Maurer, & Carney, 1999), our distortions were so

large that they made the faces verge on grotesque. Thus, selecting the unaltered face as most

attractive was deemed to be the correct response and indicative of sensitivity to how a face

varied from the norm.

Reduced accuracy for older than young adult faces in the attractiveness task could reflect

either specific deficits in referencing a norm for older faces (as shown by adults) or general

deficits in discriminating older faces (i.e., telling the two faces in the pair apart from each other).

To examine whether biases in the attractiveness task were due to specific deficits in norm-based

coding or to general impaired discrimination, we also tested children on a simultaneous match-

to-sample task with young and older faces using the same stimuli. Children were asked to match

the sample face (e.g., the compressed version) to one of two test stimuli (e.g., the compressed

and undistorted versions). Reduced accuracy for older than young adult faces in the

discrimination task would indicate impaired discrimination of older faces even when referencing

a norm was not required; similar accuracy across face ages, as observed previously in adults

(Short & Mondloch, 2013), would indicate that children's perceptual tuning for young adult

faces may be specific to norm-based coding. All children were first tested on the attractiveness

task followed by the match-to-sample task because our primary interest was in whether children,

like young and older adults, showed differential performance in gauging the attractiveness of

young and older faces, and the match-to-sample task simply served as a control.

We elected to test 3- and 7-year-olds for several reasons. First, by age 3 years children

show an own-race recognition advantage (Macchi Cassia et al., 2014b; Sangrigoli & de Schonen,

2004) and there is substantial evidence that face age influences their performance in delayed

match-to-sample tasks (Macchi Cassia, Kuefner, Picozzi, & Vescovo, 2009; Macchi Cassia et al.,

2012; Proietti, Pisacane, & Macchi Cassia, 2013). Furthermore, 3-year-olds are capable of

assessing attractiveness (e.g., Dion, 1973) and their perceptions of facial attractiveness are influenced by experience (Cooper, Geldart, Mondloch, & Maurer, 2006). However, because current studies have found evidence for norm-based coding only in children as young as 4 years (youngest age tested; Jeffery et al., 2010; Jeffery, Read, & Rhodes, 2013b; Short et al., 2011), we also tested an older group of children (7-year-olds). By 7 years of age, norm-based coding is well in place at least for own-race faces, and there is evidence that face space becomes increasingly differentiated between 5 and 8 years of age (Short et al., 2011; Short et al., 2014). Both 3- and 7-year-olds were tested with the same protocol in the attractiveness and match-to-sample tasks; however, we used different distortion levels for the two age groups (±70% for 3-year-olds and ±50% for 7-year-olds). These values were selected based on published studies (Anzures et al., 2009; Short et al., 2011) and on pilot testing that revealed that 7-year-olds were at ceiling when tested with ±70% faces and performed poorly when judging the attractiveness of faces distorted by less than ±50%.

We hypothesized that, like adults, 3- and 7-year-old children would show an advantage for young faces in the attractiveness task. Among young and older adults, the young adult face advantage was eliminated in the discrimination task, presumably because this task did not require perceptual expertise and participants could largely rely on a featural approach (Short & Mondloch, 2013). If children's performance deficit for older faces in the attractiveness task is specific to the use of a norm (e.g., a poorly refined norm for older faces), then they should show comparable performance for young and older faces in the match-to-sample task. However, if their performance deficit for older faces in the attractiveness task extends beyond the use of norm-based coding to general difficulty in detecting differences among older faces (e.g., determining which face has the larger nose or has more space between the eyes), then they

should also show a young adult face advantage in the match-to-sample task. One study to date (Proietti et al., 2013) used a match-to-sample task to examine the ability to distinguish between young and older adult faces and found that both adults and 3-year-olds with minimal experience with older adult faces showed a young adult face advantage. However, this study involved a delayed two-alternative forced-choice task and assessed recognition of individual face identities; no study has yet examined whether young children continue to show a young adult face advantage in an immediate perceptual task that has no memory demands and involves the comparison of same-identity faces.

