Younger and Older Adults' Differentiation of Trait Impressions of Faces

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Stacey Yun-Yun Ng

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ABSTRACT

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A thesis presented to the Department of Psychology

Graduate School of Arts and Sciences
Brandeis University
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By Stacey Yun-Yun Ng

Trait impressions of faces may differ between older and younger adults (YA) that may be explained by a number of phenomena. The dedifferentiation hypothesis of cognitive aging suggests that older adults’ (OA) cognitive processes become less distinct over time (Ghisletta & de Ribaupierre, 2005). This study evaluates age-related behavioral dedifferentiation in first impressions of faces by analyzing the degree to which older or younger adults use a rating scale when rating trait impressions of both older and younger faces. OA differentiated less than YA on ratings of babyfaceness, competence, health, trustworthiness, and hostility, but not attractiveness. An own-age bias was only partially supported in ratings of health, attractiveness and untrustworthiness. The positivity effect was only supported minimally in differentiation of the most untrustworthy faces. Finally, correlations between measures of cognitive and sensory abilities paralleled differentiation of trait impressions from faces between older and younger adults.
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Introduction

People form first impressions of other's psychological qualities from their facial appearance. These first impressions from faces may be so influential that people’s impressions of a face after the first 39 milliseconds of exposure are no different from those formed after prolonged exposure (Bar, Neta, & Linz, 2006; Willis & Todorov, 2006). In addition, trait impressions from faces may vary with the age of the perceiver. For example, an own-age bias suggests individuals more accurately recognize the identity of own-age faces as compared to other-age faces (Anastasi & Rhodes, 2005), indicating that they can differentiate own-age faces better than other-age faces. Moreover, an older adult (OA) positivity bias indicates that OA pay less attention to negative stimuli than do younger adults (YA) (Ebner & Johnson, 2009; Isaacowitz et al., 2007), and form more positive trait impressions, an effect that is most marked when faces are most negatively valenced (Castle et al., 2012; Ruffman, Sullivan, & Edge, 2006; Zebrowitz, Franklin, Hillman, & Boc, in press). These results suggest that, as compared to YA, OA may differentiate negatively valenced faces less than positively valenced faces. The present study investigated differences in the perceptual differentiation of faces varying in age and positivity by YA and OA as evidenced in their trait impressions. First, we investigated whether overall, OA differentiate trait impressions less than YA. Next, we examined if this effect was moderated by either face age, where individuals will differentiate own-age faces better than other-age faces, or face valence, where age differences would be most
marked for the most negatively valenced stimuli. Finally, this study investigated whether
trait differentiation is correlated with cognitive differentiation.

The rationale for the predicting age differences in differentiation of trait
impressions is provided by the dedifferentiation hypothesis of cognitive aging. This
hypothesis builds off the two-component theory of life-span cognition. General
intelligence ($g$) is categorized into two distinct factors, fluid and crystallized intelligence,
where fluid intelligence deals with the cognitive operations and structures associated with
tasks such as perceiving relations and classifications (Baltes, 1987), and crystallized
intelligence reflects the ability to use skills and experience. The two-component theory
posits that fluid and crystallized intelligence interact in a differentiation phase in late
childhood and then again in a dedifferentiation phase in old age (Balinsky, 1941). In late
childhood, differentiation of cognitive abilities, such as increased competencies in verbal
relations, induction analysis, and reasoning ability, results from the child's development
of fluid cognitive capacities in conjunction with the attainment of crystallized knowledge,
fueled by environmental factors, motivations, and other sources (Balinsky, 1941).
Conversely, dedifferentiation in older adults is likened to a reversal of this process, such
that these cognitive abilities become less distinctive and more homogenous over time
(Baltes, 1987; Ghisletta & de Ribaupierre, 2005). These cognitive abilities can be
measured through a number of cognitive batteries, including, for example, measures of
perceptual speed and categorization tasks (Ghisletta & de Ribaupierre, 2005).
Additionally, sensory functioning and intelligence in old age have been shown to be
highly correlated, and the common cause hypothesis suggests that visual and sensory
acuity may be indicators of physiological integrity of the brain in late life (Baltes, 1987;
Lindenberger & Baltes, 1994). Measuring dedifferentiation is then evidenced through
either larger correlation coefficients among these cognitive test scores in older age groups or a larger proportion of variance accounted for by the general factor of intelligence (Deary, Whiteman, Starr, Whalley, & Fox, 2004). Essentially, the covariance of cognitive abilities is measured and greater covariance indicates more dedifferentiation (Ghisletta & de Ribaupierre, 2005). As the tests share more variance and less specificity, a less differentiated cognitive structure is implied (Deary et al., 2004) in old age, which could serve to explain age differences in first impressions of faces.

In conjunction with analyzing the covariance of cognitive abilities between younger and older adults, support for the dedifferentiation hypothesis of cognitive aging has been empirically demonstrated through more global activation in the brain in OA than in YA. This has been demonstrated in a variety of tasks, reflecting an increased covariance of brain activation that may provide evidence for dedifferentiation. For example, when asked to perform the same face-processing tasks as YA, OA showed activation of greater neural networks and increased activation in the left prefrontal cortex as compared to YA (Grady, 2002). This broader activation has been interpreted as increased demands on the executive functions of the frontal lobes reflecting a compensatory mechanism (Cabeza, McIntosh, Tulving, Nyberg, & Grady, 1997; Grady et al. 1994), difficulty in recruiting specialized neural mechanisms (Cabeza, Anderson, Locantore, & McIntosh, 2002), meeting processing demands compensating for neural decline (Reuter-Lorenz, Stanczak, & Miller, 1999), and increased cognitive effort or need for resources at lower levels of load than for younger adults (Grady, 2002). Thus, OA broader activation of neural networks when given similar cognitive and face-processing tasks as YA provide neurological support for the dedifferentiation hypothesis of cognitive aging. The general loss of cognitive abilities, as evidenced by more global brain
activation, in older adulthood may contribute to age differences in the differentiation of trait impressions of faces.

