Petrican, R., English, T., Gross, J.J., Grady, C., Hai, T., & Moscovitch, M. (2012). Friend or foe? Age moderates time-course specific responsiveness to trustworthiness cues. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *68(2),* 215–223, doi:10.1093/geronb/gbs064. Advance Access publication August 28, 2012

Friend or Foe? Age Moderates Time-Course Specific Responsiveness to Trustworthiness Cues

Raluca Petrican,[1] Tammy English,[2] James J. Gross,[2] Cheryl Grady,[1,3] Tasmia Hai,[4] and Morris Moscovitch[1,4]

[1]Rotman Research Institute, Toronto, Canada.
[2]Department of Psychology, Stanford University, California.
[3]Department of Psychology and Psychiatry, University of Toronto, Canada.
[4]Department of Psychology, University of Toronto, Canada.

Objectives: There is growing evidence of a greater focus on positive relative to negative information in older adulthood. Up to date, the age-related positivity effect in affective processing has been only investigated with respect to explicit emotional cues. Thus, the purpose of this study was to investigate whether similar age-related differences would be observed in reference to subtler cues, such as emotionally suggestive structural facial characteristics.

Method: We used a gaze following paradigm and investigated the temporal dynamics of responding to facial trustworthiness cues in younger and older adults.

Results: Both age groups provided similar trustworthiness evaluations. Nonetheless, under responding conditions that allowed for volitional modulatory influences (600 ms), older (but not younger) adults with superior cognitive resources showed more gaze following in response to trustworthy than to untrustworthy looking faces.

Conclusions: This study provided initial evidence that the age-related positivity effect in affective processing extends to subtle emotional cues, generally interpreted as being reflective of socially relevant personality traits. Implications for aging theories of motivated cognition and developmental changes in reliance on superficial affective cues are discussed.

Key Words: Gaze following—Positivity effect—Trustworthiness—Working memory—Aging.

PEOPLE orient their attention automatically to interpersonal cues signaling danger in the environment or threat from their interlocutor. Across the life span, they are more proficient at detecting negative and threatening schematic emotional expressions relative to other types of emotional expressions (Eastwood, Smilek, & Merikle, 2001; Mather & Knight, 2006; Ohman, Lundqvist, & Esteves, 2001). Moreover, there is some evidence that in young adulthood, sensitivity to interpersonal threat-relevant cues persists even under conditions that allow for some cognitive control to be exerted. For example, under such conditions, younger adults are reportedly more likely to follow the gaze of fearful (relative to neutral or happy) faces (Tipples, 2006), although such effects are by no means ubiquitous (Hietanen & Leppanen, 2003).

Nonetheless, there is reason to suspect that under conditions that allow for some cognitive control to be exerted, responsiveness to interpersonal threat cues may vary across different age groups. A relatively large body of research has documented age-related motivational effects on affective processing, such that older adults are more motivated to maximize emotional well-being (Carstensen & Mikels, 2005; Mather & Carstensen, 2005), theoretically due to perceptions of limited time left in life (Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999). Accordingly, attention and memory studies have documented that, relative to younger adults, older adults tend to focus more on positive relative to negative information (Mather & Carstensen, 2005). This age-related *positivity effect* has been found in processing of various types of emotional stimuli, including words, realistic scenes, and facial expressions; for a review, see Mather and Carstensen (2005). For example, older adults tend to look toward happy faces and away from sad or angry faces (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b).

Importantly, age-related prioritization of positive emotional information is theorized to be a top-down controlled process (Mather & Carstensen, 2005), which may account, at least partly, for why it has not been documented consistently (for a meta-analysis, see Murphy & Issacowitz, 2008). It is thus most likely to be exhibited by older adults who have the cognitive resources to implement their emotion regulation goals and when the context allows for cognitive control resources to be deployed. For example, in memory studies, these age-specific biases are strongest for older adults who have the superior cognitive resources necessary to regulate their emotions (Mather & Knight, 2005; Petrican, Moscovitch, & Schimmack, 2008). Complementarily, some studies using experimental paradigms that tax older adults' cognitive resources (e.g., dual task paradigms), report a reversal of the age-related positivity effect both in older adults' emotional memories (Mather & Knight, 2005) and

© The Author 2012. Published by Oxford University Press on behalf of The Gerontological Society of America.
All rights reserved. For permissions, please e-mail: journals.permissions@oup.com.
Received April 17, 2012; Accepted June 13, 2012
Decision Editor: Bob G. Knight, PhD

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

in their attentional allocation patterns to emotional stimuli (Knight et al., 2007, but see Allard and Isaacowitz [2008], although in that study, it remains unclear how cognitively taxing the distractor task was). Moreover, in attention studies, the age-related positivity effect seems to emerge primarily with longer exposure times to the affective stimuli (i.e., exposure times of over 500 ms, see Ebner & Johnson, 2010; Isaacowitz, Allard, Murphy, & Schlangel, 2009; Orgeta, 2011), which allow for top-down modulatory processes to be implemented; for neural evidence supportive of this claim, see Williams and colleagues (2006).

However, to the best of our knowledge, the age-related positivity effect in attentional allocation to affective stimuli has been only examined with respect to responsiveness to explicit emotional cues. Thus, the question arises whether similar age-related differences would be observed in reference to subtler emotional cues.

