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Age and Motivation Predict Gaze Behavior for Facial Expressions

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Abstract

This study investigated age-related differences between younger (*M* = 25.52 yrs) and older (*M* = 70.51 yrs) adults in avoidance motivation and the influence of avoidance motivation on gaze preferences for happy, neutral, and angry faces. In line with the hypothesis of a reduced negativity effect later in life, older adults avoided angry faces and (to a lesser degree) preferred happy faces more than younger adults did. This effect cannot be explained by age-related changes in dispositional motivation. Irrespective of age, avoidance motivation predicted gaze behavior towards emotional faces. The study demonstrates the importance of interindividual differences beyond young adulthood.

(100 words)

Age and Motivation Predict Gaze Behavior for Facial Expressions

The motivation to approach positive and avoid negative stimuli seems to change with age. This effect has been proposed to increase with age due to a shortening future time perspective ("positivity effect," Carstensen & Mikels, 2005). In line with the proposed "positivity effect," studies have shown that older adults exhibit preferential gaze toward positive and away from negative stimuli, whereas younger adults show no or even the opposite preference (e.g., Isaacowitz, Toner, Goren, & Wilson, 2008). Compared to neutral or positive information, older adults remember less negative information than younger adults (e.g., Charles, Mather, & Carstensen, 2003). Finally, younger and older adults differ with respect to the depth of processing of emotional information. Mather and colleagues (2004) showed that viewing positive as compared to negative pictures led to greater amygdala activation in older, but not in younger, adults. In older adulthood, then, the tendency to avoid negative stimuli seems to outweigh the tendency to approach positive stimuli (Wood & Kisley, 2006).

Outside the aging literature, the most prominent dispositional constructs that have been investigated in regard to emotional information processing are approach and avoidance motivation. Previous research with younger adults suggests that approach and avoidance motivation are two fundamental motivational systems that differ in valence (see Carver, Sutton, & Scheier, 2000; Elliot & Covington, 2001; Gray, 1994). Approach motivation energizes and directs behavior toward desired states. In contrast, avoidance motivation energizes and directs behavior away from feared states. Approach and avoidance motivation are largely independent and influence experience and behavior in different ways (see Gable, 2006). Regarding emotional information processing, previous studies have found that avoidance, but not approach, motivation affects the perception of and reaction to emotional information (e.g., Downey, Mougios, Ayduk, London, & Shoda, 2004; Gable, 2006; Nikitin & Freund, 2010; Puca, Rinkenauer, & Breidenstein, 2006)[1]. The present study investigated whether age-related differences in avoidance motivation drive the "positivity effect" (or a

reduced "negativity effect") in older adulthood. To the best of our knowledge, no study has ever addressed the question whether younger and older adults differ with respect to avoidance motivation. Moreover, we are not aware of studies that have investigated the influence of avoidance motivation on information processing in older adults.

Avoidance motivation. Dispositional avoidance motivation is related to enhanced processing of negative information. In a study on the startle reflex, people high in social avoidance motivation showed greater attention (i.e., potentiated eye-blink startle magnitude) to pictures with rejection themes (Downey, et al., 2004). Downey and colleagues interpreted this result as an automatic activation of the defensive motivational system by rejection cues. Similarly, Strachman and Gable (2006) found that avoidance motivation is associated with emphasizing potential threats in the environment. Participants were asked to read an essay including positive, negative, and neutral social events and then rewrite the essay word-for-word from memory. Participants also evaluated the actors in the essay. Avoidance motivation was associated with better memory for negative information, a negatively biased interpretation of neutral information, and a more pessimistic evaluation of social actors in the essay. Finally, Gomez and Gomez (2002) found a positive association between dispositional avoidance motivation and enhanced processing of negative information in a word-fragmentation task, a word recognition task, and a free word recall task.

Taken together, avoidance motivation is associated with an attentional preference for and a sensitivity to negative information. All of these studies are based on samples with younger adults. To date, nothing is known about how avoidance motivation influences information processing beyond young adulthood. Age-related differences in the attention to negative information might be driven by motivational differences in avoidance motivation. The next section addresses the development of avoidance motivation across adulthood.