Age-related differences in neural responses in the visual system may also exist. Healthy aging yields a number of deficits in visual abilities that are only minimally explained by subtle changes on the anatomy of the visual pathway (Spear, 1993). Instead, visual deficits may be accounted for by neurological changes in the ventral visual cortex, an area known for its activation to faces (Kanwisher, McDermott, & Chun, 1997) and other categories such as cats and man-made objects, such as houses, chairs, scissors, shoes, and bottles (Haxby et al., 2001). These neurological changes in the aging brain may yield difficulties in differentiating between subtle differences in visual stimuli. For example, OA demonstrated between category dedifferentiation through shared activation of voxels in the ventral visual cortex that responded to stimulus categories of faces, chairs, pseudowords, and houses while YA did not show this shared activation. This shared activation exhibited dedifferentiation of neural responses to stimuli (Park et al., 2004). Demonstrating within category dedifferentiation of faces, Goh, Suzuki, & Park (2010) used fMRI to show that OA process less distinctive representations for individual faces than YA. In this study, OA and YA were asked to make same-different judgments to face pairs that were identical, moderate in similarity, or different. When faces were in the moderately similar condition, OA showed a greater adaptation in the fusiform face area, measured by the amount of response time reduction for both the moderate and identical condition relative to the different condition, while YA showed minimal adaptation (Goh et al., 2010), indicating less neural differentiation of the moderately similar faces by OA. Also, during the encoding process of memorizing facial stimuli, YA demonstrated dissociable networks during encoding and recognition of facial stimuli. OA, on the other
hand, showed activation in other regions of the cortex and diminished activation in prestriate cortex, thus indicating broader and less specialized activation completing the same memory tasks as YA (Grady et al., 1995). Park et al. (2004) argue that this dedifferentiation cannot simply be a result of OA greater experience with visual object recognition compared to YA because experience is likely to build selectivity of neural response to some stimulus categories (Polk & Farah, 2002).

Visual dedifferentiation in OA has been demonstrated through not only neural responses, but through behavioral responses as well. Research demonstrating age-related behavioral differences include greater intercorrelations during social tasks (Keightly et al., 2006), reduced accuracy in face recognition, and reduced ability to perceive differences in faces such as in changed expressions, reversed photos, or changed poses of target faces in OA as compared with YA (Bartlett & Leslie, 1986; Bartlett, Leslie, Tubbs, & Fulton, 1989). During a memory task, OA demonstrated higher false recognition of new faces than YA (Bartlett et al., 1989). Additionally, OA required higher levels of differences between face pairs in order to discriminate faces as compared to YA (Goh et al., 2010). These age-related differences in differentiation are present not only in the identification of faces, but also in recognizing different emotional expressions, especially for negatively valenced faces. In a recent meta-analysis, Ruffman, Henry, Livingstone, & Phillips (2008) found that OA showed deficits in emotion recognition as compared to YA among different modalities including faces, voices, bodies, and contexts. In the specific modality of faces, OA had greater difficulty in recognizing facial expressions of anger, sadness, fear, happiness, and surprise as compared to YA. Even at different intensities of emotional expressions, OA were worse at recognizing all intensities of sadness, fear, and anger as compared to YA, although age differences were reduced when controlled for
general cognitive functioning, suggesting that they may reflect in part age differences in
cognitive dedifferentiation (Ortega & Phillips, 2008). Taken together, OA have
demonstrated decreased ability to observe and articulate subtle changes in facial stimuli
as well as deficits in recognizing specific emotions. This supports the idea that OA may
have poorer ability than YA to differentiate the information provided in faces, which
could also be revealed in age differences in the differentiation of trait impressions.

OA not only show evidence for less neural and behavioral differentiation of visual
stimuli, but they also show a positivity bias. In particular, OA exhibit a positivity bias
through decreased memory, neural activation, and attention to negative stimuli and/or
increased memory and attention to positive stimuli (Carstensen & Mikels, 2005; Castle et
al., 2012; Charles, Mather, & Carstensen, 2003). Additionally, OA exhibit preferential
attention towards happy faces as compared to negative ones (Isaacowitz, Wadlinger,
Goren, & Wilson, 2006) and are better able to discriminate between different smile types
as compared to YA (Murphy, Lehrfeld, & Isaacowitz, 2010). Finally, OA give more
positive trait ratings to faces than do YA (Castle et al., 2012; Ebner, 2008; Ruffman et al.,
2008; Zebrowitz, Franklin, Hillman & Boc, in press). A motivational explanation for the
positivity bias is provided by the socioemotional selectivity theory, which posits that OA
are motivated to selectively attend to positive emotional information to maintain a
positive mood (Carstensen, 1995; Carstensen & Mikels, 2005). This suggests that the
positivity effect may be demonstrated more strongly for the most negatively valenced
stimuli. Consistent with this idea, Zebrowitz et al. (in press), found that the most
unhealthy looking faces were rated healthier by OA than by YA, and the most
untrustworthy looking faces were rated as less untrustworthy by OA than by YA.
Additionally, Castle et al. (2012) found that OA rated the most untrustworthy faces as
more trustworthy and demonstrated less anterior insular activity as compared to YA. Given that overall, OA may differentiate less than YA, the preceding evidence coupled with the OA positivity bias suggests that the lower differentiation by OA as compared to YA will be stronger for negative than for positive stimuli.

Finally, age differences in the differentiation of trait impressions may be moderated by an own-age bias. A meta-analysis by Rhodes & Anastasi (2012) suggests that own-age faces are more reliably identified than other-age faces, and this effect is shown for children, YA, and OA. This increased accuracy of recognizing own-age faces suggests that trait impressions may also be more differentiated for own-age faces. Consequently this own-age bias would suggest that OA may show greater differentiation in their trait impressions of older (OF) than younger faces (YF), while the reverse may be true for YA.