Method

Participants

Thirty Caucasian 3-year-olds (15 female; mean age = 3 years 7 months; age range = 3 years 1 month to 3 years 11 months) and 30 Caucasian 7-year-olds (19 female; mean age = 7 years 7 months; age range = 7 years 0 months to 7 years 11 months) participated in this study. An additional 10 children were tested but excluded from all analyses due to experimenter error (two 7-year-olds) or because they failed criterion (two 3-year-olds), did not understand task instructions (two 3-year-olds), or were inattentive (four 3-year-olds). Children were tested on both the attractiveness task and the match-to-sample task during the same session, and there was a 5-minute break between tasks.

Attractiveness Task

Materials. Color facial photographs of 12 Caucasian young women (age range = 20-27 years) and 12 Caucasian older women (age range = 71-79 years) were used as test stimuli. Face images were acquired from the Center for Vital Longevity Face Database (Minear & Park, 2004) and from a sample of photographs taken in the Face Perception Lab at Brock University; face

identities were identical to the female identities used by Short and Mondloch (2013). The 24

identities were divided into two sets of 12 (six young, six older). Each face set was shown to half

of the participants. We used the spherize tool in Adobe Photoshop Version 12.0 to expand and

compress the internal features of each face identity; using this technique, we created two new

versions of each identity, one that was expanded and one that was compressed. To avoid floor

and ceiling effects, we compressed and expanded each identity ±70% for 3-year-olds and ±50%

for 7-year-olds, values selected based on pilot testing and published studies (Anzures et al.,

2009; Short et al., 2011). For each identity, we then created two face pairs in which the

undistorted version was paired with the expanded and compressed versions (see Figure 1 for

sample stimuli). Each face in the pair was standardized such that the distance between the chin

and hairline was approximately 300 pixels, and the gap between the two faces in each pair was
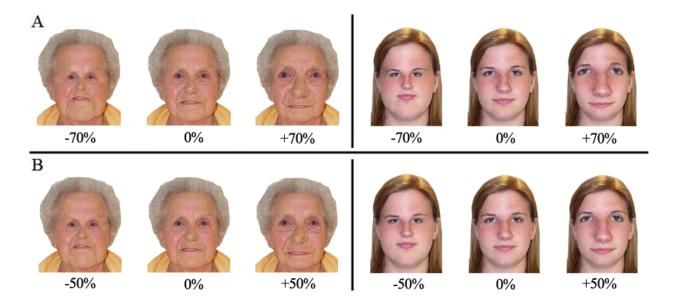
approximately 600 pixels.

Figure 1. Sample distortion continua for an older adult identity and a young adult identity, as
shown to 3- (Row A) and 7-year-old (Row B) participants. Each face pair consisted of an
undistorted face paired with an expanded or compressed version of the same identity.

Of the 12 face pairs presented to each participant, six (three young) consisted of an undistorted face paired with its expanded version and six (three young) consisted of an undistorted face paired with its compressed version. For each identity, half of the participants saw the expanded face pair and the other half saw the compressed face pair. Each face set was presented in one of four random orders to each participant and the undistorted face was on the left for half of the trials.

Criterion stimuli were used in order to keep children engaged and to verify that children remained on task throughout the duration of the experiment. The eight pairs of criterion stimuli (based on those used by Cooper et al., 2006, Experiment 3) consisted of two hand-drawn versions of the same object, one that was brightly colored and shiny and the other that was dull and dirty (e.g., a pencil with bright colors paired with a brown, chewed-up pencil).

Procedure. Before beginning the task, children completed two trials designed to illustrate the concept of prettiness. In each trial, children were shown two versions of the same object (a pair of teddy bears and a pair of gloves); one was in store-bought condition and the other had holes and stains on it. Children were asked to indicate which object was the prettiest. Children were praised after making a correct response; regardless of the response made, the experimenter highlighted differences between the two objects that resulted in one being prettier.

