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BRIEF REPORT

Adult Age Differences in the Interpretation of Surprised Facial Expressions

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Research on adult age differences in the interpretation of facial expressions has yet to examine evaluations of surprised faces, which signal that an unexpected and ambiguous event has occurred in the expresser's environment. The present study examined whether older and younger adults differed in their interpretations of the affective valence of surprised faces. Specifically, we examined older and younger participants' evaluations of happy, angry, and surprised facial expressions. We predicted that, on the basis of age-related changes in the processing of emotional information, older adults would evaluate surprised faces more positively than would younger adults. The results indicated that older adults interpreted surprised faces more positively than did their younger counterparts. These findings reveal a novel age-related positivity effect in the interpretation of surprised faces, suggesting that older adults imbue ambiguous facial expressions—that is, expressions that lack either positive or negative facial actions—with positive meaning.

Keywords: aging, emotion, facial expressions, surprise, positivity effect

Facial expressions of surprise convey individuals' attempts to understand the presence of an unexpected yet highly salient event in their environment (Horstmann, 2006). Younger adults have consistently been shown to interpret affectively ambiguous surprised faces as negative (Neta, Norris, & Whalen, 2009; Neta, & Whalen, 2010). However, because the processing of affective information shifts across the adult life span toward positivity (Carstensen & Mikels, 2005), there is good reason to suppose that the negativity bias in the processing of surprised faces does not extend into later adulthood. The present study thus examined whether older adults interpret surprised faces more positively than do their younger counterparts.

Facial expressions of other individuals are salient cues that help one interpret social behavior and decide appropriate reactions to a situation. Although some expressions are clear in the emotional valence that they communicate (e.g., anger, fear), other expressions are ambiguous and can be interpreted as reflecting either a positive or a negative valence (Kim et al., 2004; Leppänen, Milders, Bell, Terriere, & Hietanen, 2004; Neta & Whalen, 2011; Said, Sebe, & Todorov, 2009). Facial expressions can be ambiguous by displaying either a mix of positive and negative affect or an absence of clearly positive or negative affect, as in the case of surprise or neutral expressions.

The presence of a surprised expression, relative to neutral expressions, signals that a meaningful event has transpired in the environment (Horstmann, 2006; Meyer, Reisenzein, & Schützwohl, 1997). A surprised facial expression reflects an adaptive initial reaction to an unexpected event that has interrupted individuals' actions and reoriented their attention to enhance responses to an event deviating from their expectations. From a functionalist perspective, the raised brows and widened eyes of a surprised expression serve to enhance the visual field to better update schemas regarding important aspects of the environment (Shariff & Tracy, 2011). Surprised faces are evaluated as indicating that individuals' actions have been interrupted and that more information is needed prior to resuming action (Horstmann, 2003). Most importantly, surprised faces are inherently neither positive nor negative—but positive or negative interpretations have been shown to depend on the presence of a disambiguating context (Kim, Somerville, Johnstone, Alexander, & Whalen, 2003; Kim et al., 2004). Surprised expressions have thus been useful in research examining interpretive biases.

A negativity bias in interpretations of surprised expressions has been found in children, adolescents, and younger adults (e.g., Neta et al., 2009; Tottenham, Phuong, Flannery, Gabard-Durnam, & Goff, 2013). Although there was variability across individual ratings of surprised expressions, younger adult participants evaluated affectively ambiguous faces as more negative than positive (Neta et al., 2009; Neta & Whalen, 2010). Furthermore, oddball-type paradigms demonstrated that in younger adults, surprised expressions are processed more similarly to negative anger expressions compared to positive happy expressions (Neta, Davis, & Whalen, 2011). Altogether, Neta and colleagues (2011) suggested

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that younger adults interpret surprised faces as being more negative than positive.