Avoidance motivation and age. To date, very little is known about the development of avoidance motivation across adulthood. Like other dispositions, avoidance motivation

appears to have a genetic basis (Goldsmith & Lemery-Chalfant, 2008), and there is some support in the literature that interindividual differences in motivation might be relatively stable across the life span. In two surveys, Veroff, Reuman, and Feld (1984) investigated the stability of four social motives (achievement, affiliation, fear of weakness, and hope for power). Although the authors found some social-role-related differences (e.g., men's hope for power was distinctly high at mid-life), the strength of the motives was remarkably similar across different age groups. Similarly, in a longitudinal study on motive development, Franz (1994) found evidence for both stability of and change in motives across middle adulthood. Participants' individual levels of achievement and intimacy motivation remained stable from young adulthood to middle age. However, mean levels of achievement decreased and affiliation increased over time, both for men and women. Based on these findings, one might expect interindividual differences in dispositional motivation to remain stable across adulthood. At the same time, mean levels might change. Based on the literature on the "positivity effect" (or reduced "negativity effect") and the improved emotional well-being in older adulthood (Carstensen et al., in press), we assume that mean levels of avoidance motivation might decrease with age. These changes in motivation might explain changes in gaze patterns for positive and negative emotional stimuli across adulthood.

The Present Study

The present study was a first attempt at studying age-related differences in avoidance motivation and the influence of avoidance motivation on gaze preferences in younger and older adults. On the basis of previous results regarding mean-level changes in motives, we expect to find mean-level differences between younger and older adults with respect to avoidance motivation: Older adults are expected to have lower levels of avoidance motivation. The differences in avoidance motivation might explain why older adults have a stronger gaze preference for happy and a weaker gaze preference for angry faces than younger adults (the "positivity effect" or reduced "negativity effect"). Finally, we expect to find

evidence that, irrespective of age, avoidance motivation is positively associated with gaze preference for angry faces. We do not expect to find an effect of avoidance motivation on gaze times for neutral or happy faces.

Method

Participants

Participants were recruited via senior citizen clubs, flyers, and advertisements in student mailing lists. The original sample consisted of 92 younger and 92 older participants. The data of 3 younger and 13 older participants were excluded due to calibration or technical problems or because the participants looked for less than 50% of the time at the emotional faces. The final sample consisted of n = 89 younger (31 males, 58 females, age M = 25.52, SD = 2.87, range 18-30) and n = 79 older adults (37 males, 42 females, age M = 70.51, SD = 5.74, range 62-86). Participants gave written informed consent for participation. After participation, they were debriefed and received either 20 CHF or course credit as a means of compensation.

Materials and Equipment

A set of 180 positive, negative, and neutral facial expressions were selected from the Lifespan Database of Adult Emotional Facial Stimuli (Ebner, Riediger, & Lindenberger, 2010) with pictures of 60 models (15 young males, 15 young females, 15 old males, and 15 old females). Each model expressed all three states (happiness for a positive state, anger for a negative state, and a neutral expression). All three facial expressions of a given model were presented simultaneously. Each photograph was 2.6" high and 2.1" wide. The distance between the photographs was 0.3". To obtain the highest possible uniformity, all photographs were gray-scaled. Stimuli were presented on a 17" computer screen. We used the software E-Prime (Psychology Software Tools, Inc.) for stimulus presentation, timing, and data collection and the T60 eye tracker (Tobii Technology, Inc.) for eye tracking. A fixation was defined as an interval in which gaze focused within 1° of visual angle for 100 ms or more.

Procedure

Participants completed self-report instruments measuring avoidance motivation at home (online or paper-and-pencil) and were then invited to the eye-tracking part of the study in our laboratory. Following an eye test and calibration, they were told that they would be shown photographs of faces and should view them naturally, as they would if they saw them in a newspaper or magazine (for a similar procedure, see Isaacowitz et al., 2008). An experimental trial started with the presentation of a fixation cross for 2.3 s to align gaze to the center of the screen and was followed by a set of three photographs with happy, angry, and neutral facial expressions of the same model for 9 s (see Figure 1). The total presentation time of the faces was 540 s (60 models for 9 s each). The order of presentation of the models as well as the order of the three facial expressions on the screen was randomized. Two blocks of 30 trials each were run. To activate social motivation, two different pictures of social situations were presented before each of the blocks. Participants were given three minutes to write a short story about each picture.