Following these illustration trials, participants were seated approximately 60 cm in front of a 24-inch computer monitor. Children were told that they were going to play a game in which mommies and grandmas were going on a trip to the zoo. The task comprised eight criterion and 12 test trials; sets of criterion (n = 2) and test (n = 4) trials alternated, beginning with criterion trials. Prior to the first criterion trial, children were shown a magic backpack on the screen and the task was explained. On each criterion trial, children were shown a pair of objects and asked

to wave a magic wand over the prettiest one; objects remained on the screen until a response was made, at which point the backpack appeared, a sound was played, and the child received non-contingent verbal reinforcement. Children were required to be correct on at least six criterion trials to be included in the final analysis. Prior to the first test trial, children were shown a picture of a bus and the task was explained. On each test trial, children were shown a pair of faces (two versions of the same identity) and asked to wave the wand over the prettiest mommy or grandma so that she could get on the bus; the experimenter indicated via key press whether the child waved the wand over the right or left side of the screen. Faces remained on the screen until a response was made, at which point the bus appeared with silhouettes of people inside (the number of which increased across trials) and the child received verbal reinforcement.

Match-to-Sample Task

Materials. Each participant was tested with eight (four young, four older) of the 12 identities they had judged during the attractiveness task; we used only a subset of the identities in the match-to-sample task in order to keep the task brief and sufficiently engaging for young children. Individual face stimuli were printed on cardstock, and each face was standardized such that the distance between the chin and hairline was approximately 10 centimeters. On each trial, participants viewed a target face paired with two versions of the same identity; one version was undistorted and the other was either expanded or compressed (counterbalanced). Distortions were consistent with those used in the attractiveness task (±70% for 3-year-olds and ±50% for 7-year-olds). For each face age, the target face was undistorted for half of the trials (n = 2) and distorted (1 compressed; 1 expanded) for the other half. Using Velcro, the target face was placed on a piece of poster board above a pair of faces, one of which was identical to the target (see Mondloch & Thomson, 2008 for a similar method used with 4-year-old participants).

Based on Mondloch and Thomson (2008), criterion stimuli comprised pictures of animals. In each of four criterion trials, two animals were identical (e.g., two brown squirrels) and the third animal differed in its features or color (e.g., a squirrel with pig ears). Children were required to respond correctly on at least three criterion trials to be included in the final analysis. We also created a twin clubhouse, which we used to describe the concept of twins, and children were told to imagine that only people who looked alike were allowed to enter the clubhouse.

Procedure. As in Mondloch and Thomson (2008), children received one practice trial in which they were shown pictures of three umbrellas and were asked to point to the umbrella at the bottom of the board that looked just like the one at the top; incorrect responses were corrected for this trial only, to ensure that children understood the task. Children then completed four criterion and eight test trials. On each trial, the experimenter pointed to the target image and asked, "Which of the two pictures on the bottom looks exactly the same as the one on the top?" Children then pointed to the picture that they thought was the exact same as the target image at the top of the board, and the experimenter recorded their response on a sheet of paper. Trials were administered in the following sequence: criterion ($n = 1$), test ($n = 4$), criterion ($n = 2$), test ($n = 4$), criterion ($n = 1$).

Results

Children made almost no errors on either set of criterion trials. Only six 3-year-olds and one 7-year-old made errors on criterion trials in the attractiveness task, mean correct (on 8 trials) = 7.87, and only five 3-year-olds and one 7-year-old made a single error on criterion trials in the match-to-sample task, mean correct (on 4 trials) = 3.90.