Implicit Emotional Cues and Trustworthiness

Trustworthiness evaluations of an unfamiliar individual are essential in driving the perceiver's subsequent approach or avoidance behaviors (Todorov, Baron, & Oosterhof, 2008). Indeed, trustworthiness judgments are made very quickly (33 to 100 ms, Todorov, Pakrashi, & Oosterhof, 2009) and are highly stable when response deadlines are extended (Todorov et al., 2009; Willis & Todorov, 2006). Recently, Said, Sebe, and Todorov (2009) proposed that perceiving trustworthiness in emotionally neutral faces is supported by emotion recognition systems that extract valence-related information from structural facial characteristics suggestive of emotional expressions, information that is subsequently mapped onto socially relevant personality traits. Faces judged to be the most trustworthy structurally resemble expressions of happiness, whereas faces judged to be the most untrustworthy structurally resemble expressions of anger (Oosterhof & Todorov, 2008). Importantly, such faces are still consciously perceived as being emotionally neutral. Thus, although emotional arousal in perceivers that results from the recruitment of emotion processing systems biases their global evaluation of the target faces, perceivers tend to misattribute it, that is, interpret it as indicative of the presence of socially relevant traits, such as trustworthiness, manifest by the target faces (Said et al., 2009). Thus, faces that elicit negatively valenced arousal are judged as being globally negative and perceived as being untrustworthy, whereas faces that elicit positively valenced arousal are judged as being globally positive and perceived as being trustworthy (Oosterhof & Todorov, 2008; Todorov & Engell, 2008).

Present Research

In the present research, we used a between-group design to test whether there are age differences in responsiveness to subtle emotional cues, embedded in the structure of emotionally neutral faces. Specifically, we examined whether the previously documented age-related positivity effect in attentional allocation to voluntary emotional expressions (Isaacowitz et al., 2006b) would also be evident in attentional allocation patterns to trustworthy, relative to untrustworthy looking faces. This prediction is based on evidence that trustworthy looking faces exhibit structural resemblance to positive (happy) emotional expressions, and thus tend to be judged as being overall positively valenced, whereas untrustworthy looking faces are structurally similar to negative (angry) emotional expressions, and thus tend to be judged as being overall negatively valenced (Oosterhof & Todorov, 2008; Said et al., 2009; Todorov & Engell, 2008).

To this end, we capitalized on previous findings that people reliably follow the gaze of both human and schematic faces, even if irrelevant to the experimental task (Frischen, Bayliss, & Tipper, 2007). Thus, as a measure of responsiveness to the gaze of faces varying in trustworthiness, we used a nonpredictive gaze cueing task (Friesen & Kingstone, 1998), in which a face with direct or averted gaze precedes the appearance of a target stimulus. Because participants were informed that the gaze direction was nonpredictive of subsequent target location, we regarded stronger gaze following tendencies in response to trustworthy versus untrustworthy looking others as reflective of greater reflexive responsiveness and, thus, greater interest in engaging with and/or understanding the mental states of trustworthy, rather than untrustworthy, looking others.

Finally, to distinguish between reflexive versus volitional effects on responsiveness to the gaze of faces varying in trustworthiness, we used a short delay (100 ms) and a longer delay (600 ms), in light of previous findings with younger adults that the former is associated with exclusive recruitment of reflexive processes, whereas the latter is associated with joint recruitment of reflexive and more controlled processes in gaze following (Friesen, Ristic, & Kingstone, 2004). In line with findings of Friesen and colleagues, we expected that at both delays participants would be faster to respond to the target if it appeared at the gazed at (rather than the opposite) location. Moreover, in line with previous reports of interpersonal threat sensitivity being well preserved across the life span (Mather & Knight, 2006), we expected that under the automatic responding condition (i.e., 100 ms), both younger and older adults would show greater attentional orienting to the gaze direction of untrustworthy, relative to trustworthy, looking faces, for the former are structurally similar to negative emotional expressions (Said et al., 2009).

In contrast, 600 ms following the presentation of the gaze cue, Friesen and colleagues (2004) documented independent reflexive and volitional effects on gaze following among younger adults. We are not aware of similar investigations in older adults. Nonetheless, there have been reports of age-related reductions in the reflexive tendency to follow the gaze of another (Slessor, Phillips, & Bull, 2008). Thus, because at 600 ms, the reflexive gaze following tendencies of

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

younger adults can be modulated volitionally, it seems plausible that at this delay, the relatively weaker gaze following tendencies of older adults could also be modulated volitionally. Consequently, at this longer delay, where participants could exert some control over their attentional allocation patterns, we expected that they would direct their attention towards motivationally salient stimuli. Specifically, in line with previous findings of age-related positivity effects in attentional allocation (Knight et al., 2007), we hypothesized that at the longer delay older, but not younger, participants would show greater attentional orienting to the gaze direction of trustworthy, rather than untrustworthy, looking faces. Given that cognitive control is needed to direct attention in this goal-oriented way, counteracting reflexive gaze following tendencies (Friesen et al., 2004), we further predicted that the attentional bias to trustworthy looking faces would emerge primarily in older adults with superior cognitive resources. Importantly, we reasoned that this age-specific preferential attentional orienting to the gaze of trustworthy, rather than untrustworthy, looking faces would reflect the social evaluation of the faces. In light of previous findings that social evaluation processes, such as trustworthiness attributions, depend upon holistic face processing, most likely to occur when the face is presented upright (Todorov, Loehr, & Oosterhof, 2010), we predicted that this age-specific attentional orienting effect would emerge for upright, but not inverted, faces.

Method

Participants

A total of 63 young (24 men; M = 21.31 years, SD = 3.74 years) and 69 older (26 men; M = 70.35 years, SD = 5.80 years) neurologically intact adults participated for financial compensation ($10 hr^{-1} for young adults and $16 hr^{-1} for old adults).