Assessment of Avoidance Motivation

Avoidance motivation was assessed using the Multi-Motive-Grid (MMG; Sokolowski et al., 2000). The Multi-Motive-Grid consists of 14 pictures of different social situations, each accompanied by a set of 4 to 10 statements. Participants were asked to indicate which statements, in their view, best fit a given situation. The statements represent motivational tendencies. Motive scores were calculated by summing the number of items endorsed that reflect a given motive (affiliation, achievement, power) across pictures. Motive scores for avoidance motivation can range from 0 to 12. Previous studies have repeatedly demonstrated excellent retest-reliability, internal consistency, and validity of the avoidance scale (Gable, Reis, & Elliot, 2003; Kehr, 2004; Langens & Schmalt, 2002; Sokolowski, Schmalt, Langens, & Puca, 2000). In the present study, the internal consistency (Cronbach's α) of the avoidance scale was .84 (M = 4.95, SD = 2.13).

Assessment of Gaze Preference

Gaze preference for happy, angry, and neutral faces was measured using three indicators: (1) the relative *frequency of the first gaze* at a happy, an angry, or a neutral face after the presentation of the fixation cross (effectively, the second gaze was measured, as the first gaze was fixed to the middle of the screen by the fixation cross), (2) the relative *fixation frequency* (i.e., the sum of fixations on each emotional expression relative to all fixations during the whole presentation time), and (3) the relative *gaze duration* (i.e., the sum of time participants looked at each facial expression relative to total gaze duration). The frequency of the first gaze informs us about how emotional information influences attention immediately after presentation of the stimuli, whereas total gaze duration and number of fixations inform us about how long emotional stimuli hold participants' attention (gaze duration) and how often participants' gaze returns to each emotional stimulus (number of fixations). The frequency of the first gaze was neither correlated with number of fixations nor with gaze duration (all correlations $r < .11$, $p > .14$). In contrast, gaze duration and number of fixations were highly correlated (happy faces $r = .75$, angry faces $r = .81$, neutral faces $r = .70$, all ps $< .001$). These results reflect the difference between the immediate relevance or "spotlight" function of significant stimuli (here represented by the first gaze), on the one hand, and their "holding power" (here represented by fixation frequency and gaze duration), on the other hand (see Derryberry & Reed, 1994, for a similar interpretation).

Results

Preliminary Analyses

Using an ANOVA, we tested for differences in gaze preferences for happy, angry, and neutral faces as a within-subject factor. The three facial expressions differed significantly in first-gaze frequency ($F[2,167] = 29.01$, $p < .001$, $\eta_p^2 = .15$), fixation frequency ($F[2,167] = 66.48$, $p < .001$, $\eta_p^2 = .28$), and gaze duration ($F[2,167] = 58.75$, $p < .001$, $\eta_p^2 = .26$).

On average, young and older adults looked more frequently with their first gaze at happy ($M = 37.49\%$ of all first fixations, $SD = 7.77\%$) than at angry faces ($M = 31.41\%$, $SD =$

6.53%), $F(1,167) = 39.05$, $p < .001$, $\eta^2 = .19$, and at happy faces than at neutral faces (M = 31.10%, SD = 6.87%), $F(1,167) = 39.72$, $p < .001$, $\eta^2 = .19$. There was no difference in first gaze for angry and neutral faces (F [1,167] < 1).

Young and older adults looked more frequently at happy faces (M = 35.75% of all fixations, SD = 4.05%) than at angry faces (M = 30.48%, SD = 3.46%), $F(1,167) = 95.71$, $p <$ .001, $\eta^2 = .36$, more frequently at happy than at neutral faces (M = 33.77%, SD = 2.77%), $F(1,167) = 18.29$, $p < .001$, $\eta^2 = .10$, and more frequently at neutral than at angry faces, $F(1,167) = 80.07$, $p < .001$, $\eta^2 = .32$.