However, due to motivational shifts toward emotion regulation goals in later life (see, e.g., Charles & Carstensen, 2007), it is likely that developmental differences in the processing of surprised faces may be observed in late adulthood. As proposed by socioemotional selectivity theory (Carstensen, 2006), older adults are more motivated than their younger counterparts to optimize emotional well-being due to their constrained time horizons. This motivation leads older adults to process either positive information to a greater extent or negative information to a lesser extent than do younger adults. The *positivity effect*—the age-related preference for positive as opposed to negative material in information processing (Carstensen & Mikels, 2005)—is considered to be motivated and volitional in nature; this effect is amplified when people are free to process information as they like, for instance, in unconstrained rather than constrained information-processing tasks (Reed, Chan, & Mikels, 2014). However, the bulk of this research has used unambiguous positive and negative emotional material.

Researchers have only recently examined adult age differences in the interpretations of ambiguous information. For instance, compared to younger adults, older adults were found to generate less negative resolutions to emotionally ambiguous scenarios (Mikels & Shuster, 2016). Kellough and Knight (2012) presented older and younger adults with facial expressions representing a blend of discrete positive and negative emotions. Relative to younger adults, older adults provided more positive evaluations for the blended expressions. Blends of positive and negative expressions simultaneously display a partial smile in addition to components of sadness, anger, or fear. These blends display a mix of positive and negative affect and are thus fundamentally different from expressions of surprise. Surprised faces convey a discrete emotional reaction, which uniquely signals that an unexpected event has occurred and that the expresser is vigilantly trying to assess the situation (Horstmann, 2003). Unlike blended expressions, surprised faces do not contain muscle actions that are *exclusive* to expressions of discrete positive or negative emotions. Studies examining the visual processing of facial expressions during emotion identification tasks have revealed that older adults tend to divert attention from the eyes in favor of gazing at the mouth (e.g., Murphy & Isaacowitz, 2010). As such, older adults' relatively more positive evaluations of blended expressions may result from perceptual biases rather than an interpretive bias.

The present study utilized surprised faces rather than blends in order to determine whether older relative to younger adults provide more positive evaluations of facial expressions that lack facial actions exclusively associated with positive or negative affect. To do so, we used a modified version of the facial evaluation task of Neta et al. (2009), where older and younger adults evaluated the valence of happy, angry, and surprised expressions. We predicted that, on the basis of previous findings regarding age differences in the processing of ambiguity, older adults, relative to younger adults, would evaluate the surprised expressions as being more positive. For exploratory purposes, facial electromyography was also collected to examine potential relations between affective evaluations and facial responses.

Method

Participants

Thirty-one younger adults and 32 older adults were recruited (see Table 1 for participant characteristics). This sample size is comparable to that in previous research that examined age differences in the interpretation of ambiguous situations (Mikels & Shuster, 2016) and studies examining relations between evaluative biases and facial electromyography (fEMG) activity (e.g., Neta et al., 2009). Older adults were compensated for their participation monetarily; younger adults were compensated with payment or course credit.

Table 1
Participant Characteristics, Cognitive Measures, Valence Ratings, and Facial Activity by Age Group

Variable	Younger adults			Older adults				
	M	*SD*	%	*M*	*SD*	%	*t*	*p*
Age (in years)	20.93	(3.23)		73.56	(7.44)			
Sex (female)			73.3			71.9		
Education (in years)	13.37	(3.25)		15.66	(3.26)		−2.77	.008
Socioeconomic level[a]	2.84	(1.10)		2.87	(.94)		−.14	.828
Vocabulary[b]	32.42	(8.92)		41.84	(9.62)		−4.03	<.001
Digit-Symbol Coding[c]	83.68	(12.78)		60.75	(15.22)		6.12	<.001
Digit Span[d]	28.16	(4.97)		25.87	(5.76)		1.67	.099
Valence ratings[e]								
Overall	.58	(.69)		1.20	(.69)		−3.50	<.001
Angry	−2.04	(.34)		−2.21	(.44)		1.72	.091
Happy	2.14	(.31)		2.30	(.44)		−1.61	.114
Surprised	−.16	(.53)		.59	(.71)		−4.77	<.001
Corrugator activity	−.05	(.17)		−.24	(.26)		3.43	.010
Zygomaticus activity	−.02	(.05)		−.06	(.06)		2.91	.005

[a] On a scale ranging from 1 (*lower income*) to 5 (*upper income*). [b] From the Wechsler Adult Intelligence Scale (4th ed.; WAIS-IV; Wechsler, Coalson, & Raiford, 2008): maximum score = 57. [c] From the WAIS-IV: maximum score = 135. [d] From the WAIS-IV: maximum score = 48. [e] Measured on a scale ranging from −3 (*very negative*) to +3 (*very positive*).

