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Social perception and aging: The relationship between aging and the perception of subtle changes in facial happiness and identity

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ABSTRACT

Previous findings suggest that older adults show impairments in the social perception of faces, including the perception of emotion and facial identity. The majority of this work has tended to examine performance on tasks involving young adult faces and prototypical emotions. While useful, this can influence performance differences between groups due to perceptual biases and limitations on task performance. Here we sought to examine how typical aging is associated with the perception of subtle changes in facial happiness and facial identity in older adult faces. We developed novel tasks that permitted the ability to assess facial happiness, facial identity, and non-social perception (object perception) across similar task parameters. We observe that aging is linked with declines in the ability to make fine-grained judgements in the perception of facial happiness and facial identity (from older adult faces), but not for non-social (object) perception. This pattern of results is discussed in relation to mechanisms that may contribute to declines in facial perceptual processing in older adulthood.

1. Introduction

Our ability to correctly perceive and interpret social cues (social perception) is a critical component of human life. One important source of social signals is the face. For instance, from a face we are able to judge if someone we meet is a friend or a stranger (i.e. their identity), whether that person is pleased or upset to see us (e.g. if they are happy, angry, or sad), and make trait judgments about that person's character (e.g. judging if they look trustworthy or aggressive). While these processes are relatively rapid, they can have profound effects on our behaviour. For example, emotional facial expression perception plays an important role in interpersonal communication (Ruffman, Henry, Livingstone, & Phillips, 2008; Ryan, Murray, & Ruffman, 2009), and difficulties with social perception are associated with a range of psychosocial consequences (e.g., Kanai et al., 2012; Spell & Frank, 2000). It is therefore unsurprising that considerable research interest has focused on establishing how the capacity for social perception varies across individuals.

In recent decades, there has been a focus on age differences in facial emotion recognition. The general pattern that has emerged is that older adults appear to have declined recognition of negative facial expressions of emotions such as anger, sadness, fear and surprise (e.g. McDowell, Harrison, & Demaree, 1994; Phillips, MacLean, & Allen, 2002; Calder et al., 2003; MacPherson, Phillips, & Sala, 2006; Sullivan & Ruffman, 2004; Isaacowitz et al., 2007; see Ruffman et al., 2008 for review). There are, however, some factors that can influence emotion perception changes linked with aging. These include the use of dynamic versus static stimuli (Murphy, Lehrfeld, & Isaacowitz, 2010; Riediger, Studtmann, Westphal, Rauers, & Weber, 2014), the type of target expression (see Ruffman et al., 2008 for review), and the age of the face expressing the emotion (e.g. see Folster, Hess, & Werheid, 2014 for review).

With regard to target expression, there is some evidence to suggest that while older adults show reductions in the perception of negative emotions (e.g. anger, sadness, fear) the perception of positive emotion can be spared. One explanation suggested for this difference is that older adults may show a preference to engage/encode signals that promote positivity, emotional balance, and well-being (socio-emotional selectivity theory - Carstensen & Charles, 1998). An alternative explanation for reduced negative emotion, but spared happiness perception during aging is that in several studies happiness recognition performance was at ceiling for at least one age group tested (e.g. Brosgole & Weisman, 1995; Isaacowitz et al., 2007; McDowell et al., 1994; Moreno, Borod, Welkowitz, & Alpert, 1993; Orgeta & Phillips,

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2007). Indeed, a general limitation involved in most previous research is that only high-intensity prototypes of facial expression images have been used. This is problematic for two reasons. Firstly, it is known that the ability to correctly perceive facial emotional expressions can vary across different prototypical emotions (i.e. they are not matched for difficulty; e.g. see Calder et al., 2003), thus comparisons in performance differences across emotion types can be difficult. Secondly, although the study of high intensity emotion has proved useful, more subtle facial expression that have lower intensities are common in daily social interactions (Orgeta & Phillips, 2007).

There have been fewer investigations into age-related perceptual differences when using low intensity emotion stimuli (Hess, Blairy, & Kleck, 1997; Orgeta & Phillips, 2007). Those that have done so indicate that older adults show impairment in the perception of low intensity emotions of sadness, anger and fear, however no differences in happiness, disgust, or surprise perception were observed (Orgeta & Phillips, 2007). A number of questions remain: e.g. a) are these differences a consequence of domain-specific deficits in subtle emotion perception or more domain-general shifts in the ability to make fine-grained visual discrimination, b) could the lack of age-related effects in certain emotions relate to task sensitivity (e.g. better performance on happiness perception relative to other emotion types), and c) to what extent do these results hold when controlling for perceptual biases that may aid younger adults over older adults during task completion?