Measures

Attentional orienting to facial cues of trustworthiness.—Participants completed six blocks of a gaze cueing task designed following Friesen and Kingstone's (1998) guidelines and intended to assess participants' tendency to orient in the direction of another's gaze. To assess the impact of interpersonal threat cues embedded in the structure of neutral faces on gaze following, we incorporated two structural variations on trustworthiness of the same realistic male face in six gaze control blocks (six male identities for a total of 12 faces). The six pairs of faces used in this study were part of the "175 faces manipulated on trustworthiness" dataset, downloaded from Alexander Todorov's website http://webscript.princeton.edu/~tlab/databases/. Within each pair, the untrustworthy looking face was three standard deviations below, whereas the trustworthy looking face was three standard deviations above, the trustworthiness score of the original male identity (Oosterhof & Todorov, 2008). Importantly, according to their creators, within these stimulus parameters, the faces are rated as emotionally neutral (in the sense of not voluntarily expressing emotions), although the untrustworthy looking one structurally resembles expressions of anger, and the trustworthy looking one resembles expressions of happiness (Oosterhof & Todorov, 2008).

A trial began with the central presentation of a 4 inch by 4 inch face that looked left, right, or straight ahead. To test whether any association between gaze orienting patterns and age is indicative of uniquely social perception processes, we compared responses to upright (half of the trials) and inverted faces. One hundred (for half of the participants in each age group) or 600 (for the remaining participants) milliseconds (ms) following the appearance of the face, a target letter (F or T) appeared to the left or right side of the face. Participants were directed to press the left arrow whenever a letter appeared on the left side of the screen (relative to the face), or the right arrow whenever a letter appeared on the right side of the screen. The face and target display remained on the screen until a response was made or until 2700 ms had passed (whichever occurred first). The inter-trial interval was 680 ms.

In each of the six gaze control blocks, there were 288 trials (1,728 total). Each block contained three types of trials, presented in randomized order for each participant: 96 no-cue trials, with the eyes looking straight ahead and the target letter equally likely to appear on either side of the face; 96 cued, with the eyes looking left or right and the target letter appearing where the eyes were looking; and 96 countercued, with the eyes looking left or right and the target letter appearing opposite the eyes' gaze direction. Direct gaze (i.e., no-cue) trials were introduced in order to establish the direction of the gaze cueing effects obtained (i.e., whether participants would be slower in the countercued and faster in the cued trials). Moreover, direct gaze trials allowed us to verify that in our task, the age-related positivity effect would manifest as older adults' greater tendency to follow the gaze of positively valenced others rather than older adults' greater distraction by positively valenced others who look directly at them.

At the beginning of the task, participants were informed of the task structure and told that the gaze direction was nonpredictive of subsequent target location. The dependent variable was reaction time (RT, in ms) to the target letter (i.e., localizing it). Because participants were told that the gaze cues were nonpredictive of subsequent target location, faster RTs for cued trials (relative to countercued and no-cue trials) and longer RTs for the countercued trials (relative to the cued and no-cue trials) were interpreted as reflecting greater responsiveness to the gaze of trustworthy or untrustworthy looking faces.

Manipulation check.—At the end of the study session, participants judged the trustworthiness of the 12 faces

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

included in the gaze following task on a 7-point Likert-type scale (from *very untrustworthy* to *very trustworthy*). Consistent with Oosterhof and Todorov's (2008) findings, within each pair the validated untrustworthy face was rated as less trustworthy than the validated trustworthy face ($p < .001$ for the paired samples comparisons). Both younger and older adults provided similar judgments, irrespective of their cognitive resources. To further verify that indeed there were no age differences in the tendency to give higher trustworthiness ratings to the validated trustworthy looking faces and lower trustworthiness ratings to the validated untrustworthy looking faces, we subtracted trustworthiness ratings for the latter from trustworthiness ratings given to the former. A regression analysis, where age, cognitive resources and their associated interaction term were entered as predictors, revealed that neither age, cognitive resources, nor their interaction predicted increased polarization of the trustworthiness judgments (all *ps* > .26). The results were unchanged if gender was also entered as a predictor (all *ps* > .15). Likewise, subsequent regression analyses revealed that neither age, cognitive resources, nor their interaction were significant predictors of separate trustworthiness ratings for the validated trustworthy and untrustworthy looking faces, respectively (all *ps* > .13). Nonetheless, explicit trustworthiness judgments were not related to gaze performance, so are not discussed further in the present report.

Cognitive resources.—Participants completed a complex spatial working memory (WM) task (Unsworth, Heitz, Schrock, & Engle, 2005) as a measure of cognitive control (Kane & Engle, 2002). We downloaded the automated E-Prime version of the Symmetry Span task from Randall Engle's website http://psychology.gatech.edu/renglelab/index.htm [TASKS]. As in all complex WM span tasks, presentation of the to-be-remembered stimuli (i.e., colored squares) in the symmetry span task is embedded within a processing task (i.e., judging the symmetry of abstract designs). The number of memory items ranged from two to five and there were three trials at each memory level, for a total of 12 recall trials (Unsworth et al., 2005).

Procedure

During a single session, participants completed the following measures in fixed order: three gaze control blocks, a WM task, the remaining three gaze control blocks, and an explicit trustworthiness judgment task. We chose this study session structure because we were aware that the gaze following task was fairly tenuous from an attentional vigilance standpoint; so, we thought it would be necessary to introduce a different type of task in the middle of the gaze control blocks in order to avoid fatigue and boredom-related effects (particularly for the participants in the longer delay condition). Participants were never provided feedback regarding their overall performance on the WM task. Moreover, we verified in preliminary analyses that there were no significant performance-related differences among the six blocks with regards to participants' responsiveness to the gaze cues, either globally or as a function of facial trustworthiness.