Stimuli

Following Neta and colleagues' (2009) methodology, images of facial expressions of anger, happiness, and surprise were selected from nine male and nine female models from the NimStim database of emotional facial expressions that were validated as having high rates of intraparticipant agreement in emotion identification tasks (Tottenham et al., 2009).

Measures

Facial muscle activity. Facial electromyography (fEMG) measured participants' facial responses to the images (Larsen, Norris, & Cacioppo, 2003). Pairs of 4-mm Ag/AgCl electrodes were attached to the *corrugator* (brow) and *zygomaticus* (cheek) muscle sites according to Fridlund and Cacioppo's (1986) guidelines. Facial muscle activity was recorded at a sampling rate of 1 kHz with an integrated wireless system and software package (Biopac MP150, AcqKnowledge; BIOPAC Systems, 2016). Measures were collected across the entire task. The fEMG data were processed according to the protocol used in previous physiological examinations of affect (e.g., Mikels et al., 2016).

Assessments of cognitive ability. Three standard Wechsler Adult Intelligence Scale (4th ed.; Wechsler, Coalson, & Raiford, 2008) measures of cognitive functioning were included to compare older and younger adults. Vocabulary required participants to provide brief verbal definitions of word lists that increased in difficulty. Digit-Symbol Coding measured participants' processing speed by requiring them to match symbols that corresponded to digits as quickly as possible for 2 min. Digit Span measured short-term memory by having participants remember and repeat strings of digits. See Table 1 for means and standard deviations.

Procedure

After providing consent, participants were fitted with fEMG sensors placed over their *corrugator* and *zygomaticus* muscles. Participants completed a 5-min acclimation period to accustom themselves to the sensors. Next, participants were informed they would be viewing and evaluating a series of facial expressions that would be presented for brief durations. Each of the 54 images was presented twice over two separate runs in random order for a total of 108 trials. Images were presented on a computer screen with a white background, one at a time, for 1 s each. Before each expression, participants were presented with a black fixation cross on a white screen for 6 s followed by a white screen with a red fixation cross for 500 ms (to help the participants orient themselves to the upcoming image). After each image, participants rated the expression's valence using labeled keyboard keys. The labeled keys represented a 6-point scale ranging from −3 (*very negative*) to +3 (*very positive*). Last, the fEMG sensors were removed from the participants, who then completed the cognitive tasks and demographic survey.

Results

To examine age differences in the valence ratings of the three facial expressions, we conducted a 2 (age group) × 3 (expression) mixed-measures analysis of variance (ANOVA). A main effect of expression emerged, indicating that valence ratings were significantly different across the three categories of facial expression, $F(2, 122) = 1{,}285.37$, $p < .001$, $\eta_p^2 = .955$. Bonferroni-corrected pairwise comparisons revealed that the average valence ratings for each expression were significantly different from the others. Angry expressions were rated the most negative ($M = -2.13$, $SD = .40$), happy expressions were rated the most positive ($M = 2.22$, $SD = .39$), and surprised expressions were rated in the middle ($M = .21$, $SD = .73$). Furthermore, a main effect of age emerged such that older adults ($M = .23$, $SD = .32$) rated facial expressions significantly more positively overall compared to younger adults ($M = -.02$, $SD = .23$), $F(1, 61) = 12.25$, $p = .001$, $\eta_p^2 = .167$.

