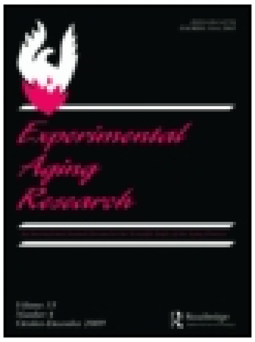

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Age-related Differences in Expression Recognition of Faces with Direct and Averted Gaze Using Dynamic Stimuli

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ABSTRACT

Background: It is still an open to what extent the ecological validity of face stimuli modulates age-related differences in the recognition of facial expression; and to what extent eye gaze direction may play a role in this process. The present study tested whether age effects in facial expression recognition, also as a function of eye gaze direction, would be less pronounced in dynamic than static face displays.

Method: Healthy younger and older adults were asked to recognize emotional expressions of faces with direct or averted eye gaze presented in static and dynamic format.

Results: While there were no differences between the age groups in facial expression recognition ability across emotions, when considering individual expressions, age-related differences in the recognition of angry facial expressions were attenuated for dynamic compared to static stimuli.

Conclusion: Our findings suggest a moderation effect of dynamic vs. static stimulus format on age-related deficits in the identification of angry facial expressions, suggesting that older adults may be less disadvantaged when recognizing angry facial expressions in more naturalistic displays. Eye gaze direction did not further modulate this effect. Findings from this study qualify and extend previous research and theory on age-related differences in facial expression recognition and have practical impact on study design by supporting the use of dynamic faces in aging research.

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Introduction

Expression and eye gaze are important facial cues in social interaction (Emery, 2000). Processing of these facial cues facilitates decoding of the motivational states of others and is central to interpersonal communication. In fact, according to the shared signal hypothesis (Adams & Kleck, 2003, 2005), perception of anger and happiness in faces is enhanced when combined with direct (relative to averted) gaze, possibly because direct gaze signals the motivation to approach. In contrast, perception of sadness and fear in faces is enhanced when combined with averted (relative to direct) gaze, possibly because averted gaze signals

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Supplemental data for this article can be accessed on the publisher's website.

motivation to avoid (Adams & Kleck, 2003, 2005; Milders, Hietanen, Leppänen, & Braun, 2011; N'Diaye, Sander, & Vuilleumier, 2009; Ziaei et al., 2017). Support for the shared signal hypothesis comes exclusively from research with younger adults, however.

Indeed, the limited research that currently exists on older adults has documented age-related deficits in the ability to process and combine facial expression and eye gaze cues, particularly for angry faces (Slessor, Phillips, & Bull, 2010; Ziaei et al., 2016), a deficit that may lead to social disengagement and contribute to loneliness in old age (Bath & Deeg, 2005). Also, this previous research has not considered variations of effects by facial expressions. Thus, systematic examination of emotion and eye gaze effects on facial expression recognition among older adults is warranted to delineate the conditions under which age-related deficits in facial expression recognition occur. Greater knowledge on these processes is crucial for the development of effective strategies to counteract social impairment and its negative consequences from emotion recognition deficits in aging.

Another major limitation of previous studies on facial expression recognition is the use of static (and not dynamic) facial cues (Ziaei & Fischer, 2016). Emotional events in real life typically unfold dynamically, and static emotional face displays are limited in their capture of this complex process (Ambadar, Schooler, & Cohn, 2005; Isaacowitz & Stanley, 2011; Sze, Goodkind, Gyurak, & Levenson, 2012). It is possible that the lower ecological validity of static faces is associated with lower emotional salience when compared with "more naturalistic" dynamic emotional face displays. These differences in emotional salience may contribute to difficulties in facial expression recognition for static compared to dynamic stimuli, particularly in aging. This may be because the more naturalistic display of emotion in dynamic, compared to, static images reduces the added challenge of correctly identifying "posed" expressions, and thus renders performance in older adults more like performance in younger adults. Also, interpreting dynamic cues in real life involves processing emotional components learned through life experience, which is different from the less naturalistic processing of static images of facial expressions (Isaacowitz & Stanley, 2011), and thus may particularly benefit older adults.

Currently, the literature on age-related differences in dynamic face recognition as well as in recognition of facial expression is very limited; and the few existing studies have produced somewhat mixed findings. In particular, while some of the previous evidence supported comparable or better performance in the recognition of dynamic facial expressions in older than younger adults (Holland, Ebner, Lin, & Samanez-Larkin, 2018; Krendl & Ambady, 2010; Sze et al., 2012), other studies showed worse performance in older than younger adults (Grainger, Henry, Phillips, Vanman, & Allen, 2015; Sullivan & Ruffman, 2004). Of note, only one previous study directly compared age-related performance on static and dynamic facial expressions, controlling for the influence of other emotional signals (i.e., auditory, contextual, body cues), and found comparable age-related differences for dynamic and static stimuli (Grainger et al., 2015).