For both the attractiveness and match-to-sample tasks, performance was assessed in terms of the mean proportion of correct faces chosen. In the attractiveness task, selection of the

undistorted face as prettiest was scored as correct because it indicated a preference closer to the

norm, consistent with adult (Langlois & Roggman, 1990) and child (Vingilis-Jaremko & Maurer,

2013) preferences for averageness. Data were collapsed across expanded and compressed trials,

as preliminary analyses indicated that there was no main effect of distortion type, $p = .44$, and

distortion type did not interact with any other variables, all ps $> .08$. Single-sample t-tests

revealed that for both participant age groups, accuracy was significantly greater than chance

(.50) and significantly below ceiling (1.0) for both young and older faces in each task, all ps $<$

.05. A 2 (task: attractiveness, match-to-sample) x 2 (face age: young, older) x 2 (participant age:

3-year-olds, 7-year-olds) mixed ANOVA revealed a main effect of task, $F(1, 58) = 14.53$, $p <$

.001, $\eta_p^2 = .20$. Children were more accurate on the match-to-sample task ($M = .87$, $SE = .02$)

than the attractiveness judgment task ($M = .78$, $SE = .02$). There was also a main effect of face

age, $F(1, 58) = 17.87$, $p < .001$, $\eta_p^2 = .24$; accuracy was higher for young ($M = .86$, $SE = .02$)

than older adult faces ($M = .78$, $SE = .02$). Lastly, there was a main effect of participant age, $F(1,$

$58) = 22.86$, $p < .001$, $\eta_p^2 = .28$; 7-year-olds were more accurate overall ($M = .90$, $SE = .02$) than

3-year-olds ($M = .74$, $SE = .02$), despite being tested with a more difficult set of stimuli. There

were no significant two- or three-way interactions, all ps $> .12$, η_p^2s $< .04$. Crucially, there was

no task by face age interaction, $F(1, 58) = .88$, $p = .35$, $\eta_p^2 = .02$, revealing that the young adult

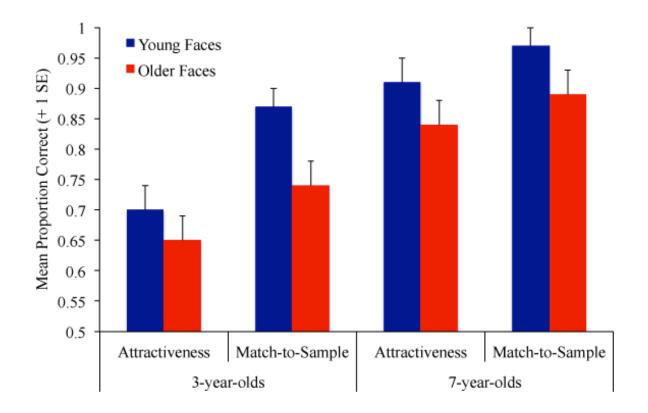bias was not specific to the attractiveness task (see Figure 2).

Figure 2. Mean proportion correct (+1 SE) for young and older adult faces in the attractiveness and match-to-sample tasks for both participant age groups.

Discussion

Like adults (Short & Mondloch, 2013), both 3- and 7-year-old children showed greater accuracy in judging the attractiveness/normality of young relative to older adult faces. However, whereas adults were equally accurate in discriminating between young and older faces, 3- and 7-year-olds were more accurate with young faces in the simultaneous match-to-sample task. Adults' superior performance with young faces in the normality task but not the discrimination task suggests that their bias for young faces is specific to the use of norm-based coding; in particular, deficits in judging the normality of older faces may be due to reliance on a face space that is optimized for the dimensions of young adult faces. Although adults' ability to reference each face to a prototype is superior for young faces, they are equally capable of discriminating young and older faces, perhaps because they are able to rely on a feature-based strategy to a greater extent in the discrimination than in the normality judgment task. In contrast, 3- and 7-year-olds' young adult face bias extended to the match-to-sample task, which suggests that their superior performance with young faces in the attractiveness task may be partially attributable to reduced sensitivity to large differences in feature shape or spacing in older than in young adult faces.