In relation to perceptual biases that might affect relationships between aging and social perception, one issue is the other-age effect: where participants tend to show superior performance in perception of own versus other age faces (Anastasi & Rhodes, 2005; Ebner, He, & Johnson, 2011; Ebner & Johnson, 2009; Wright & Stroud, 2002). While there have been some studies comparing older and younger adults in the ability to perceive emotion from faces displayed by younger and older adult actors using prototypical emotions (Ebner et al., 2011), prior work examining low intensity emotion perception in older adults has tended to use young adult faces as target stimuli. In this regard one could argue that declines in performance displayed by older adults in previous research were related to the use of young adult actors in the task, which favours young adult participants.

In addition to facial expression perception, there is prior work suggesting that facial identity perception abilities may decline with age (e.g. Bowles et al., 2009; Megreya & Bindemann, 2015). Despite an awareness of age-related changes in facial identity and facial emotion perception, most studies on the relationship between aging and social perception have only investigated one aspect of face processing at a time (i.e. emotion or identity in isolation) or used tasks that have inconsistent paradigms involving different task complexities (e.g. working memory demands). This raises questions regarding whether previously reported differences in the perception of facial emotion and facial identity rely on common perceptual mechanisms or are related to other factors (e.g. tasks that might tap additional processes to the use of perceptual cues). In this regard, prior work struggles to give a clear picture about how normal aging is related to different aspects of face perception, meaning that the extent to which age influences face identity and face expression perception abilities in a similar or different manner remains unclear.

In view of the above, the present study sought to assess social perception of subtle changes in facial emotion and facial identity shown by older adult actors using similar task parameters and levels of difficultly. To achieve these aims we developed a series of novel tests that built upon a well utilised paradigm for studying fine-grained visual discrimination of facial identity and facial emotion in younger adult participants - the Cambridge Face Perception Test (CFPT; see Section 2.2 for details; Duchaine, Germine, & Nakayama, 2007a; Duchaine, Yovel, & Nakayama, 2007b). The CFPT format requires participants to discriminate between visual stimuli on the basis of visual properties alone (Bowles et al., 2009; Duchaine et al., 2007a, 2007b). This offers benefits to assess perceptual differences over other task formats (e.g. labelling tasks, same-different judgment tasks) that might theoretically tap additional processes alongside perceptually driven performance factors (Adolphs, 2002; Palermo, O'Connor, Davis, Irons, & McKone, 2013). For example, labelling based measures of emotion processing require additional demands of assigning a verbal label to an emotion, thus placing additional constraints on performance related to variation in emotional vocabulary (Barrett, Lindquist, & Gendron, 2007). Further, labelling and same-different judgment tasks often require increased working memory demands, thus placing additional constraints on performance related to cognitive load (Phillips, Channon, Tunstall, Hedenstrom, & Lyons, 2008). An additional benefit of the CFPT is similarity in task parameters and accuracy across the multiple versions of the measure (e.g. identity, emotion, object), which permits the ability to compare performance differences across different visual categories when task demands remain similar. If emotion perception is affected by normal aging, but facial identity and object perception remains intact, it points to the possibility that age-related declines in social perception are emotion-specific; whereas if normal aging also affects facial identity perception, it may suggest that there is a general face processing decline; finally, if it affects all tasks (identity, emotion and object) it suggests a domain-general (i.e. non-social specific) decline may account for changes in subtle emotion perception associated with typical aging.

2. Methods

2.1. Participants

Twenty-six younger adults (seven male and nineteen female; age range 18–36 years, mean age = 24 years, SD = 6 years) and twenty-seven older adults (seven male and twenty female; age range 60–77 years, mean age = 69 years, SD = 6 years) took part. All participants were native-English Caucasians, with no known history of neurological problems or language-related problems. Participants also had normal or corrected-to-normal vision. These sampling criteria were in place to ensure that participants were typical adults without any difficulties in understanding task instructions or general visual impairment difficulties. The recruitment of Caucasians was to avoid any potential confounding effect of the other-race effect on task performance in the face tasks (Tanaka, Kiefer, & Bukach, 2004). Younger participants were recruited through the university's undergraduate participant pool, and older participants were recruited from the Goldsmiths Psychology Department participant pool.