Finally, young and older adults looked longer at happy faces (M = 38.12% of total gaze time, SD = 7.80%) than at angry faces (M = 28.71%, SD = 6.22%), $F(1,167) = 86.70$, $p <$ .001, $\eta^2 = .34$, longer at happy than at neutral faces (M = 33.17%, SD = 5.22%), $F(1,167) =$ 30.0, $p < .001$, $\eta^2 = .15$, and longer at neutral than at angry faces (F[1,167] = 46.93, $p < .001$, $\eta^2 = .22$).

Avoidance Motivation

First, we investigated whether there are age-related differences between young and older adults with respect to dispositional avoidance motivation. An independent samples t-test revealed no significant differences in dispositional avoidance motivation between the age groups (young M = 5.18, SD = 2.15, old M = 4.70, SD = 2.09, t[165] = 1.47, p = .14). Thus, our expectation of mean-level differences in motivation was not confirmed.

Age and Avoidance Motivation as Predictors of Gaze Preferences for Emotional Faces

To test the role of age and avoidance motives for gaze preferences, we conducted hierarchical regression analyses, entering age as a dummy variable (-1 = young, 1 = old) in the first step, avoidance motivation in the second step, and the interaction of age and motivation in the third step as predictors of gaze preferences. As expected, we found no interaction effects of age and motivation. Thus, we report only the first two steps of the regression analysis.

As hypothesized, age negatively predicted gaze preferences for angry faces (see Table 1). Older participants looked less *frequently* (first gaze and total fixation frequency) and less *long* at angry faces than young adults. Additionally, there was a statistical trend for older, as compared to younger, adults to look longer at happy faces. The results on avoidance motivation also supported the hypotheses. As Table 1 shows, avoidance motivation was positively associated with first gaze and the total fixation frequency as well as gaze duration for angry faces. Moreover, avoidance motivation predicted gaze preferences for happy faces on all three indicators of gaze behavior (see Table 1). The higher avoidance motivation was, the less frequently (first gaze and total fixation frequency) and less long young and older adults looked at happy faces. Importantly, and in line with our expectations, none of the predictors was associated with gaze preferences for neutral faces in any of the analyses (all $\Delta R^2 < .01$, $p > .20$).

Discussion

The present study investigated age-related differences in (i) avoidance motivation and (ii) the relationship between avoidance motivation and gaze preferences for positive and negative information. The results suggest no age-related differences in avoidance motivation. Confirming the positivity and reduced negativity bias in older adulthood, older adults looked less frequently and less long at angry and somewhat longer at happy faces than younger adults. Irrespective of age, avoidance motivation was associated with the processing of emotional faces. The higher avoidance motivation was, the more participants' attention was driven and held by angry faces and the less it was held by happy faces. Taken together, interindividual differences in avoidance motivation seem to affect gaze behavior beyond young adulthood.

Although we expected to find a decrease in avoidance motivation with age, young and older participants did not significantly differ in avoidance motivation. Further studies are needed before we can draw any conclusions.

Although both younger and older adults looked less frequently and less long at angry than at neutral and happy faces, this effect was more pronounced in older adults. At the same time, older adults looked only slightly longer at happy faces. No age-related differences were found in first gaze and total fixation frequency. Thus, older adults showed a stronger *avoidance* of negative emotional information. This is in line with previous research. For example, Mather and Carstensen (2003) found that older adults responded faster to a dot when it was presented in the same place as a neutral as compared to a negative face, but not faster when it was presented in the same place as a positive as compared to a neutral face. Thus, it seems that, at least in some situations, older adults tend to avoid negative stimuli more than they approach positive information. Future research should explore under which conditions these differences appear. Note, however, that *both* young and older adults in the present sample showed a gaze preference for positive as compared to neutral or negative faces. Thus, in general, people seem to approach positive stimuli. This might be due to mood-congruent information processing as most people are in a positive mood most of the time (Diener & Diener, 1996). Moreover, positive information might match their predominantly positive expectations of the future (e.g., Taylor & Brown, 1988).