Data Reduction and Analysis

Incorrect responses in the gaze following task (3%) were eliminated prior to all analyses. We used three methods to deal with RT outliers. First, we eliminated RTs more than three standard deviations above or below the mean for that participant. This resulted in the elimination of 4% of all RT responses. Second, we computed mean RTs for each participant for each of the 12 presentation types (i.e., face orientation × cue validity × trustworthiness) and log-transformed the scores. (The results are unchanged if the log-transformation is applied to the raw or averaged RT score.) Third, because preliminary analyses revealed no cueing effect differences among the six blocks and because we were interested only in gaze following performance differences between trustworthy and untrustworthy looking faces, we collapsed across all six faces within each of the two trustworthiness levels. The resulting distribution of the aggregated RT scores showed no evidence of outliers and exhibited skewness levels within generally acceptable levels (<.80). The WM data departed from normality and violated heterogeneity of variance assumptions and no transformation could normalize it; so, we used raw scores and reported the robust standard error estimates for all the following analyses below (Hox, 2002).

Data analytic strategy and effect sizes.—We used hierarchical linear modeling (HLM 6.03, Raudenbush, Bryk, & Congdon, 2005) to examine both the within-person effects of cue validity, face orientation, and trustworthiness on RT in the gaze following task, as well as the moderating effect of between-person differences in cognitive resources, age, and delay. As Nezlek (2008) noted, when researchers are interested in the effect of between-person differences in within-person relationships, such as individual differences effects in RT experiments, hierarchical modeling techniques provide better estimates than ordinary least square techniques. The model contained two levels, wherein RTs on each gaze control trial type (level-1) were nested within individuals (level-2). Model estimates are computed based on the log-transformed RT data. Following Nezlek's (2008) advice, as effect size estimates, we computed predicted values of the RT outcome variable based on our fitted model, using untransformed average RTs.

Only male faces were used in our study because we intended to use faces that had already been validated on trustworthiness and the only set of faces that we were aware of that fit that criteria were Alexander Todorov's sets of faces, which contained only male identities. Because of this, we first ran all the analyses, controlling for gender. We had no specific gender-relevant predictions and neither

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

gender nor any of its associated interaction terms with age, delay, or cognitive resources exerted any significant effects on global or trustworthiness-specific gaze following processes (all $p > .09$). Therefore, we eliminated it from all analyses reported next.

HLM models.—To test our hypotheses regarding differential attentional orienting to untrustworthy versus trustworthy faces, the following level-1 model was specified

$$Y = \beta_0 + \beta_1*(\text{CUE}) + \beta_2*(\text{ORIENTATION}) + \beta_3*(\text{CUE} \times \text{ORIENTATION}) + \beta_4*(\text{TRUSTWORTHINESS}) + \beta_5*(\text{CUE} \times \text{TRUSTWORTHINESS}) + \beta_6*(\text{ORIENTATION} \times \text{TRUSTWORTHINESS}) + \beta_7*(\text{CUE x ORIENTATION} \times \text{TRUSTWORTHINESS}) + R$$

where *Y* is the log-transformed average RT for each participant for each of the 12 experimental conditions (cue validity × orientation × trustworthiness), cue the ordinal variable (coded −1 for invalid, 0 for no-cue, and 1 for valid), (face) orientation the dummy variable (coded 0 for inverted and 1 for upright), and trustworthiness the dummy variable (coded 0 for untrustworthy and 1 for trustworthy).

To test our hypotheses regarding the interactive effects of delay, cognitive resources, and age on differential attentional orienting to untrustworthy versus trustworthy faces, the following level-2 models were specified for the level-1 intercept (β_0) and slopes (β_i), respectively

$$\beta_0 = \chi_{00} + \chi_{01}*(\text{AGE}) + \chi_{02}*(\text{WORKING MEMORY}) + \chi_{03}*(\text{AGE} \times \text{WORKING MEMORY}) + \chi_{04}*(\text{DELAY}) + \chi_{05}*(\text{AGE} \times \text{DELAY}) + \chi_{06}*(\text{DELAY} \times \text{WORKING MEMORY}) + \chi_{07}*(\text{AGE} \times \text{DELAY} \times \text{WORKING MEMORY}) + E$$

$$\beta_i = \chi_{i0} + \chi_{i1}*(\text{AGE}) + \chi_{i2}*(\text{WORKING MEMORY}) + \chi_{i3}*(\text{AGE} \times \text{WORKING MEMORY}) + \chi_{i4}*(\text{DELAY}) + \chi_{i5}*(\text{AGE} \times \text{DELAY}) + \chi_{i6}*(\text{DELAY} \times \text{WORKING MEMORY}) \chi_{07}*(\text{AGE} \times \text{DELAY} \times \text{WORKING MEMORY}),$$

where age is the dummy variable (coded 0 for the younger adult group and 1 for the older adult group); WM represents participants' scores on the symmetry span task; and delay is the dummy variable (coded 0 for the 100 ms and 1 for the 600 ms cue-target interval).

Results

Preliminary Analyses

Cognitive resources.—In line with previous findings of age-related impairments in cognitive control abilities (Raz, 2000), a MANOVA with age and gender as fixed factors revealed that older adults ($M = 6.07$, $SD = 5.36$) scored significantly lower than younger adults ($M = 20.22$, $SD = 9.07$) on the WM task, $F(1, 128) = 111.34$, $p < .01$.

Gaze cueing.—Using the level-1 model specified previously, we verified that across both delays, participants followed reliably the gaze of both upright and inverted faces, $b = -.001$, $SE = .0006$, $t(1568) = -2.49$, $p < .05$, and that they were most susceptible to following the gaze of upright faces, $b = -.002$, $SE = .001$, $t(1568) = -2.66$, $p < .01$.