While previous research on age-related differentiation in face perception has been investigated through neurological and behavioral measures, the current study uses a different type of behavioral measure to examine age differences in differentiation in trait and appearance ratings of faces. Instead of measuring differentiation through accuracy of facial recognition, this study will measure differentiation with a discrimination index, $P_D$, developed by Linville, Salovey, and Fischer (1986). This measure was initially developed to look at stereotype category differentiation, or the ability to perceive many types within a given category. This index was also used by Zebrowitz, Montepare, and Lee (1993) to investigate differentiation of impressions of own-race faces compared to other-race faces. This measure can also be used to investigate differentiation of trait impressions of older adults as compared to younger adults. The discrimination index, $P_D$, reflects the probability that a perceiver will assign two randomly chosen individuals to different levels on a
rating scale. The more levels on a rating scale of a trait that a perceiver uses when rating a series of faces, the higher the differentiation score or the more differentiated are the perceiver’s ratings.

We will test four hypotheses. First, we predict that OA will differentiate less than YA in their ratings of the traits and appearance qualities of faces. Second, this age main effect will be moderated by the valence of the faces, with the lower differentiation by OA most marked for the most negatively valenced faces and least marked for the most positively valenced faces. Third, the age main effect will be moderated by face age, with both OA and YA differentiation scores significantly greater for same-age than other-age faces. Finally, we predict that OA will also show less cognitive differentiation than YA, and that cognitive differentiation will be correlated with differentiation in trait impressions of faces.
Method

Participants

Forty-eight young adults (23 males) and 48 older adults (24 males) participated in the study. YA were recruited from a local university and were ages 18-22 (M=18.8, SD=1.0). They completed the study for course credit or payment of $15. OA, ages 65-86 (M=76.3, SD=6.4), were recruited from the local community through fliers, paid $25 for completing the study and screened through the Mini-Mental State Examination (Folstein et al., 1975) all scoring above 26 out of 30 (M=28.9, SD=1.2). Each age group was split into 3 groups, viewing one of 3 sets of facial stimuli (MIDUS faces or one of two sets of IGS faces).

Facial Stimuli

Facial stimuli were taken from two databases of faces. One sample of faces was from a study of Midlife Development in the United States (MIDUS) funded by the John D. and Catherine T. MacArthur Foundation (Lachman, 1997). The individuals whose faces were used were from Boston. The images used were color frontal facial photographs of people with neutral expressions wearing a gray cape to mask clothing. A total of 69 YA (41 males) between the ages 25 and 39 and 68 OA (44 males) between the ages of 60 and 74 were included. Images were displayed at an approximate size of 7.5 centimeters by 9.5 centimeters. The second sample of faces was obtained from the Intergenerational Studies (IGS) archive. The individuals in this longitudinal study were
born in Berkeley, California in the late 1920s or were attending school in Oakland, California in the 1930s (Eichorn, 1981). One hundred ninety-eight individuals (74 males) were photographed at ages 17-18 and then again at ages 52-62 years old. This collection of grayscale photographs was divided into two sets to reduce rating length, with equal numbers of male and female and older and younger faces in each set. Moreover, these faces were matched such that each set had individuals of equal attractiveness, as determined by previous ratings of YA (Zebrowitz, Olson, & Hoffman, 1993). IGS images were displayed at an approximate size of 9 x 11 centimeters.

**Dependent Measures**

*Ratings*

Four traits and two appearance measures were rated on 7-point scales with endpoints labeled (1) *not at all* (healthy, competent, untrustworthy, aggressive or hostile, attractive, babyfaced) to (7) *very* (healthy, competent, untrustworthy, aggressive or hostile, attractive, babyfaced). The four trait ratings were always completed before appearance ratings. Trait and appearance ratings were reverse-ordered across participants and presented in the order of healthy, competent, untrustworthy, aggressive or hostile, attractive, babyfaced or aggressive or hostile, untrustworthy, competent, healthy, babyfaced, attractive. The term “aggressiveness” was used for rating the MIDUS faces, but previous analyses demonstrated lower agreement among OA than YA. Zebrowitz et al. (in press) suggested less agreement among the definition of the term aggressive in OA than in YA; as a result, the term hostile was used for ratings of the IGS faces given potentially different interpretations of the term aggressive. Thus, ratings for aggressiveness were not included in the differentiation analyses.

*Differentiation*
Differentiation scores in trait and appearance ratings of faces were computed using the probability of differentiation (\( P_D \)), where \( P_D = 1 - \frac{1}{n} \sum P_i^2 \), \( i \) is the level on the rating scale (1-7), and \( P \) is the proportion of ratings at the \( n \)th level (Linville et al., 1986). The more levels on a rating scale of a trait that a perceiver uses when rating a series of faces, the higher the differentiation score. Differentiation scores were calculated for each participant for each set of faces, by face age, face sex, and face valence.

To test the effects of face valence, faces were coded into “low” and “high” for each trait impression, and differentiation scores were computed for both YA and OA using the following procedure. For each set of faces, grouped by face age and face sex, average trait scores were computed for each face by raters of each age. Then, faces were grouped into 3 levels of each trait impression: negatively valenced, average valenced, and positively valenced, based on a median split calculated separately for both YA and OA, as well as for older and younger male and female faces. Faces that were below the median split for both YA and OA were categorized as negatively or positively valenced, depending on the trait impressions. For example, faces rated below the mean in untrustworthiness were categorized as positively valenced, while faces rated below the mean in attractiveness were categorized as negatively valenced. Faces that were not consistently rated below or above the median split for each age group were categorized as “average.” Then, differentiation scores were computed for each trait rating based on valence.