Level of education, premorbid intelligence (NART) (Nelson & Wilson, 1991), and handedness were recorded at the beginning of experiments; the two groups did not significantly differ in these factors (details given in the Results section). The Mini-Mental State Examination (MMSE) was also used as a screening evaluation to test older participants for possible dementia (Folstein, Folstein, & McHugh, 1975). The MMSE is a commonly used measure to screen for cognitive status. A cut-off limit of < 24 was used, which has a good sensitivity for dementia in the older population (Chayer, 2002). No participants were excluded from the study on the basis of this criterion. All participants gave informed consent prior to beginning the experiment and were fully informed about the experimental procedure. The local ethics committee approved the study.

2.2. Materials and procedure

We developed a series of novel tests that built upon the Cambridge Face Perception Test (CFPT). The CFPT was originally developed to study subtle differences in the perception of facial identity perception (hereafter referred to as CFPT-Identity) under conditions in which working memory demands are minimal (Duchaine et al., 2007a; Duchaine et al., 2007b), and has since been adapted to examine subtle differences in the perception of happiness (CFPT-Happy), anger (CFPT-

Anger), and facial traits (e.g. trustworthiness) (Janik-McErlean, Susilo, Rezlescu, Bray, & Banissy, 2016; Rezlescu, Susilo, Barton, & Duchaine, 2014). During CFPT-Identity participants are presented with a target face and six faces morphed between the target and one of six distractor faces in varying proportions so that they vary systematically in their similarity to the target face. The participant's task is to sort the six morphed faces from most to least like the target face. During CFPT-Happy, participants are presented with six faces that show morphs between the expression of 'happiness' and a 'neutral' expression in varying proportions; the participant's task is to sort the faces from most to least happy (in CFPT-Happy). These tasks have been used successfully to assess fine-grained social perception abilities in younger adult participants (e.g. Janik, Rezlescu, & Banissy, 2015; Romanska, Rezlescu, Susilo, Duchaine, & Banissy, 2015), and to distinguish between groups (e.g. social perception in prosopagnosia – Duchaine et al., 2007a; Duchaine et al., 2007b; Rezlescu et al., 2014; Shah, Gaule, Sowden, Bird, & Cook, 2015; social perception in synaesthesia – Janik-McErlean et al., 2016).

Current CFPT tasks, however, only use young adult target faces as stimuli. Given that this may bias performance in favour of younger adult participants (e.g. due to the other age-effect) we sought to develop modified versions of the CFPT-Identity and CFPT-Happy using older adult faces as stimuli (CFPT-Identity Older Adult and CFPT-Happy Older Adult). In addition, to date no object-based CFPT measure exists, but to highlight specificity of any differences to face perception a comparison task assessing object perception is required. To address this gap we developed a novel version of the CFPT assessing perception of cars (CFPT-Car). Details of each task are found below. The order of completion of each task was random across participants.

2.2.1. CFPT-Identity Older Adult

This task followed the same procedure as the standard CFPT-Identity (previously called CFPT, see Duchaine et al., 2007a; Duchaine et al., 2007b), but here we used older adult faces rather than younger adult faces. During the task, participants were displayed a target face and six faces (from a frontal view) morphed between the target and distractor in varying proportions (88%, 76%, 64%, 52%, 40%, and 28% of the target face). In each trial, participants were asked to sort the six faces by similarity to the target face with a one-minute time limit. If participants completed the trial before the time limit expired they were able to click an option on screen to begin the next trial. The task involved eight upright and eight inverted trials that alternated in a fixed pseudo-random order. This allowed investigation of the inversion effect for face perception (Yin, 1969). Face inversion is linked with reduced performance compared to upright facial perception, which is often thought to relate to configural processing being disrupted by facial inversion (Farah, Tanaka, & Drain, 1995; Leder & Carbon, 2006). By including inverted faces we were able to check whether differences in performance on the identity-processing task were specific to perceptual processes associated with upright versus inverted face processing.

Stimuli were created using the software FantaMorph. All facial stimuli used were from Park Aging Mind laboratory face database (http://agingmind.cns.uiuc.edu/facedb/), which contain standardised pictures of males and females from different ages. In order to match the older facial stimuli to the young facial stimuli used in the original CFPT-Identity (Duchaine et al., 2007a; Duchaine et al., 2007b), external facial features were removed from images and coloured images were transformed into grey scale images (Fig. 1a). Performance on CFPT is measured by an error score, which is calculated for each trial type. This is calculated by summing the deviations from the correct position for each face, with one error reflecting each position that a face must be moved to be in the correct location. For example, if a face was one position from the correct location, the error score was 1. If it was 3 positions away from the correct location, this was an error score of 3. Error scores on each trial type were summed to determine the total number of errors for each orientation. We then used this to calculate the percentage of correct responses. Chance performance is 36% (Duchaine et al., 2007a, 2007b).