Responsiveness to Trustworthiness Cues

We used the level-1 and -2 models, outlined previously, to test our predictions regarding reflexive and volitional effects on differential attentional orienting to the gaze direction of trustworthy and untrustworthy looking others. Results of this analysis revealed that across all trial types, older adults were significantly slower to respond to the target ($M = 462.92$ ms, $SD = 155.26$ ms), relative to younger adults ($M = 317.06$ ms, $SD = 54.02$ ms), $b = .17$, $SE = .02$, $t(124) = 8.61$, and $p < .01$. Most importantly, as hypothesized, there was a significant interactive effect of age, cognitive resources, delay, trustworthiness, cue validity, and face orientation, $b = -.01$, $SE = .005$, $t(1512) = -2.64$, $p < .01$. No other effects were significant (all $ps > .08$).

To shed more light on the interactive effect of age, cognitive resources, and delay on attentional orienting to the gaze of trustworthy versus untrustworthy looking faces, we conducted some follow-up analyses within each delay.

Reflexive effects.—At the shorter delay, no significant effects of age and/or cognitive resources were observed (all $ps > .10$), indicative of the fact that at 100 ms, both younger and older adults, irrespective of cognitive functioning level, were equally likely to follow the gaze of both trustworthy and untrustworthy looking faces. Thus, we did not find support for the hypothesis that overall, participants would orient their attention preferentially to the gaze direction of untrustworthy, rather than trustworthy, looking faces at the shorter delay, although the effect was in that direction, $b = .001$, $SE = .001$, $t(776) = 1.17$, $p = .24$.

Volitional effects.—As hypothesized, at the longer delay, age, and cognitive resources exerted an interactive effect on responsiveness to trustworthy versus untrustworthy looking faces in the upright face condition only, $b = -.01$, $SE = .004$, $t(760) = -2.17$, $p < .05$. Thus, at this longer delay, older (but not younger) adults with greater cognitive resources showed greater attentional orienting to the gaze direction of upright (but not inverted) trustworthy faces, relative to untrustworthy looking faces, $b = -.003$, $SE = .001$, $t(396) = -2.05$, $p < .05$ (Figure 1 and Table 1).

Age-group specific effects.—Finally, to provide a more complete characterization of the interactive effect of age,

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

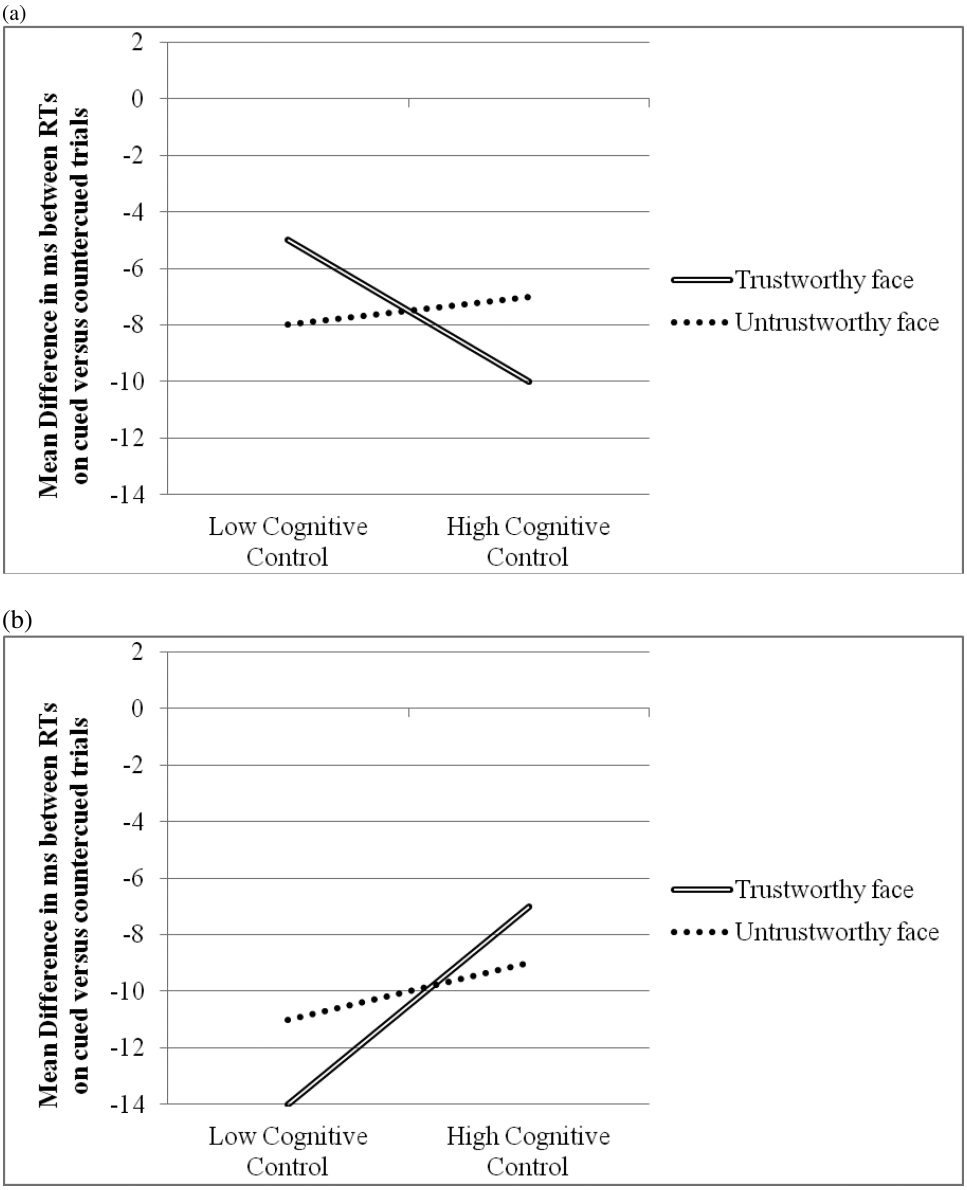

Figure 1. Mean difference in milliseconds (ms) between reaction times (RTs) on cued versus countercued trials in response to trustworthy and untrustworthy looking faces in the upright face condition with a 600-ms delay in low ($M - 1$ SD) and high ($M + 1$ SD) cognitive control for older adults (panel a) and younger adults (panel b). Negative scores reflect greater ease in responding to the target when it appears at the gaze cued location and greater difficulty in responding to the target when it appears at the countercued location.