Although there were several methodological differences between our child-friendly tasks and the adult versions used by Short and Mondloch (2013), we contend that the attractiveness and match-to-sample tasks administered to children tapped comparable perceptual processes to the normality and discrimination tasks previously administered to adults. First, as noted in the introduction, both judgments of attractiveness and normality reflect sensitivity to deviations from the norm, and past studies have repeatedly used the highly familiar concept of prettiness when testing young children (e.g., Anzures et al., 2009; Cooper et al., 2006). On the surface, the tasks

used to measure discrimination in adults and children differed; whereas adults were asked to indicate which of two faces in a pair was more expanded, children were tested with a match-to-sample task. However, in both discrimination tasks, faces were presented simultaneously and participants simply needed to indicate that they could tell the two faces apart (i.e., participants were not required to reference a norm). Although the differences in methodology preclude a direct comparison between children's and adults' performance, differences in the pattern of results within each age group are informative. First, given that children showed deficits for older faces in both the attractiveness and the discrimination tasks, we can conclude that the young adult face bias emerges as early as 3 years of age. Second, whereas adults' bias was specific to norm-based coding, perceptual tuning in children appears to include a general decreased sensitivity to differences (e.g., in feature shape, size, and spacing) among older faces; indeed their ability to use norm-based coding for older adult faces may be limited by their ability to discriminate among them.

Our results cannot be attributed to either floor or ceiling effects. We avoided floor effects by adjusting distortion levels for each age group based on pilot data and a previously published study (Anzures et al., 2009). Consequently, accuracy was well above chance for both face ages in all conditions, ruling out the possibility that either task was too difficult for children to complete. The performance of 7-year-olds was near ceiling (though significantly different from 1.0) when discriminating young adult faces in the match-to-sample task; however, this does not weaken our conclusion that children's deficit for older adult faces extends to the discrimination task for several reasons. First, 3-year-olds showed neither ceiling nor floor effects, yet exhibited a pattern of results comparable to that of 7-year-olds. Second, 7-year-olds' accuracy for older faces on the match-to-sample task (89%) was comparable to young adults' accuracy for older

faces on the discrimination task (92%; Short & Mondloch, 2013), but only 7-year-olds showed

superior performance when discriminating young adult faces. Third, 7-year-olds were not at

ceiling for the attractiveness task. In the attractiveness task, there was plenty of opportunity for

accuracy on young adult face trials to increase and for accuracy on older adult face trials to

decrease; however, the magnitude of the young adult face bias was no larger in the attractiveness

task than in the match-to-sample task. This is especially notable given that potential ceiling

effects for young adult faces may have minimized the effect of face age in the match-to-sample

task, enhancing the opportunity for a larger effect of face age in the attractiveness judgment task.

Our results are consistent with past studies showing that children show reduced

sensitivity to facial distortions relative to adults (Jeffery et al., 2010; Jeffery, Rathbone, Read, &

Rhodes, 2013a) and provide evidence that sensitivity to the dimensions of face space improves

between 3 and 7 years of age. Despite being tested with less extreme facial distortions, 7-year-

olds were more accurate than 3-year-olds on both tasks. Furthermore, 7-year-olds' accuracy was

comparable to that of young adults despite being tested with more extreme distortions. Our

findings are consistent with evidence that children are less sensitive than adults to distortions that

increase the grotesqueness (Mondloch, Dobson, Parsons, & Maurer, 2004) or distinctiveness

(McKone & Boyer, 2006) of a face and require greater differences among faces in order to

consistently rate unaltered faces as more attractive than faces with compressed or expanded

features (Anzures et al., 2009). Improved sensitivity to the dimensions of face space may thus be

one factor that contributes to increased face recognition across childhood.