2.2.2. CFPT-Happy Older Adult

In this task, participants were presented six frontal view faces morphed between the expression of 'happiness' and a 'neutral' expression in varying proportions (25%, 20%, 15%, 10%, 5%, and 0% happiness). These proportions were used based on piloting to establish the most optimal parameters for sensitive task difficulty (e.g. to avoid ceiling effects) and to permit comparability to the original young adult CFPT-Happy (note that the percentage morphs are slightly higher than the original young adult CFPT-Happy, but performance accuracy is comparable; Janik-McErlean et al., 2016). Participants were required to sort the faces according to how happy they appeared from the face that looks least happy to the face that looks most happy (note all images appeared in the same fixed random order as per young adult CFPT-Happy at the start of each trial). The time limit for each trial was 60 s, and as per all tasks participants could click on an option to begin the next trial if they completed the trial before this time. As with the CFPT-Identity Older Adult task, the stimuli were created using the software FantaMorph; all facial stimuli used were from Park Aging Mind laboratory face database (http://agingmind.cns.uiuc.edu/facedb/); and external facial features were removed from images and coloured images were transformed in to grey scale images (Fig. 1c). Performance accuracy was calculated using the same approach as outlined for CFPT-Identity Older Adult task. Chance performance is 36% (Janik-McErlean et al., 2016).

2.2.3. CFPT-Cars

To test object perception we also developed another new version of the CFPT involving using car stimuli as opposed to faces. This test adapted the same experimental paradigm of the original CFPT-Identity (Duchaine et al., 2007a and 2007b) and the CFPT-Identity Older Adult Task described above. That is to say that during the task, participants were shown a target car and six cars (from a frontal view) morphed between the target and one of six distractor cars in varying proportions (88%, 76%, 64%, 52%, 40%, and 28% of the target car; Fig. 1b). In each trial, participants were asked to sort the six cars by similarity to the target car with a one-minute time limit, and as per all tasks participants could click on an option to begin the next trial if they completed the trial before this time. The task involved eight upright and eight inverted trials that alternated in a fixed pseudo-random order. Performance accuracy was calculated using the same approach as outlined for CFPT-Identity Older Adult task. Chance performance is 36%.

3. Results

Prior to analysis, three younger adult participants were withdrawn from analysis due to them being identified as outliers in at least one task. More specifically, each participant that was withdrawn performed three standard deviations away from the group mean on one or more tasks, and was verified as an outlier using Grubb's Test (Grubbs, 1950).

3.1. Demographic differences

Following outlier removal, the mean age of the younger adult group was 25 years (SD = 6 years) and the mean age of the older adult group was 69 years (SD = 6 years). The younger group comprised of 16 females and 7 males, with 2 left handed participants. The older group comprised of 20 females and 7 males, with 1 left handed participant. The two groups did not significantly differ in gender [χ^2 (1), $N = 50 = 0.125$, $p = 0.723$]. The years of education [young group: mean = 15 years, SD = 3 years; old group: mean = 16 years, SD = 3 years; $t(48) = 1.16$, $p = 0.253$] and NART scores of the two age groups were compared and they were not significantly different [young group: mean = 118.71, SD = 6.92; old group: mean = 120.67,