Finally, because face sex was not part of the hypotheses, the differentiation scores for male and female faces were averaged to create a differentiation score within negativity and face age for each trait impression. For example, the differentiation score for older male high attractive faces was averaged with older female high attractive faces.
and so on.

Control measures

Participants completed control measures for assessing mood (PANAS; Watson, Clark, & Tellegen, 1988), visual acuity (Snellen Eye Chart), contrast sensitivity (Mars Letter Contrast Sensitivity Test, Mars Perceptrix, Chappaqua, NY), color vision (Ishihara's Tests for Color Deficiency, Ishihara, 2010), facial matching (Benton Facial Recognition Test, Benton, Van Allen, Hamsher, & Levin, 1983), crystallized intelligence, (Shipley's Vocabulary Test, Shipley, 1946), and processing speed (Pattern Comparison Test, Salthouse, 1993). To assess executive functioning, participants who rated MIDUS faces completed a Letter-Number Sequencing Task (Wechsler, 1997) and those who rated the IGS faces completed a computerized version of the Wisconsin Card Sort Task (the Berg Card Sort Task (BCST; downloaded from http://pebl.sourceforge.net/battery.html and validated by Piper et al., 2012).

Procedure

Participants came into the study laboratory and were given an informed consent form. Next, they were seated at a computer and completed a computerized version of the Positive and Negative Affect Schedule (PANAS). Participants then rated the appearance and traits of one of the three sets of images, MIDUS faces or one of the two sets of IGS faces, using MediaLab software (Empirisoft, New York City, NY). Faces were shown for either 4 seconds (MIDUS faces) or 3 seconds (IGS faces) after which the trait rating scale appeared and stayed on screen until the participant made a selection. Participants were asked to rate each face in comparison with other faces of that same age group and sex. Participants rated all faces on one trait rating scale before moving on to the next scale. Additionally, faces were shown in one of four orders, blocked by age and sex
and counterbalancing the age and sex of the face. Participants then completed the remaining control measures.
Results

Differentiation scores for each impression scale were analyzed using a 2 (subject age: older vs younger adults) x 2 (face age: older vs younger) x 3 (negativity: negative, neutral, and positive) mixed-factor ANOVA, where face age and negativity were the within-subjects factors and rater age was the between-subjects factor. The dependent variable was each subject’s probability of differentiation for older and younger faces within each set of faces for each trait impression.

Rater age effects. OA did not differentiate attractiveness ratings of faces significantly less than YA ($M_{OA} = .59 SD = .14; M_{YA} = .60 SD = .14$), $F(1,94) = 18, p = .67, \eta^2 = .002$. However, OA showed significantly less differentiation for all other impressions: babyfaceness, ($M_{OA} = .56 SD = .20; M_{YA} = .64 SD = .13$), $F(1,94) = 8.75, p = .004, \eta^2 = .085$, competence, ($M_{OA} = .55 SD = .20; M_{YA} = .66 SD = .11$), $F(1,94) = 13.38, p < .001, \eta^2 = .13$, health, ($M_{OA} = .57 SD = .17; M_{YA} = .64 SD = .10$), $F(1,94) = 10.33, p = .002, \eta^2 = .099$, untrustworthiness, ($M_{OA} = .57 SD = .17; M_{YA} = .67 SD = .10$), $F(1,94) = 16.79, p < .001, \eta^2 = .15$, and hostility, ($M_{OA} = .55 SD = .17; M_{YA} = .65 SD = .11$), $F(1,62) = 14.96, p < .001, \eta^2 = .20$. Figure 1 presents the overall age differences in differentiation scores.

Face age effects. There was a main effect of face age where older faces were differentiated less for attractiveness, ($M_{OF} = .57 SD = .15; M_{YF} = .62 SD = .12$), $F(1,94) = 32.52, p < .001, \eta^2 = .26$, babyfaceness, ($M_{OF} = .57 SD = .19; M_{YF} = .62 SD = .15$),
\[ F(1,94) = 15.44, p < .001, \eta_r^2 = .14, \] competence, \( (M_{OF} = .59 \) \( SD = .17; M_{YF} = .62 \) \( SD = .14) \), \[ F(1,94) = 11.91, p = .001, \eta_r^2 = .11, \] and untrustworthiness, \( (M_{OF} = .61 \) \( SD = .15; M_{YF} = .63 \) \( SD = .12) \), \[ F(1,94) = 4.55, p = .036, \eta_r^2 = .046. \]

Overall, there was partial support for the own-age bias in ratings of attractiveness, health, and untrustworthiness. There was a marginal face age by subject age interaction for attractiveness, \( (OA: M_{YF} = .61, SD = .12, M_{OF} = .57, SD = .15; YA: M_{YF} = .63, SD = .12, M_{OF} = .57, SD = .15;) \), \[ F(1,94) = 3.05, p = .084, \eta_r^2 = .031. \] Although both YA and OA differentiated YF more than OF this tendency to differentiate young faces more than old faces was stronger for YA \( (p < .001) \) than for OA \( (p = .006) \), consistent with an own age bias. This interaction is presented in the left panel of Figure 2.

Additionally, there was a marginally significant interaction between face age and subject age for ratings of health, \( F(1,94) = 3.29, p = .073, \eta_r^2 = .034. \) Planned comparisons demonstrated a non-significant trend where OA differentiated OF more than YF, \( (M_{OF} = .58 \) \( SD = .16, M_{YF} = .56 \) \( SD = .17, p = .32, \) and YA differentiated YF more than OF \( (M_{OF} = .64 \) \( SD = .11, M_{YF} = .65 \) \( SD = .09, p = .12. \) See Figure 2, center.