Norm-based coding likely facilitates face recognition (Rhodes, Jeffery, Taylor, Hayward,

& Ewing, 2014; Rhodes & Leopold, 2011; Wilson et al., 2002). Adults' face space is

characterized by dissociable category-specific norms (e.g., Jaquet, Rhodes, & Hayward, 2008;

Jaquet & Rhodes, 2008; Little, DeBruine, & Jones, 2005; Little, DeBruine, Jones, & Waitt,

2008) and is optimized for faces from frequently encountered categories (Rhodes et al., 2014;

Valentine & Endo, 1992). Although children as young as 4 years appear to reference a norm (as

shown by figural and identity aftereffects; Jeffery et al., 2010; Jeffery et al., 2013b; Short et al.,

2011), they rely on a single category-generic prototype, with category-specific norms emerging

between 5 and 8 years of age (Short et al., 2011; Short et al., 2014). Our current data suggest that

differential sensitivity to ==facial distortions== precedes the development of age- and perhaps other

category-specific norms. Although young children are less sensitive than adults to large

differences among faces, our findings show that by 3 years of age children are more sensitive to

differences among young adult faces than older adult faces, reflecting the emergence of adult-

like perceptual tuning for young adult faces.

Our data also contribute to the debate about whether there is any domain-specific

development in face perception throughout childhood. Weigelt et al. (2014) argue that whereas

improvements in face memory during childhood are domain specific, improvements in face

perception are entirely attributable to domain-general processes. Children's overall accuracy on

any face perception task likely is influenced by general cognitive development (e.g., Baudouin,

Gallay, Durand, & Robichon, 2010; Mondloch et al., 2004; Mondloch, Maurer, & Ahola, 2006).

However, we contend that age-related improvements in our tasks ==are likely not== attributed to

domain-general cognitive development alone. Even 3-year-olds performed largely without error

on criterion trials, demonstrating that limitations in attention ==cannot fully account== for children's

errors throughout the task. Although more 7-year-olds than 3-year-olds were errorless on

criterion trials, 20 of the 30 3-year-olds tested were completely without error on both tasks,

indicating that the majority of 3-year-olds encountered no difficulty in completing object trials;

however, we do note that 7-year-olds may have been more engaged overall while completing the task. Moreover, improvements in accuracy were comparable across the two task types, even though the match-to-sample task had no memory demands, and were evident even for young adult faces, a category with which young children have abundant experience (Rennels & Davis, 2008). Lastly, general cognitive development alone cannot explain differential performance for young and older faces given that faces from these two categories were presented in identical tasks.

One limitation of the present study is that all children were first tested on the attractiveness task followed by the match-to-sample task, and the same identities were used in both tasks. To be consistent with Short and Mondloch (2013), we elected to use the same face identities in both of our tasks. One possible effect of doing so is that exposure to the identities in the attractiveness task may have made the match-to-sample task less difficult. However, despite higher overall accuracy in the match-to-sample task, children continued to show differential performance for young and older adult faces in both tasks. As additional evidence that the lack of counterbalancing likely had little effect on our findings, we emphasize that Short and Mondloch counterbalanced task order, yet found that it did not significantly interact with any other variables and that, like children, adults' accuracy was higher in the discrimination task regardless of the order in which the tasks were administered.

Experience with different face ages may affect the extent to which children show a young adult face bias (Proietti et al., 2013). Future studies should examine whether children raised by grandparents (i.e., with exposure to two older adult exemplars on a daily basis) or in aging communities (i.e., with exposure to numerous older adults on a regular basis) show the reverse pattern of results. Short and Mondloch (2013) demonstrated that significant exposure to older

adults later in life is not sufficient to bias the dimensions of face space toward older faces;

however, this same amount of exposure in childhood may alter the system to a greater extent, as

there is some evidence that the face processing system is more malleable early relative to later in

life (e.g., Hills, Holland, & Lewis, 2010; Macchi Cassia et al., 2009). For example, Proietti et al.

(2013) found that 3-year-olds with ample exposure to grandparents and other older adults were

more accurate in discriminating upright older than young adult faces and exhibited a larger

inversion effect for older than young adult faces. Future studies should also examine the earliest

age at which the young adult face bias emerges; Macchi Cassia et al. (2014a) recently reported

evidence of perceptual tuning for young adult relative to infant faces by 9 months of age, yet no

study to date has examined the specificity of this bias for young (relative to older) adult faces.

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