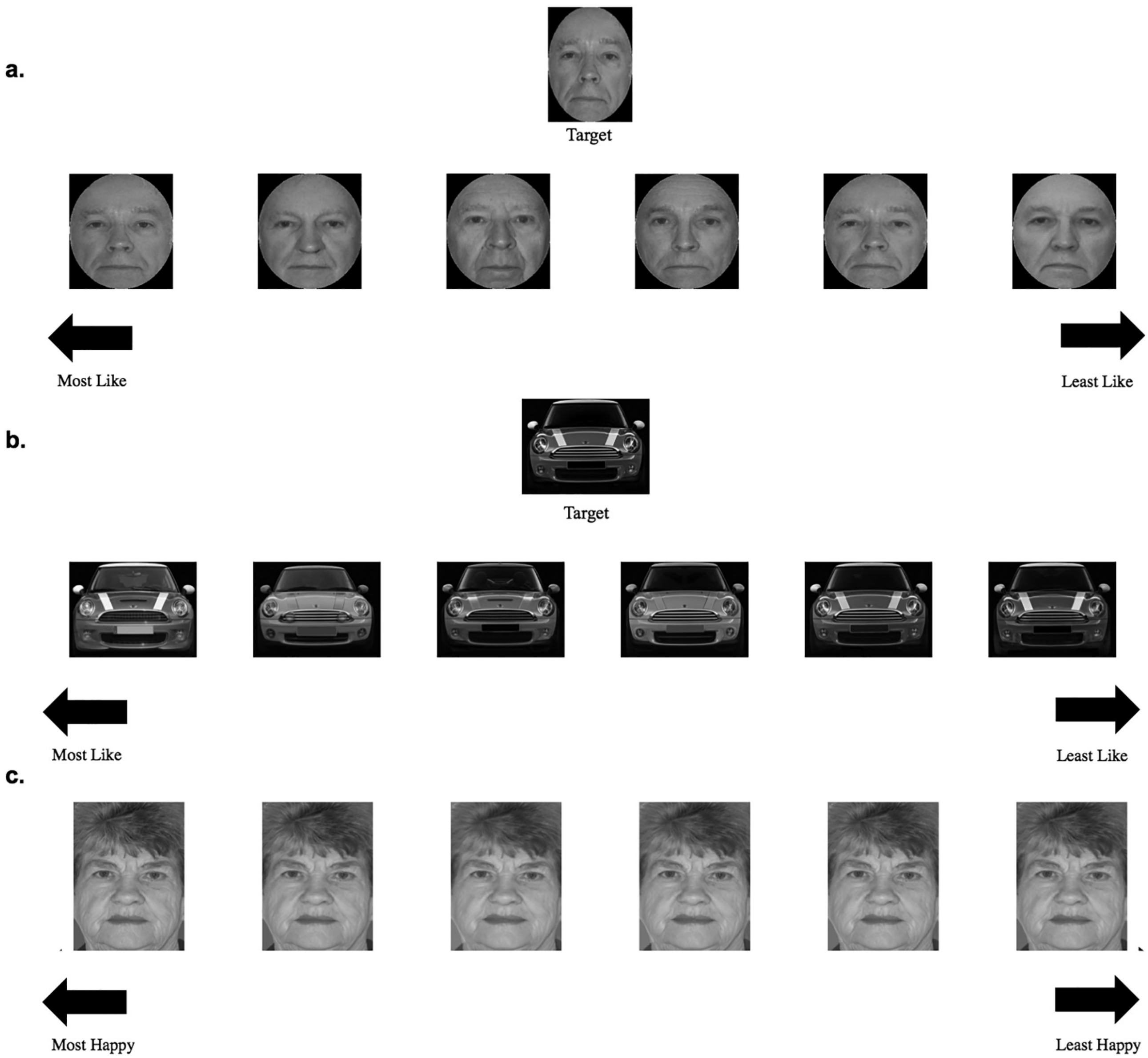

Fig. 1. Example trials of (a) *CFPT-Identity Older Adult*, (b) *CFPT-Car* and (c) *CFPT-Happy Older Adult*. In *CFPT-Identity Older Adult* and *CFPT-Car* participants were displayed a target face/car and six faces/cars (from a frontal view) morphed between the target and distractor in varying proportions (88%, 76%, 64%, 52%, 40%, 28%). Their task was to sort the six faces/cars according to the degree of similarity to the target. Half of the trials contain upright faces/cars and half inverted faces/cars. In the *CFPT-Happy Older Adult* participants were presented with six faces (from a frontal view) morphed between the expression of happiness and a neutral expression in varying proportions (25%, 20%, 15%, 10%, 5%, 0%). Participants were required to sort the faces according to how happy they appeared from the face that looks least happy to the face that looks most happy.

SD = 7.79; $t(48) = 1.18$, $p = 0.243$].

3.2. Differences in social perception performance between groups

Perceptual performance of the two groups was analysed using a 2 (group) × 5 (task type) mixed-ANOVA. Mauchly's test indicated that the assumption of sphericity had been violated so the Greenhouse-Geisser correction was employed.

The results revealed a significant effect of task type [$F(3.048, 146.311) = 32.84$, $p < 0.001$, $\eta^2 = 0.406$]. Bonferroni corrected post-hoc comparisons revealed that this was because overall, participants performed better on the happiness perception relative to inverted face perception and car perception (for both Upright and Inverted conditions), and because overall participants were more accurate on Upright Facial Identity trials relative to inverted face perception and car perception (for both Upright and Inverted conditions). There was also a significant main effect of group [$F(1, 48) = 20.54$, $p < 0.001$, $\eta^2 = 0.300$], which was due to older adult participants performing worse overall compared to young adult participants.