Finally, while there was no significant face age by subject age interaction for untrustworthiness, \( F(1,94) = 1.32, p = .25, \eta_r^2 = .014, \) simple effects demonstrated that YA differentiated YF significantly more than OF, consistent with an own-age bias \( (M_{YF} = .68 \) \( SD = .08; M_{OF} = .65 \) \( SD = .11), p = .022, \) while OA differentiated OF and YF equally \( (M_{YF} = .58 \) \( SD = .15; M_{OF} = .57 \) \( SD = .18), p = .49. \) See Figure 2, right. Finally, there were no face age by subject age interactions for babyfaceness, \( F(1,94) = .78, p = .38, \eta_r^2 = .008, \) competence, \( F(1,94) = .013, p = .91, \eta_r^2 < .001, \) and hostility, \( F(1,94) = .79, p = .38, \eta_r^2 = .013. \)

Face valence effects. Means and standard deviations by subject age and negativity
are shown in Table 1. For ratings of attractiveness, a main effect of face negativity ($M_{LA} = .57$ $SD = .15$, $M_{AA} = .56$ $SD = .14$, $M_{HA} = .66$ $SD = .12$), $F(2,94) = 58.36$, $p < .001$, $\eta^2 = .38$, demonstrated that low attractive faces were differentiated equally to neutral faces ($p = .95$), but significantly less than high attractive faces ($p < .001$). Average attractive faces were also differentiated significantly less than high attractive faces ($p < .001$). A significant subject age by negativity interaction, $F(2,94) = 6.98$, $p = .001$, $\eta^2 = .069$, showed that YA differentiated highly attractive faces significantly more than either low or average attractive faces ($ps < .001$), but differentiated low and average attractive faces equally ($p = .33$). OA also demonstrated this same effect of differentiating high attractive more than low or average faces ($ps < .001$) and low and average faces equally ($p = .29$).

Finally, YA and OA differentiated the least and average attractive faces equally ($ps > .36$), but YA only differentiated more than OA on the most attractive faces ($p = .021$).

For ratings of babyfaceness, there was a main effect of face negativity, ($M_{LB} = .55$ $SD = .21$, $M_{AB} = .58$ $SD = .17$, $M_{HB} = .66$ $SD = .15$), $F(1,94) = 44.19$, $p < .001$, $\eta^2 = .32$, reflecting a tendency for the least babyfaced faces to be differentiated significantly less than both the average ($p = .011$) and most babyfaced faces ($p < .001$), as well as the average babyfaced faces to be differentiated significantly less than the most babyfaced faces ($p < .001$). There was no subject age interaction with face negativity, $F(1,94) = .37$, $p = .69$, $\eta^2 = .004$, and OA differentiated less than YA on the least ($p = .031$), average ($p = .013$) and most ($p < .001$) babyfaced faces.

Similarly, for ratings of competence, there was a main effect of negativity, ($M_{LC} = .60$ $SD = .17$, $M_{AC} = .59$ $SD = .17$, $M_{HC} = .63$ $SD = .17$), $F(1,94) = 9.88$, $p < .001$, $\eta^2 = .095$, where differentiation was not significantly different between the least and average competent faces ($p = .87$), but the most competent faces were differentiated more than the
least competent \((p = .003)\) and average competent \((p < .001)\) faces. There was no significant interaction between subject age and negativity, \(F(1,94) = .75, p = .47, \eta^2 = .008\), where OA differentiated less than YA on the least \((p = .005)\), average \((p = .001)\) and most \((p < .001)\) competent faces.

For ratings of health, there was a main effect of negativity \((M_{LHe} = .64 SD = .12, M_{AHe} = .56 SD = .16, M_{HHe} = .62, SD = .15), F(1,94) = 37.64, p < .001, \eta^2 = .29.\) The least \((p < .001)\) and the most \((p < .001)\) were differentiated significantly more than the average healthy faces. Also, the least healthy faces were differentiated marginally more than the most healthy faces \((p = .061)\). There was no significant interaction between subject age and negativity, \(F(1,94) = 1.59, p = .21, \eta^2 = .017.\) However, while OA differentiated all face valences less than YA, the effect was weaker for the least healthy faces \((p = .006)\) than the most healthy faces \((p = .001)\), demonstrating contradictory evidence for the positivity bias.

For ratings of hostility, there was a significant main effect of negativity, \((M_{LHo} = .57 SD = .19, M_{AHo} = .55 SD = .16, M_{HHo} = .67, SD = .10), F(1,62) = 33.54, p < .001, \eta^2 = .35,\) where the least hostile faces were differentiated as much as the average hostile faces \((p = .20)\), and the most hostile faces were differentiated significantly more than both the least \((p < .001)\) and average \((p < .001)\) hostile faces. There was a significant subject age by negativity interaction, \(F(1,62) = 4.70, p = .011, \eta^2 = .070,\) where while YA differentiated more than OA on all face valences on hostility, the effect was stronger for the least and most hostile faces \((ps = .001)\), and weaker for the average hostile faces \((p = .049)\).

Finally, for ratings of untrustworthiness, there was a main effect of face negativity, \((M_{LU} = .63 SD = .15, M_{AU} = .58 SD = .16, M_{HU} = .65, SD = .13), F(1,94) =\)
34.06, \( p < .001 \), \( \eta^2_p = .27 \), where both the low (\( p < .001 \)) and high untrustworthy (\( p < .001 \)) faces were differentiated more than the average untrustworthy faces, and the low was differentiated significantly less than the high untrustworthy faces (\( p = .029 \)). There was no subject age by face negativity interaction, \( F(1,94) = .33, p = .72, \eta^2_p = .003 \).

However, simple effects demonstrated that the tendency for OA to differentiate less than YA was more pronounced for the most untrustworthy faces (\( M_{OA} = .60, SD = .15, M_{YA} = .70, SD = .08 \)), \( p < .001 \), and average untrustworthy faces (\( M_{OA} = .53, SD = .18, M_{YA} = .63, SD = .11 \)), \( p < .001 \) than for the least untrustworthy faces (\( M_{OA} = .59, SD = .18, M_{YA} = .68, SD = .10 \)), \( p = .0014 \).