In both young and older adults, avoidance motivation was positively associated with gaze preference for angry faces and negatively associated with gaze preference for happy faces. The present finding on the link between avoidance motivation and gaze preferences are in line with previous studies on avoidance motivation in young adulthood (e.g., Gable, 2006; Gomez & Gomez, 2002). Importantly, we found no association between avoidance motivation and gaze duration for neutral faces, supporting the view that avoidance motivation leads to selective attention for emotional information. Not surprisingly, the motivation to avoid negative stimuli results in people directing their attention to negative stimuli. An angry person represents a challenge to one's resources (Sell et al., 2009) and social status (van Honk & Schutter, 2005) and is associated with a preparedness to attack (Berkowitz, 1993). In other

words, an angry person represents a threat to one's feeling of control over a situation. Highly avoidant people are, by definition, particularly amenable to this kind of social threat (Sokolowski et al., 2000). Visual search studies on the "pop-out effect" suggest that people are faster at detecting possible threats than at detecting possible positive incentives (e.g., Öhman, 1997). Consequently, an angry face should be particularly salient for an avoidance-motivated person. The present study provides the first support for this hypothesis. Additionally, it suggests that highly avoidance-motivated people cannot easily ignore the source of social threat irrespective of its importance or relevance in a given situation. Note that in the present study participants did not have to interact with the angry person, nor was the angry person in any way important for them as regards subsequent social interactions. We assume that, if the angry face is neither important nor relevant for the observer, he/she avoids looking at it and instead prefers to look at happy or neutral faces. This is in line with Wilson and MacLeod's (2003) shifted attentional function model of attentional orienting. According to this model, mildly aversive stimuli as those used in the present study do not represent an imminent threat to the person and, therefore, elicit attentional avoidance, presumably in order to help preserve a positive mood state. A negative stimulus only grabs and holds a person's attention if it is threatening. In the present study, the attention-grabbing and attention-holding effect of angry faces increased only with increasing avoidance motivation, suggesting that this kind of motivation is constantly activated in connection with social-emotional stimuli reflecting danger. The results further revealed that this spotlight function and holding power of angry faces occurs at the expense of attention to happy but not neutral faces. This might indicate an especially disadvantageous attentional pattern of avoidance motivation for social experience and behavior. Future research needs to further explore why avoidance-motivated persons not only direct their attention towards negative but also away from positive social stimuli.

The results of the present study do not suggest an age-differential impact of dispositional motivation on gaze preferences. Although older adults are generally more motivated to avoid negative information by looking away from angry faces, dispositional motivation had the same influence on gaze preferences across adulthood. The results of the present study regarding age-related differences in gaze duration for emotional faces are in line with previous research. However, avoidance motivation did not mediate this age-related difference in gaze duration. Thus, factors other than social approach or avoidance motivation seem to be driving the age-related attentional shift of preference for emotional faces.

One limitation of the present study is the artificial setting and task. As discussed above, looking at faces on a computer screen without subsequent social interaction is of no real-life relevance to participants. Thus, the influence of motivation on gaze preferences might be even stronger in a natural setting when people are confronted with an actual happy or angry person. Additionally, the cross-sectional nature of our design necessarily confounds cohort and age effects. Longitudinal studies including the age-range from young to old adulthood, however, would span over multiple decades, rendering them extremely time-costly. Moreover, we did not include a group of middle-aged adults in the study. Therefore, the current data do not allow us to test whether the development of avoidance motivation is characterized by a linear or a curvilinear trend. As reported in the introduction, some forms of motivation (e.g., hope for power) might follow an inverted U-shape form over adulthood. A sample with a continuous age distribution spanning from young to old adulthood is needed to investigate this. Finally, we did not analyze separately avoidance tendencies in affiliation, achievement, and power motivation. Further studies using more detailed instruments assessing approach and avoidance motivation in different motives need to address the interesting question of possible motive-specific developmental differences.