Importantly, the ANOVA also revealed a significant interaction between group and task type [$F(3.048, 146.311) = 11.103$, $p < 0.001$, $\eta^2 = 0.188$]. In view of this, pairwise comparisons with Bonferroni correction were performed between the older and younger group on the five face perception tasks. This revealed a significant difference in happiness perception [$p < 0.001$, $r = 0.513$], upright facial identity perception, [$p < 0.001$, $r = 0.665$] and inverted face perception [$p < 0.001$, $r = 0.587$] (Fig. 2). Accuracy performance of upright and inverted car perception did not differ significantly between the two age groups (Fig. 2; $p = 0.510$, $r = 0.095$; $p = 0.773$, $r = 0.042$). Therefore, older participants showed reduced performance relative to younger adults in their ability to make fine-grained perceptual judgments of faces (emotion and identity), but not objects.

Given the moderate differences in gender between the groups we also ran the above analyses when controlling for gender. To do so we

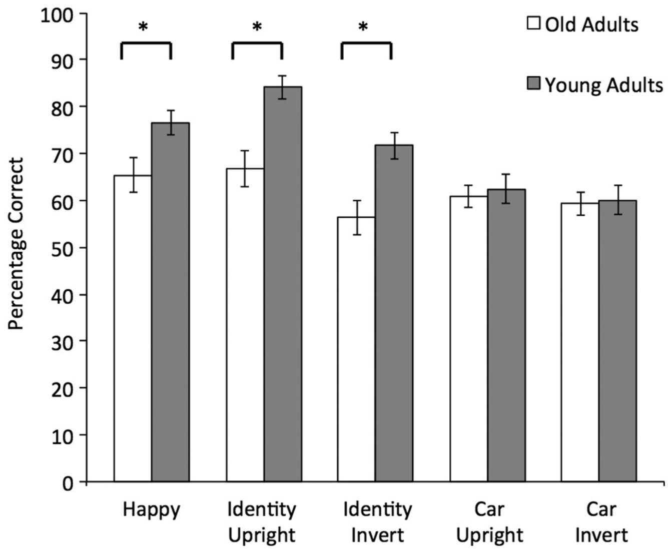

Fig. 2. Group-average performance of young and old adults on the *CFPT-Happy Older Adult*, *CFPT-Identity Older Adult*, and *CFPT-Cars*. Older adults showed reduced performance on CFPT-Happy Older Adult and CFPT-Identity Older Adult (Upright and Inverted Trials are shown separately). No differences were found between the groups in CFPT-Car performance (Upright and Inverted Trials are shown separately). * = p < 0.05 Boneferroni Corrected.

conducted a 2 (group) × 5 (task type) × 2 (gender) mixed-ANOVA. This revealed a similar pattern of data as our main findings: namely, main effect of task type [F(3.025, 142.175) = 5.36, p = 0.002, $\eta^2 = 0.102$], main effect of group [F(1,47) = 22.46, p ≤ 0.001. $\eta^2 = 0.323$], and significant interaction between group and task type [F (3.025, 142.175) = 11.018, p - < 0.001, $\eta^2 = 0.190$]. Post-hoc comparisons revealed that the nature of the interaction between task type and age group was for the same reasons as our main findings: namely, reduced facial happiness, facial identity upright and facial identity inverted performance shown by older relative to younger adults. The main effect of gender approached, but did not reach significance [F (1,47) = 3.54, p = 0.066, $\eta^2 = 0.070$] and there were no interactions involving gender.

In addition we examined the contribution of age, gender, and education level to performance accuracy on each perceptual task using correlation and regression analyses. Correlational analyses revealed significant negative correlations between age and performance on the CFPT-Identity Older Adult (both Upright [r = − 0.585, p ≤ 0.001, and Inverted Trials [r = − 0.528, p ≤ 0.001]) and the CFPT-Happy Older Adult [r = − 0.488, p ≤ 0.001], but no significant relationship between CFPT-Car performance and age was observed (Upright trials [r = − 0.149, p = 0.302]; Inverted Trials [r = − 0.025, p = 0.865]). There was no correlation between gender and any variable of interest, or between years of education and any variable of interest. The data were therefore entered into a hierarchical regression analysis to test the relative contribution of age to performance on each task, while controlling for gender and years of education. Gender (1 = female, 2 = male) and years of education were entered into the first step of the regression model, and age into the second step. This was conducted separately for performance on each trial type. For all tests, the first step of the model did not reach significance (i.e. gender and education level were not predictive of performance on any of the trial types). When age was added to the model, it was found to be the only variable that was predictive of performance and to significantly increase the variance explained on CFPT-Happy Older Adult by 26.3% [$\beta = -0.517$, $t = -4.17$; F(3,46) = 6.73, p = 0.001], CFPT-Identity Older Adult Upright Trials by 35.4% [$\beta = -0.599$, $t = -5.17$; F(3,46) = 9.85, p ≤ 0.001], and CFPT-Identity Older Adult Inverted Trials by 29.4% [$\beta = -0.547$, $t = -4.42$; F(3, 46) = 6.77, p ≤ 0.001]. This was not the case for performance on CFPT-Cars Upright or Inverted (see Table 1).