**Cognitive differentiation.** Three measures were computed to examine cognitive differentiation. First, to assess for age-related cognitive differentiation, based on a statistical method by Baltes (1997), several measures of cognitive abilities were correlated within each age group, and then a paired samples t-test was performed between each age group. These measures included all the cognitive-perceptual control measures: the Snellen Visual Acuity test, the Wisconsin Card Sort Test (for the subjects that viewed the IGS faces) or the Letter-Number Sequencing Task (for the subjects that viewed the MIDUS faces), the Benton Facial Recognition Test, the Mars Letter Contrast Sensitivity, the Pattern Comparison Test, and the Shipley's Vocabulary Test. These scores were z-scored within age group; also, because a lower score on the Snellen Visual Acuity test reflects better, and not worse, visual acuity, this measure was reverse-scored such that higher scores would reflect better visual acuity in order to properly correlate the measures. We predicted that OA would be significantly greater in their correlations than YA.

Correlations between each of the cognitive measures for each age group are...
presented in Table 2. No significant correlations between each of the cognitive measures were found among the YA; however, significant correlations were found between the measure of contrast sensitivity and the WCST or LNST ($r = .29, p = .047$), the PCT ($r = .39, p = .008$), or the Shipley's Vocabulary Test ($r = .32, p = .029$) among the OA. Then a paired samples t-test between each of the correlations among the control measures between older and younger adults demonstrated a significant difference, $t(14) = -5.06, p < .001$ (YA: $M = .00047, SD = .15$; OA: $M = .23, SD = .17$), showing that the cognitive measures among OA were significantly more correlated than those of YA.

Because this method only examined correlations at the group level of cognitive measures, two other measures were created to assess correlations between cognitive and trait differentiation at the individual level. First, to assess the differentiation of fluid and crystallized intelligence, z-scores were computed for scores on the Pattern Comparison Test (a measure of processing speed that taps fluid intelligence) and the Shipley's Vocabulary Test (a measure of crystallized intelligence) for each subject within each age group. The absolute value of the difference between the z-scores of these two measures was computed as an index of cognitive differentiation, with a smaller value indicating less differentiation. An independent t-test of the mean of the difference scores for each age group revealed no significant differences between the age groups ($M_{OA} = .86, SD = .64$, $M_{YA} = 1.07, SD = .81$), $t(94) = 1.40, p = .16$. This score was then correlated with the average trait differentiation score for each face age for each subject by age group. No significant correlations between this score and the trait differentiation scores were found (OA: all $rs < .21$, all $ps > .20$; YA: all $rs < .20$, all $ps > .18$). See Table 3 for these correlations.

A second measure of cognitive differentiation was computed using all cognitive-
perceptual measures included in the control tests. Scores from the Snellen Visual Acuity test, the Wisconsin Card Sort Test (for the subjects that viewed the IGS faces) or the Letter-Number Sequencing Task (for the subjects that viewed the MIDUS faces), the Benton Facial Recognition Test, and the Mars Letter Contrast Sensitivity Form were each z-scored within each age group. The standard deviation of the 6 z-scores was then calculated for each subject on the assumption that a higher standard deviation would signify greater differentiation. Independent t-tests of the means of the standard deviations revealed no significant differences between older and younger adults ($M_{OA} = .86$ $SD = .37$, $M_{YA} = .93$ $SD = .35$), $t(94) = .96$, $p = .34$. Subsequently, we correlated the 6-measure index of cognitive differentiation with the average trait differentiation score for each subject.

For OA, no significant correlations between this standard deviation score and any trait differentiation scores were found. However, for YA, there was a significant correlation for older faces on ratings of babyfaceness, $r = .31$, $p = .034$, and a marginal correlation between this difference score and the trait differentiation scores for older faces' ($r = .26$, $p = .069$) and younger faces' ($r = .27$, $p = .066$) health.
Discussion

The present findings add to previous research examining differences in older and younger adults' perception of faces (e.g., Ebner, 2008; Ruffman et al., 2006; Zebrowitz et al., in press) by investigating age differences in the differentiation of trait ratings. The measure of calculating the proportion of numbers used on a rating scale, adapted from previous work on stereotype categorization, provides a novel method of capturing age-related differentiation in trait impressions from faces. As predicted, OA differentiated less than YA in all trait ratings except for attractiveness. Additionally, partial support for the own-age bias was provided in ratings of attractiveness, health, and untrustworthiness. Specifically, while both YA and OA differentiated YF more than OF, this effect was stronger for YA than for OA on ratings of attractiveness. Additionally, a non-significant trend demonstrated that both OA and YA differentiated own-age faces more than other-age faces in ratings of health. Finally, YA differentiated YF significantly more than OF, while OA differentiated YF and OF equally in ratings of untrustworthiness. Contrary to predictions, face valence did not moderate differentiation of trait impressions of babyfaceness, competence, and untrustworthiness. In addition, simple effects demonstrated that the age difference in differentiating the least attractive, babyfaced, competent, and healthy faces was smaller than for the most babyfaced, competent, or healthy faces. OA also differentiated both the most and the least hostile faces significantly less than YA, while differentiating the average faces equally with YA.
Finally, our results demonstrated age differences in cognitive differentiation, with higher correlations among OA than YA in measures of cognitive-perceptual abilities, but found no support for a relationship between cognitive and trait dedifferentiation.

OA lesser differentiation of faces on trait dimensions is consistent with previous work which showed that older adults required higher levels of differences between face pairs in order to discriminate faces (Goh et al., 2010) and also OA difficulties in distinguishing different facial expressions (Bartlett & Leslie, 1986). One interpretation is not that OA are necessarily unable to make these fine distinctions, but may choose not to exert the mental energy required to do so. Whether this effect is due to neurocognitive deficits in old age or motivational reasons, support was provided in this study for dedifferentiation of trait impressions from faces in older adults.