cognitive resources and delay, we examined differential attentional orienting patterns to the gaze of trustworthy versus untrustworthy looking faces as a function of delay, cognitive resources, and their interactive effect within each age group.

Within the younger adult group, there were no significant effects of delay or cognitive resources on differential attentional orienting to the gaze of trustworthy versus untrustworthy looking faces (all $ps > .13$). Thus, younger adults were equally likely to follow the gaze of both trustworthy and untrustworthy looking faces, both under more automatic responding conditions and under conditions where they could exert some control over their gaze behavior. In contrast and as hypothesized, within the older adult group, cognitive resources exerted distinct modulatory effects on responsiveness to the gaze direction of trustworthy versus untrustworthy looking faces at the longer versus the shorter delay, $b = -.005$, $SE = .002$, $t(788) = -2.17$, $p < .05$. Specifically, only at the longer delay, older adults with greater cognitive resources showed greater attentional orienting to the gaze direction of upright (but not inverted) trustworthy faces, relative to untrustworthy looking faces, $b = -.003$, $SE = .001$, $t(396) = -2.05$, $p < .05$.

Discussion

The primary aim of the present research was to examine age differences in responsiveness to emotionally suggestive structural facial characteristics, relevant to interpersonal

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

Table 1. Mean Reaction Time (RT) Estimates on the Cued and Countercued Trials in the Upright Face Condition in the Gaze Following Task as a Function of Facial Trustworthiness and Individual Differences in Cognitive Control Resources

		100 ms				600 ms			
		Untrustworthy		Trustworthy		Untrustworthy		Trustworthy	
Group	Trial type	Low cognitive control	High cognitive control	Low cognitive control	High cognitive control	Low cognitive control	High cognitive control	Low cognitive control	High cognitive control
Older adults	Countercued	493 (.91)	443 (.91)	488 (1.43)	442 (1.43)	480 (1.26)	449 (1.26)	480 (1.10)	450 (1.10)
	Cued	488 (.91)	437 (.91)	483 (.91)	442 (1.43)	472 (1.26)	442 (1.26)	475 (1.10)	440 (1.10)
	Cueing effects	−5	−6	−5	0	−8	−7	−5	−10
Young adults	Countercued	296 (3.10)	309 (3.10)	296 (1.54)	310 (1.54)	331 (1.16)	344 (1.16)	333 (1.49)	340 (1.49)
	Cued	290 (3.10)	311 (3.10)	293 (1.54)	309 (1.54)	320 (1.16)	335 (1.16)	319 (1.49)	333 (1.49)
	Cueing effects	−6	2	−3	−1	−11	−9	−14	−7

Note. To estimate RTs, four separate regression analyses were ran for (a) trustworthy and (b) untrustworthy looking faces in the upright face condition for younger and older adults, with cognitive control as a predictor of RTs on the cued and countercued trials. The four resulting regression equations were used to compute mean RTs for low (M − 1 SD) and high (M + 1 SD) cognitive control participants in each age group for each trial type. Values within parentheses represent the standard errors of the coefficient associated with the effect of cognitive control on reaction times in the upright face condition as a function of cue validity. In this table, cueing effects were computed as a measure of responsiveness to gaze cues as a difference score between RTs on the cued and RTs on the countercued trials.

approach/avoidance behaviors (i.e., trustworthiness, Todorov et al., 2008). In line with previous reports of age-related positivity effects in attentional allocation to voluntary emotional expressions (Ebner & Johnson, 2010; Isaacowitz et al., 2009), we found that under responding conditions that allowed for volitional resources to be deployed (Friesen et al., 2004), older adults with superior cognitive resources were more likely to follow the gaze of trustworthy, rather than untrustworthy, looking faces. This result is consistent with findings from previous studies, which used only longer exposure times (i.e., over 500 ms) to affective stimuli and which documented that older adults attended preferentially to positive, rather than negative or neutral information (Allard & Isaacowitz, 2008; Isaacowith et al., 2009). Nonetheless, in line with other recent investigations highlighting the role of dispositional variables in age-related differences in affective processing (e.g., future time perspective, see Kellough & Knight, 2012), our results indicate that this effect would be most robust in older adults with superior cognitive resources. Further indicative of the role of cognitive control in this effect, at the shorter delay, where only reflexive processes have been documented (Friesen et al., 2004), older adults were equally likely to follow the gaze of both trustworthy and untrustworthy looking faces. Moreover, suggesting the importance of age-specific motivational factors, at both delays, younger adults exhibited similar attentional orienting patterns to the gaze direction of both trustworthy and untrustworthy looking faces.