Table 1
Values of additional predictor variables entered into regressions to assess contribution of age, gender, and years of education (YoE) to task performance.

Task	Predictor	*t*	*Beta*	*p*
Happiness	Gender	− 0.643	− 0.079	0.523
	YoE	1.97	0.245	0.054
	Age	**− 4.17**	**− 0.517**	**0.001**
Identity up	Gender	− 1.53	− 0.176	0.133
	YoE	1.10	0.127	0.279
	Age	**− 5.17**	**− 0.599**	**< 0.001**
Identity invert	Gender	− 0.437	− 0.054	0.664
	YoE	1.25	0.155	0.217
	Age	**− 4.42**	**− 0.547**	**< 0.001**
Object up	Gender	− 1.40	− 0.200	0.167
	YoE	0.202	0.029	0.841
	Age	− 1.05	0.151	0.299
Object invert	Gender	− 1.64	− 0.235	0.108
	YoE	− 0.112	− 0.016	0.911
	Age	− 0.145	− 0.021	0.886

Bold indicates a significant predictor (p < 0.05).

4. Discussion

This study sought to investigate the relationship between normal aging and the perception of subtle changes in facial emotional and facial identity in older adult faces. We found that aging is related to declines in the ability to make fine-grained visual discriminations regarding the perception of facial happiness and facial identity (for both upright and inverted faces). Importantly, no differences were observed between young and older adults for the perception of subtle changes in non-face stimuli (cars), indicating that age-related differences in the perception of facial emotional and facial identity in older adult faces are specific to social perception and do not reflect domain-general changes in fine-grained visual discrimination with age.

The general pattern of change in facial emotion and identity perception associated with aging that we observe is consistent with prior work that has typically tested these abilities in isolation. That being said, there are a number of studies that have suggested that the perception of happiness remains stable during aging (e.g. Moreno et al., 1993; Calder et al., 2003; Orgeta & Phillips, 2007; see Ruffman et al., 2008 for review); our findings conflict with this conclusion. The reasons for the difference between our findings related to declined happiness perception in older adults and prior work may be due to the use of more subtle low intensity emotion stimuli used in the current study. Moreover, a number of prior studies have tended to use more prototypical exemplars of happiness that use high intensity emotion. While helpful to study emotion perception, arguably high intensity emotions are less commonly encountered in daily life interactions (i.e. we tend to encounter more subtle facial expression that have lower intensities on a daily basis) and often have led to ceiling effects in past research, thus potentially masking perceptual deficits (e.g. Brosgole & Weisman, 1995; Isaacowitz et al., 2007; McDowell et al., 1994; Moreno et al., 1993; Orgeta & Phillips, 2007). By testing the perception of low-to-medium intensity expressions of happiness we were able to a) test happiness perception in conditions that were not at ceiling and b) examine older adults' perceptual abilities to determine subtle emotional expressions that may be important in everyday life (Hess et al., 1997).

The finding that older adults do not differ from younger adults in their perception of objects is also consistent with previous findings reporting that aging is associated with declined face recognition, while object recognition remains intact or is less affected by aging (Boutet & Faubert, 2006; Meinhardt-Injac, Persike, & Meinhardt, 2014; Sullivan & Ruffman, 2004). For instance, Sullivan and Ruffman (2004) examined older and younger adults' emotion recognition abilities on tasks involving making judgments about morphed emotions or shapes, and on tasks where they had to judge which of two faces expressed a greater amount of a given emotion or which of two containers had more liquid in it. In all tasks young adult faces were used. They found that facial emotion perception deficits were present in older adults, but this was not observed for the non-face control tasks (although there were performance differences in task difficulty between the emotion and non-face control tasks). Our data on emotion, but not object based, perceptual differences between younger and older adults are consistent with the results from their study. We extend the prior findings by: a) using older adult target faces to remove the potential contribution of other-age effects, and b) examining another important aspect of face processing skills - facial identity, under a common task format (note, Sullivan & Ruffman did control for gender perception skills in their analyses via performance on a task where participants had to judge which of two faces looked more male). In addition by ensuring similar task demands for our identity, happiness, and non-face perceptual tasks we are able to ensure that differences in the pattern of relationship between aging and performance is not due to specific task demands (e.g. working memory, emotional vocabulary). This is an important addition to prior work that has compared older and younger adults in the ability to perceive emotion from faces displayed by younger and older adult actors because much of that work has used prototypical emotions in labelling based tasks. Theoretically these measures might tap additional processes alongside perceptually driven performance factors (Phillips et al., 2008). Our findings suggest that older adults display difficulties in social perception even when additional constraints on performance (e.g. emotional vocabulary, cognitive load, working memory) are low.