The partial support for an own-age bias is similar to previous work demonstrating a lack of consistency for the own-age bias in face recognition, especially for older adults. For example, greater recognition accuracy was found for younger adults in identifying previously studied young faces, but this effect was not found for older adults (Weise, Schweinberger, & Hansen, 2008). In another study by Slessor, Laird, Phillips, Bull, & Filippou (2010), own-age benefits of gaze following, or the ability to detect a stimulus that another individual in a social environment is focused on, was found for younger, but not older, adults. Finally, age-related increases in false recognition of faces was not affected by face age (Fulton & Bartlett, 1991). In the current study, given the inconsistency of results demonstrating the own-age bias, data must be interpreted cautiously.

The finding that YA showed greater differentiation of own-age faces on attractiveness may reflect YA greater preoccupation with appearance than OA. For
example, a review by Tiggemann (2004) found that at least for women, body appearance diminishes in importance with increasing age. Along another line, the finding that OA showed a trend of greater differentiation of own-age faces on health ratings may reflect a greater preoccupation with health due to the greater health-related losses in old age. Adding a measure of evaluating an individual's health concerns during control measures may potentially provide a way to correlate this effect with individual and group health concerns. Finally, given that OA generally differentiate less than YA, their equal differentiation of untrustworthiness of older and younger faces provides some weak evidence for an own-age bias.

Some of the reasons behind the lack of a consistent own-age bias in differentiation of trait impressions could be that the own-age bias in identification of own-age faces typically has a small effect size, significantly less than that shown for the own-race bias (Wright & Stroud, 2002). Additionally, the own-age bias in face perception has previously been applied in accuracy of face recognition (e.g. Anastasi & Rhodes, 2005; Hills & Lewis, 2011) rather than in differentiation of trait impressions of own-age faces. Thus, the own-age bias in face recognition might not generalize to an own-age bias for trait differentiation.

Given previous evidence that older adults demonstrate preferential attention to positive stimuli and/or less attention to negative stimuli (e.g. Isaacowitz, et al., 2006; Murphy et al., 2010), we predicted that the age difference in differentiation of trait impressions would be most pronounced for more negatively valenced faces. However, our results demonstrated that face valence did not moderate trait impressions from faces for ratings of babyfaceness, competence, health, and untrustworthiness. In fact, the only significant face valence effects included: (1) OA less differentiation of the most attractive
faces compared to YA and (2) OA less differentiation of both the most and the least hostile faces as compared to YA, while differentiating the average hostile faces equally with YA. Additionally, contrary to predictions, age differences were more pronounced for positively valenced faces for trait differentiation of babyfaceness, competence, and health. As these differences were quite small, these results suggest that perhaps older adults' positivity bias might not be a product of making less distinctions among negatively valenced faces as compared to positively valenced faces.

Finally, while YA differentiated more than OA on all face valences on hostility, the effect was stronger for the least and most hostile faces, and weaker for the average hostile faces. The only marginal evidence supporting the positivity bias is that the age difference in differentiation of impressions of untrustworthiness was more pronounced for the most untrustworthy and average untrustworthy faces than for the least untrustworthy faces. Again, this difference was quite small and may not generalize to future studies. Overall, evidence from this study does not support previous findings indicating a positivity bias in OA through this measure of differentiation.

Although no predictions were made regarding main effects of valence, it is interesting to note several findings. First, faces low and average in attractiveness, competence, and hostility were differentiated equally, and faces high in those traits were differentiated significantly more than faces either low or average in those trait ratings. Additionally, faces low and high in health and untrustworthiness were differentiated significantly more than faces average in those traits. Finally, for ratings of health, the least healthy faces were differentiated marginally more than the most healthy faces, and for ratings of untrustworthiness, the most untrustworthy faces were differentiated significantly more than the least untrustworthy faces. These results may indicate that
varying differentiation patterns for positively and negatively valenced faces are subject to the trait impression being evaluated and would be worth replicating with more trait impressions.

Finally, a significant difference in the correlations of the control measures between younger and older adults were found, where correlations were greater for older adults than younger adults, indicating support for the dedifferentiation hypothesis of cognitive aging. Additionally, among the correlations of the cognitive measures, OA showed significant correlations between some of the control measures, while YA showed no significant correlations between the control measures. This study adds to the evidence that sensory functioning and intelligence in old age have been shown to be highly correlated (Baltes, 1987; Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994) which may in turn affect differentiation of trait impressions from faces.

However, despite the evidence of cognitive dedifferentiation using correlations from control measures for each age group, a lack of correlation was found when attempting to correlate each individual's cognitive differentiation with their trait differentiation scores. One explanation for the lack of correlation between the difference score of the pattern comparison task and the vocabulary measure and an individual's differentiation score could be the insensitivity of the index using only one measure each of crystallized and fluid intelligence. The difference in one's vocabulary and one's ability to categorize patterns as same or different may not be a very responsive index of an individual's differentiation of cognitive abilities. The second method used an additional 4 measures, incorporating 2 sensory control measures, one for visual acuity and one for contrast sensitivity, a measure of facial recognition, and another measure of fluid intelligence. These additional factors yielded a significant correlation between younger
adults’ cognitive differentiation and trait differentiation of older faces in babyfaceness, and marginal correlations within the same age group for both older and younger faces in health. The theoretical significance of these results are unclear. The lack of a pattern of correlations between cognitive differentiation with individual trait differentiation scores provides no evidence supporting an association between dedifferentiation in cognitive abilities and dedifferentiation of trait impressions from faces among older adults. Perhaps including more measures of crystallized and fluid intelligence would provide a more robust calculation of cognitive differentiation. Regardless, parallel support was provided separately for both dedifferentiation of trait impressions from faces as well as cognitive dedifferentiation in older adults.