In light of previous findings that people are particularly sensitive to interpersonal threat cues (Bonifacci, Ricciardelli, Lugli, & Pellicano, 2008; Tipples, 2006) and that this sensitivity is well preserved across the life span (Mather & Knight, 2006), we expected that under the automatic responding condition (i.e., 100 ms), both younger and older adults would show greater attentional orienting to the gaze direction of untrustworthy, relative to trustworthy, looking faces. However, this was not the case. Although not predicted, this finding echoes a number of previous investigations, which failed to document a modulatory effect of voluntary emotional expressions over gaze behavior (Hietanen & Leppanen, 2003; Pecchinenda et al., 2008, Experiment 2). Moreover, one would need to interpret this null finding in the context of our experimental task. For example, one would be expected to follow the gaze of an angry interlocutor in order to understand his/her immediate intentions and predict his/her behaviors, because the latter may cause harm to the self. Nonetheless, the threat to the self posed by an untrustworthy looking other is less likely to have immediate consequences (e.g., an aggressive act) and is more likely to result in subtler forms of aggression (e.g., deception), which, given difficulty in anticipating them, seem to be best circumvented by avoiding the respective interlocutor altogether. Future research may be needed to test these hypotheses.

The present findings extend previous investigations on the age-related positivity effect (Knight et al., 2007; Mather & Knight, 2005; Petrican et al., 2008) in two significant ways. First, we provide evidence that the age-specific prioritization of positive information occurs in a socially relevant task context (because gaze following is regarded as the building block of social behavior, Frischen et al., 2007), involving stimuli that vary in subtle emotional cues, suggestive of stable, rather than transient (Isaacowitz et al., 2006b), interpersonal threat potential (Oosterhof & Todorov, 2008). Moreover, the present findings also argue for the uniquely social nature of this effect, because the age-related preferential attentional orienting to the gaze direction of trustworthy, rather than untrustworthy, looking faces occurred only when the faces were presented upright, and thus processed as a socioemotional stimulus (Todorov et al., 2010). Second, we have provided evidence that although both younger and older adults judged faces varying in facial trustworthiness in a similar manner, they differed in their patterns of attentional allocation to these faces. Thus, although older adults with higher cognitive resources were not slower in responding to the target, relative to the other

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

participants, their performance at the longer delay was disproportionately influenced by the trustworthiness of the experimental faces, as they were more inclined to follow the gaze of trustworthy, rather than untrustworthy, faces. The question thus arises whether this behavior reflects just increased interest in engaging with others that elicit positive, rather than negative, emotional arousal or whether it (also) reflects an implicit belief that the gaze direction of trustworthy looking others would be more informative for successful performance on the experimental task relative to the gaze of untrustworthy looking others. The latter interpretation that older adults would rely on superficial cues of trustworthiness is particularly intriguing, in light of previous findings of age-related deficits in detecting deception (Ruffman, Murray, Halberstadt, & Vater, 2011), and is in contrast to findings with younger adults, where either behaviorally (Bayliss & Tipper, 2006) or facially (as in our study) manipulated perceptions of trustworthiness failed to affect gaze following behavior.

In sum, this study provided initial evidence of age-related differences in responsiveness to subtle emotional cues, generally interpreted as being reflective of socially relevant personality traits. Additional research is now needed to shed light on the developmental trajectory and "real life" socioemotional implications of such processes.

Correspondence

Correspondence should be addressed to Raluca Petrican, Rotman Research Institute, 3560 Bathurst Street, Toronto, Ontario, M6A 2E1, Canada. E-mail: raluca.petrican@gmail.com.

References

Allard, E. S., & Isaacowitz, D. M. (2008). Are preferences in emotional processing affected by distraction? Examining the age-related positivity effect in visual fixation within a dual-task paradigm. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*, *15*, 725–743. doi:10.1080/13825580802348562

Bayliss, A. P., & Tipper, S. P. (2006). Predictive gaze cues and personality judgments: Should eye trust you? *Psychological Science*, *17*, 514–520. doi:10.1111/j.1467-9280.2006.01737.x

Bonifacci, P., Ricciardelli, P., Lugli, L., & Pellicano, A. (2008). Emotional attention: Effects of emotion and gaze direction on overt orienting of visual attention. *Cognitive Processes*, *9*, 127–135. doi:10.1007/s10339-007-0198-3

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. *Psychology and Aging*, *7*, 331–338. doi:10.1037/0882-7974.7.3.331

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist*, *54*, 165–181. doi:10.1037/0003-066X.54.3.165

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science*, *14*, 117–121. doi:10.1111/j.096-3-7214.2005.00348.x

Eastwood, J. D., Smilek, D., & Merikle, P. M. (2001). Differential attentional guidance by unattended faces expressing positive and negative emotions. *Perception and Psychophysics*, *63*, 1004–1013. doi:10.3758/BF03194519

Ebner, N. C., & Johnson, M. K. (2010). Age-group differences in interference from young and older emotional faces. *Cognition & Emotion*, *24*, 1095–1116. doi:10.1080/02699930903128395

Friesen, C. K., & Kingstone, A. (1998). The eyes have it! Reflexive orienting is triggered by nonpredictive gaze. *Psychonomic Bulletin & Review*, *5*, 490–495. doi:10.3758/BF03208827

Friesen, C. K., Ristic, J., & Kingstone, A. (2004). Attentional effects of counterpredictive gaze and arrow cues. *Journal of Experimental Psychology: Human Perception and Performance*, *30*, 319–329. doi:10.1037/0096-1523.30.2.319

Frischen, A., Bayliss, A. P., & Tipper, S. P. (2007). Gaze cueing of attention: Visual attention, social cognition, and individual differences. *Psychological Bulletin*, *133*, 694–724. doi:10.1037/0033-2909.133.4.694

Hietanen, J. K., & Leppanen, J. M. (2003). Does facial expression affect attention orienting by gaze direction cues?. *Journal of Experimental Psychology: Human Perception and Performance*, *29*, 1228–1243. doi:10.1037/0096-1523.29.6.1228

Hox, J. (2002). *Multilevel analysis techniques and applications. Quantitative methodology series*. Mahwah, NJ: Lawrence Erlbaum Associates.