Of importance, the interaction between age group and expression was significant, $F(2, 122) = 14.91$, $p < .001$, $\eta_p^2 = .196$. An independent-samples *t* test was conducted for each expression type to compare the valence ratings provided by older and younger adults. The valence ratings provided by younger ($M = -2.04$, $SD = .34$) and older ($M = -2.21$, $SD = .44$) adults did not significantly differ for angry expressions, $t(61) = 1.72$, $p = .09$, $d = .432$. It was similar for happy expressions; the older ($M = 2.30$, $SD = .44$) and younger ($M = 2.14$, $SD = .31$) adults did not significantly differ on their valence ratings, $t(55.25) = -1.61$, $p = .114$, $d = .420$. However, older adults rated surprised facial expressions significantly more positively ($M = .59$, $SD = .71$) than did younger adults ($M = -.16$, $SD = .53$), $t(57.47) = -4.77$, $p < .001$, $d = 1.197$. These analyses were repeated with the inclusion of the three cognitive assessment scores as covariates to examine whether age differences in valence ratings were possibly explained by age differences in cognitive performance. Including these scores did not change the pattern or significance of the results.

To examine differences in fEMG activity, we conducted a 2 (age group: younger adults vs. older adults) × 3 (expression: happy, angry, surprised) mixed-measures ANOVA for *corrugator* and *zygomaticus* separately. A main effect of age emerged for both *corrugator* and *zygomaticus* activity indicating that younger adults had higher levels of activity compared to older adults, $F(1, 61) = 11.79$, $p = .001$, $\eta_p^2 = .162$, and $F(1, 61) = 40.57$, $p = .005$, $\eta_p^2 = .122$, respectively (see Table 1). No other effects emerged.

Discussion

This study provides evidence for age differences in the evaluation of affectively ambiguous surprised faces. As predicted, relative to younger adults, older adults interpreted surprised expressions as being more positive. The valence ratings provided by older and younger adults did not significantly differ for angry or happy expressions. Thus, the age difference in affective interpretations of facial expressions was specific to only the surprised expressions. This finding provides an important boundary condition to the positivity effect in affective evaluations, such that only ambiguous surprised faces may be susceptible to age differences in interpretation. Such age differences could have inadvertent downstream consequences, insofar as interpretations of surprised faces in unpredicted situations can influence how people appraise their social partners' intentions (Jusyte & Schönenberg, 2014).

These findings are consistent with those in recent work on age differences in affective evaluations and interpretations of facial expressions that were mixed in terms of valence (Kellough & Knight, 2012). Our study's use of surprised expressions rather than positive–negative blends extends Kellough and Knight's (2012) findings into expressions of surprise that uniquely signal an adaptive emotional reaction that is initiated by the appraisal of uncertainty caused by changing aspects of the environment. Our findings also parallel research demonstrating that relative to the young, older adults form more positive trait impressions (e.g., health and trustworthiness) of neutral facial expressions (Zebrowitz, Franklin, Hillman, & Boc, 2013). Along with the findings by Zebrowitz et al. (2013), our findings extend the scope of the positivity effect into evaluations of socioemotional stimuli that are neither positive nor negative in valence. Previous research on the positivity effect has been limited to using stimuli that were positive, negative, or mixed in valence (see Reed et al., 2014). Due to our use of surprised faces (rather than mixed expressions), our findings suggest that older adults imbue facial expressions that are neither positive nor negative in terms of their valence with positive meaning.

Although the present investigation documented age differences in the interpretation of ambiguous facial expressions, there are limitations regarding generalization to real-life contexts. Recent literature has suggested that the context surrounding facial expressions may sometimes determine how those expressions are identified and that older (compared to younger) adults may be more reliant on context to correctly identify facial expressions (Noh & Isaacowitz, 2013). Thus, future research should consider the role of contextual factors surrounding ambiguous expressions to improve ecological validity. Regarding the exploratory fEMG data, our findings did not provide any additional insights, possibly due to lower facial reactivity among older adults. Future studies should include larger samples, especially when examining physiological measures, due to their greater variability.

Our investigation provides evidence for age differences in the interpretation of surprised faces that are ambiguous in terms of valence. Specifically, older adults, in comparison to younger adults, rated the surprised faces as more positive. Therefore, older versus younger adults may differentially appraise and interpret the faces of others during unpredicted situations, which could impact subsequent courses of action.

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