Sullivan and Ruffman (2004) also examined different emotion types and observed declined performance in older adults on trials involving anger, sadness, and fear, but not trials involving happiness. The happiness deficit that we observe is not consistent with this finding. This novel finding in our current investigation may relate to task difficulty - in Sullivan and Ruffman (2004) happiness was the easiest trial type for both young and older adults. In our study, where there were similar levels of difficulty between emotion types, we observe evidence for deficits in happiness perception during aging.

The reasons for reductions in social perception throughout aging remain a topic of debate. Explanations include socio-emotional selectivity theory (SST; Carstensen & Charles, 1998), which suggests that older adults may show deficits compared to younger adults in the perception of negative emotions due to a preference to engage/encode signals that promote positivity, emotional balance, and well-being. Our findings conflict with this account since we observe declines in the perception of positive emotions in older compared to younger adults. This is in line with criticisms of SST arguing that prior work indicating that older adults show deficits in the perception of negative, but not positive, emotions may relate to the ease of tasks involving positive emotions in past research (Isaacowitz & Stanley, 2011).

Alternative explanations of age-related changes in social perception include accounts based on perceptual strategies employed by older compared to younger adults. Prior work has suggested that older adults tend to use perceptual information from upper parts of the face (e.g. eye region) less often and less efficiently (i.e. they are worse at detecting changes in this region) than young adult participants (Chaby, Narme, & George, 2011; Circelli, Clark, & Cronin-Golomb, 2013; Murphy & Isaacowitz, 2010; Slessor, Riby, & Finnerty, 2013; Sullivan, Ruffman, & Hutton, 2007; Wong, Cronin-Golomb, & Neargarder, 2005). This has been used to explain why older adults tend to show more consistent impairment in the perception of some negative emotions (anger, sadness, and fear) than positive emotion since the upper part of the face plays a more important role in the expression of anger, fear and sadness, whereas happiness perception should rely more heavily on the lower part of the face (Calder, Young, Keane, & Dean, 2000). As we did not measure eye-movements in the current investigation we cannot be sure whether our findings of impaired happiness and identity perception are related to inefficient eye-movement patterns. Moving forward, investigating eye-movements in the perception of subtle differences in social cues in younger and older adults will be an important extension of the current work.

Another important consideration for future work is to address a caveat of our study - namely that we lack data from participants in the middle adulthood range (from 40 years to 60 years). While our results are indicative that subtle facial happiness and facial identity perception change throughout adulthood, examining the trajectory of this change requires future work. There is some evidence to suggest that facial identity processing (particular face recognition memory) peaks in middle adulthood, before declining into and throughout older adulthood (Germine, Duchaine, & Nakayama, 2011). Whether a similar pattern holds for facial identity and emotion perception remains an important question for future studies. In addition it will be important to examine the extent to which age-related differences in facial emotion perception that we observe here for happiness perception hold for other emotion types.

Finally, in developing new versions of the CFPT specifically involving older face stimuli and non-face stimuli we hope that our study provides the research community with novel tasks that will be useful for future work. A common caveat of past work on aging and social perception is the use of young adult faces as task stimuli, which may weight performance in favour of young adult participants due to own-age biases (e.g. own-age effect whereby we are better at perceiving faces of a similar age to ourselves, Anastasi & Rhodes, 2005; Wright & Stroud, 2002; Mill, Allik, Realo, & Valk, 2009), thus the development and inclusion of comparable tests for facial identity and facial emotion perception that involve the use of older adult stimuli may benefit future research. For example, by overcoming the potential for own-age biases the tasks may be helpful for other researchers examining social perception in aging, and in atypical groups where age appropriate task stimuli may be useful (e.g. in prosopagnosia research where the original CFPT-Identity involving young adult stimuli is commonly used as part of diagnostic batteries).

In summary, here we assessed how aging is associated with changes in the perception of subtle cues related to facial identity of older adults and facial emotion (happiness) displayed by older adults. We also examined how aging is linked to object identity (cars) perception. We found that both facial identity and facial emotion are associated with declines in older adulthood, indicative of declines in the ability to process social facial cues in aging. This pattern was not seen for object perception. Collectively these findings suggest that aging is linked to specific declines in perceiving social facial cues.

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