In conclusion, the present study represents a first step in the exploration of the relationship between dispositional avoidance motivation and attentional processes in younger

and older adults. The influence of avoidance motivation on gaze preferences seems to remain relatively stable from young to older adulthood.

(287 lines)

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Footnotes

[1]Similar to previous studies, approach motivation in this study did not predict any of the gaze-behavior criteria.

Table 1

Hierarchical regression of gaze time for happy and angry faces on age and avoidance motivation

	First gaze		Gaze frequency		Gaze duration	
Predictor	Happy faces	Angry faces	Happy faces	Angry faces	Happy faces	Angry faces
Step 1 (ΔR^2)	(.02)	(.02*)	(.02)	(.03*)	(.02$^+$)	(.02$^+$)
Age	.12	-.16*	.12	-.17*	.13$^+$	-.14$^+$
Step 2 (ΔR^2)	(.02$^+$)	(.02$^+$)	(.05**)	(.03*)	(.03*)	(.04**)
Age	.11	-.14$^+$	.10	-.15$^+$	.11	-.11
Avoidance Motivation	-.13$^+$	.14$^+$	-.22**	.17*	-.18*	.21**
n	167		167		167	

Note. The results represent standardized coefficients (β).

$^+$ $p < .10$. *$p < .05$. **$p < .01$.

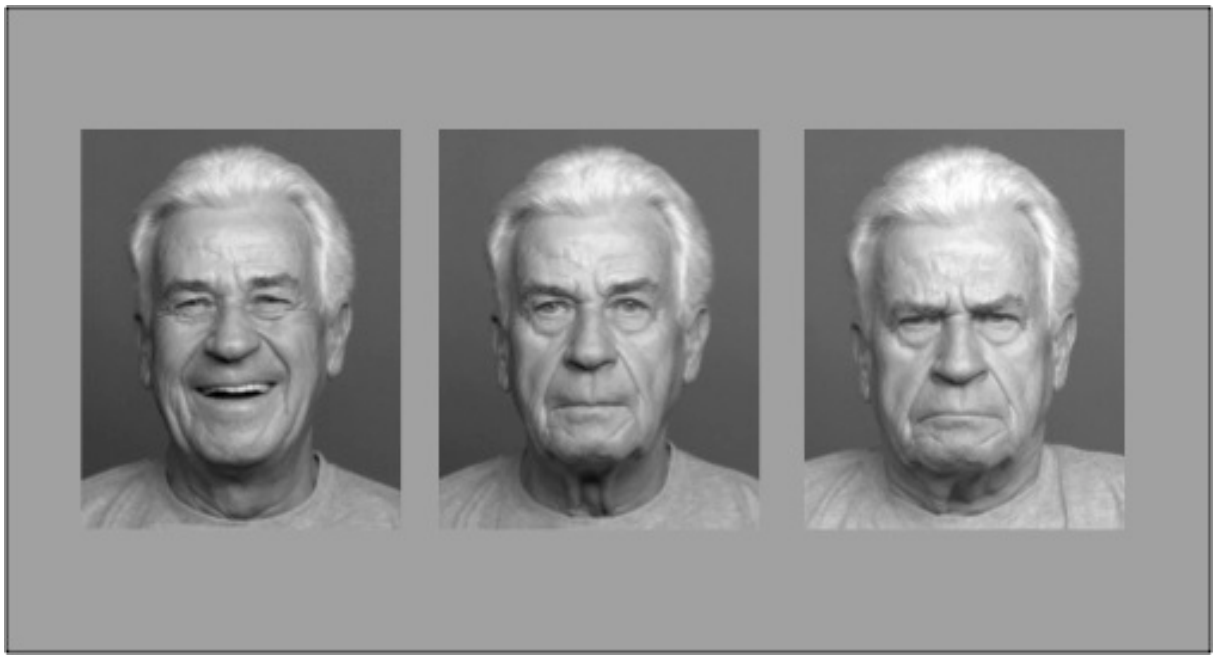

Figure 1. Stimulus material: Example of an old male face.