Isaacowitz, D. M., Allard, E. S., Murphy, N. A., & Schlangel, M. (2009). The time course of age-related preferences toward positive and negative stimuli. *Journal of Gerontology: Psychological Sciences*, *64B*, 188–192. doi:10.1093/geronb/gbn036

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006a). Is there an age-related positivity effect in visual attention? A comparison of two methodologies. *Emotion*, *6*, 511–516. doi:10.1037/1528-3542.6.3.511

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006b). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging*, *21*, 40–48. doi:10.1037/0882-7974.21.1.40

Kane, M. J., & Engle, R. W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. *Psychonomic Bulletin & Review*, *9*, 637–671. doi:10.3758/BF03196323

Kellough, J. L., & Knight, B. G. (2012). Positivity effects in older adults' perception of facial emotion: the role of future time perspective. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *67*, 150–158. doi:10.1093/geronb/gbr079

Knight, M., Seymour, T. L., Gaunt, J. T., Baker, C., Nesmith, K., & Mather, M. (2007). Aging and goal-directed emotional attention: Distraction reverses emotional biases. *Emotion*, *7*, 705–714. doi:10.1037/1528-3542.7.4.705

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*, 496–502. doi:10.1016/j.tics.2005.08.005

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*, 554–570. doi:10.1037/0882-7974.20.4.554

Mather, M., & Knight, M. R. (2006). Angry faces get noticed quickly: Threat detection is not impaired among older adults. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *61B*, P54–P57. doi:10.1093/geronb/61.1.P54

Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging*, *23*, 263–286. doi:10.1037/0882-7974.23.2.263

Nezlek, J. B. (2008). An introduction to multilevel modeling for social and personality psychology. *Social and Personality Psychology Compass*, *2*, 842–860. doi:10.1111/j.1751-9004.2007.00059.x

Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology*, *80*, 381–396. doi:10.1037/0022-3514.80.3.381

Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences of the United States of America*, *105*, 11087–11092. doi:10.1073/pnas.0805664105

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020

Orgeta, V. (2011). Avoiding threat in late adulthood: Testing two life span theories of emotion. *Experimental Aging Research*, *37*, 449–472. doi:10.1080/0361073X.2011.590759

Pecchinenda, A., Pes, M., Ferlazzo, F., & Zoccolotti, P. (2008). The combined effect of gaze direction and facial expression on cueing spatial attention. *Emotion*, *8*, 628–634. doi:10.1037/a0013437

Petrican, R., Moscovitch, M., & Schimmack, U. (2008). Cognitive resources, valence and memory retrieval of emotional events in older adults. *Psychology and Aging*, *23*, 585–594. doi:10.1037/a0013176

Raudenbush, S., Bryk, A., & Congdon, R. (2005). *HLM 6.03 for Windows [Hierarchical linear and nonlinear modeling software]*. Lincolnwood, IL: Multivariate Software, Inc.

Raz, N. (2000). Aging of the brain and its impact on cognitive performance: Integration of structural and functional findings. In F. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (2nd ed., pp. 1–90). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Ruffman, T., Murray, J., Halberstadt, J., & Vater, T. (2011). Age-related differences in deception. *Psychology and Aging*. doi:10.1037/a0023380.

Said, C. P., Sebe, N., & Todorov, A. (2009). Structural resemblance to emotional expressions predicts evaluation of emotionally neutral faces. *Emotion*, *9*, 260–264. doi:10.1037/a0014681

Slessor, G., Phillips, L. H., & Bull, R. (2008). Age-related declines in basic social perception: Evidence from tasks assessing eye-gaze processing. *Psychology and Aging*, *23*, 812–822. doi:10.1037/a0014348

Tipples, J. (2006). Fear and fearfulness potentiate automatic orienting to eye gaze. *Cognition and Emotion*, *20*, 309–320. doi:10.1080/02699930500405550

Todorov, A., Baron, S., & Oosterhof, N. N. (2008). Evaluating face trustworthiness: A model based approach. *Social, Cognitive, & Affective Neuroscience*, *3*, 119–127. doi:10.1093/scan/nsn009

Todorov, A., & Engell, A. (2008). The role of the amygdala in implicit evaluation of emotionally neutral faces. *Social, Cognitive, & Affective Neuroscience*, *3*, 303–312. doi:10.1093/scan/nsn033

Todorov, A., Loehr, V., & Oosterhof, N. N. (2010). The obligatory nature of holistic processing of faces in social judgments. *Perception*, *39*, 514–532. doi:10.1068/p6501

Todorov, A., Pakrashi, M., & Oosterhof, N. N. (2009). Evaluating faces on trustworthiness after minimal time exposure. *Social Cognition*, *27*, 813–833. doi:10.1521/soco.2009.27.6.813

Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, *37*, 498–505. doi:10.3758/BF03192720

Williams, L. M., Liddell, B. J., Kemp, A. H., Bryant, R. A., Meares, R. A., Peduto, A. S., & Gordon, E. (2006). Amygdala-prefrontal dissociation of subliminal and supraliminal fear. *Human Brain Mapping*, *27*, 652–661. doi:10.1002/hbm.20208

Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after 100 ms exposure to a face. *Psychological Science*, *17*, 592–598. doi:10.1111/j.1467–9280.2006.01750.x

Downloaded from https://academic.oup.com/psychsocgerontology/article/68/2/215/572321 by Universitaetsbibliothek user on 30 September 2020