In conclusion, this study provided a novel perceptual measure of differentiation of trait impressions from faces, tapping into the use of rating scales of trait impressions. The results provided consistent evidence that OA demonstrate less differentiation in their trait impressions than do YA. Although these effects paralleled age differences in cognitive differentiation, the two measures were unrelated, perhaps due to weakness in the individual measures of cognitive differentiation. Further research would be warranted given the inconsistency of results supporting the own-age bias and the positivity effect. Additionally, a greater number of measures of cognitive abilities may improve or elicit correlations between differentiation scores and cognitive dedifferentiation. This study further substantiates those reported in the literature of the dedifferentiation hypothesis of cognitive aging in face perception, where older adults were shown to differentiate faces less than younger adults on a number of trait impressions. The next step would be identifying if this measure of differentiation correlated with broader neurological activations while assessing trait impressions from faces and further analyzing
motivational or neurobiological differences that contribute to dedifferentiation of face impressions in old age.
<table>
<thead>
<tr>
<th>Valence</th>
<th>Attractiveness</th>
<th>Babyfaceness</th>
<th>Competence</th>
<th>Health</th>
<th>Hostility</th>
<th>Untrustworthiness</th>
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<tr>
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<td>.61(^e)</td>
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<td>.71(^f)</td>
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*Note: Means for contrasting groups with superscripts “a” and “b” differ at \(p < .05\), “c” and “d” at \(p < .01\), and “e” and “f” at \(p < .001\). Non-significant differences share the same superscript (a).\(N = 48\) older adult (OA) raters and 48 younger adult (YA) raters for attractiveness, babyfaceness, competence, healthy and untrustworthiness; \(N = 32\) OA and 32 YA raters for hostility.*
Table 2

Correlations Between Cognitive-Perceptual Control Measures of Older (OA) and Younger (YA) Adults.

<table>
<thead>
<tr>
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<th>5</th>
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Note: Variables are z-scored within age group, and the Snellen Visual Acuity is reverse-scored.
†p < .10, *p < .05, **p < .01
Table 3

*Pearson Correlations Between the Crystallized-Fluid Intelligence Difference and Trait Differentiation Scores by Older and Younger Adults*

<table>
<thead>
<tr>
<th>Trait</th>
<th>Crystallized-Fluid Intelligence Difference</th>
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<th>Younger Adult</th>
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<td><em>r</em></td>
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</table>

*Note:* The crystallized-fluid intelligence difference is the absolute value of the difference between the z-scores of Shipley's Vocabulary Test and Pattern Comparison Task for each individual.
Table 4

*Pearson Correlations Between the Standard Deviation (SD) of Cognitive Measures and Trait Differentiation Scores by Older and Younger Adults*

| Trait         | SD of 6 Cognitive Measures\(^a\) |           |           |           |           |
|---------------|----------------------------------|-----------|-----------|-----------|
|               |                                  | Older Adult| Younger Adult |
| Attractiveness|                                  |           |           |           |           |
| Older Faces   | \(r\) \(= 0.12\) \(p = 0.43\) \(r = 0.05\) \(p = 0.72\) |           |           |           |           |
| Younger Faces | \(r = 0.09\) \(p = 0.55\) \(r = -0.16\) \(p = 0.26\) |           |           |           |           |
| Babyfaceness  |                                  |           |           |           |           |
| Older Faces   | \(r = 0.06\) \(p = 0.66\) \(r = 0.31\) \(p = 0.03^*\) |           |           |           |           |
| Younger Faces | \(r = 0.06\) \(p = 0.68\) \(r = 0.14\) \(p = 0.33\) |           |           |           |           |
| Competence    |                                  |           |           |           |           |
| Older Faces   | \(r = 0.06\) \(p = 0.71\) \(r = 0.09\) \(p = 0.55\) |           |           |           |           |
| Younger Faces | \(r = 0.04\) \(p = 0.81\) \(r = 0.12\) \(p = 0.40\) |           |           |           |           |
| Health        |                                  |           |           |           |           |
| Older Faces   | \(r = 0.14\) \(p = 0.36\) \(r = 0.26\) \(p = 0.07^*\) |           |           |           |           |
| Younger Faces | \(r = 0.17\) \(p = 0.26\) \(r = 0.27\) \(p = 0.07^*\) |           |           |           |           |
| Hostility     |                                  |           |           |           |           |
| Older Faces   | \(r = 0.14\) \(p = 0.43\) \(r = 0.08\) \(p = 0.66\) |           |           |           |           |
| Younger Faces | \(r = 0.09\) \(p = 0.62\) \(r = 0.06\) \(p = 0.75\) |           |           |           |           |
| Untrustworthiness |                              |           |           |           |           |
| Older Faces   | \(r = -0.004\) \(p = 0.98\) \(r = 0.21\) \(p = 0.16\) |           |           |           |           |
| Younger Faces | \(r = 0.08\) \(p = 0.60\) \(r = 0.17\) \(p = 0.26\) |           |           |           |           |

\(^a\) This measure is the standard deviation for each individual of each of the z-scored cognitive measures: Shipley's Vocabulary Test, Pattern Comparison Test, the Wisconsin Card Sort Task or Letter-Number Sequencing Task, Mars Contrast Sensitivity and Benton Facial Recognition Test. \(^* p < .10, \,* p < .05.\)
Figure 1. Older (OA) and Younger (YA) Adults' Overall Probability of Differentiation of Trait Impressions from Faces

Note: **p < .01, ***p < .001
Figure 2. Older (OA) and Younger (YA) Adults' Differentiation of Trait Impressions of Attractiveness, Health, and Untrustworthiness of Older (OF) and Younger (YF) Faces

Note: *p < .05, **p < .01, ***p < .001.
References