The current study set out to add to this small, inconclusive literature and specifically extended previous work by determining age-related differences in facial expression recognition of static vs. dynamic emotional displays that also systematically varied emotion expression and eye gaze directions. Based on previous findings (Slessor et al., 2010; Ziaei et al., 2016), and diverging from the "shared signal hypothesis" (derived from research with young adults only), we expected age-related expression recognition deficits for angry faces when presented with direct (relative to averted) gaze (*Hypothesis 1a*), reflected in both less accurate and slower responding. In contrast, for happy faces, we expected older relative to younger participants to show better or comparable performance for direct (relative to averted) gaze (*Hypothesis 1b*). For faces with sad and fearful displays, we hypothesized age-related expression recognition deficits when the faces were presented with direct (relative to averted) gaze (*Hypothesis 1c*).

We also hypothesized that age-related deficits in facial expression recognition would be attenuated for dynamic relative to static stimuli (*Hypothesis 2a*), again reflected in both accuracy and response time (RT). This prediction was based on the notion that dynamic compared to static stimuli have greater ecological validity, thus enhancing emotional salience and rendering processing of dynamic stimuli comparatively easier for older adults. Further, based on robust evidence that age-related deficits in facial expression recognition were particularly pronounced for negative static expressions (Ruffman, Henry, Livingstone, & Phillips, 2008; Ziaei & Fischer, 2016), we expected relatively better performance for negative (and especially angry) compared to positive expressions in the dynamic relative to the static format (*Hypothesis 2b*). We also explored effects of eye gaze direction in this set of hypotheses.[1]

Methods and Materials

Participants

This protocol was approved by the University of Queensland Ethics Board. Forty-two generally healthy younger (22 females; M = 21.02, SD = 2.45) and 39 older (19 females; M = 71.64, SD = 4.79) adults participated in this study.[2] All provided written informed consent, were English speakers, and had no presence of psychiatric, psychological, or neurological illness. Older participants were screened for cognitive impairment using the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) and all scored above the recommended cutoff of 26. Background measures, including intelligence, verbal ability, negative affect, and executive functioning, were used as control variables to ensure that age-related differences in executive functioning or emotional distress did not contribute to age effects in facial expression recognition (see Table 1 for descriptive and inferential statistics of demographic and control measures).[3] For the full description of background measures see the supplemental material.

Material

Stimuli

This task used high-quality color photographs of face images displaying happy, angry, fearful, sad, and neutral expressions, selected from the FACES database (Ebner, Riediger, & Lindenberger, 2010). The faces were gaze-modified by Dr. Alexander Lischke, University of Greifswald, Germany. We used 20 different face identities, and, across the experiment, each emotional category had equal numbers of faces with direct vs. averted gaze, younger vs. older faces, and male vs. female faces. For counterbalancing, we created two image lists, each containing the same 20 face identities presented in each list. Use of the same face identities across the two lists allowed us to control for facial attractiveness and other facial features not under investigation here. Each list consisted of equal numbers of faces per age, gender, and

Table 1. Sample descriptive data and inferential statistics (age-group differences) for background measures.

	Younger participants		Older participants		Inferential statistics		
	M	*SD*	*M*	*SD*	*t*	*df*	*Effect size (Cohen's d)*
Age (years)	21.02	2.45	71.64	4.79			
Education (years)	14.69	1.96	16.24	5.57	1.65	46	0.37
NART FSIQ	111.24	4.81	117.28	5.19	5.43*	79	1.22
RMET	24.93	3.75	23.49	4.64	1.54	79	0.34
Fluency Test	40.48	9.62	43.59	13.18	1.22	69	0.27
DASS							
Stress Subscale	3.36	3.55	2.92	2.22	0.66	79	0.15
Anxiety Subscale	3.00	3.23	1.41	1.86	2.74*	66	0.62
Depression Subscale	1.95	1.97	1.077	1.29	2.38*	71	0.54
Executive Functioning							
Stroop Interference Score (%)	15.89	14.99	26.66	16.74	3.04*	78	0.68
Task-switching Index	25.14	16.12	34.62	23.43	2.10*	76	0.47
N-back	22.43	4.86	18.67	6.45	2.95*	70	0.66

* $p < 0.05$. NART FSIQ = National Adult Reading Test Full-Scale IQ (Nelson, 1982); Fluency Test (Benton et al., 1976); DASS = Depression Anxiety Stress Scale (Lovibond & Lovibond, 1995); Stroop Interference Score = ((RT in incongruent trials – RT in neutral trials)/RT in neutral trials)*100 (Ziaei, Von Hippel, Henry, & Becker, 2015); Task-switching Index = Trail Making Test Part B – Trail Making Test Part A (Reitan & Wolfson, 1986); N-back = total number of correct trials (Kirchner, 1958); *df* = degree of freedom; *SD* = standard deviation; *M* = mean; *t* = student t-test.

gaze direction, and contained faces that matched on facial attractiveness (*M* = 38.45, *SD* = 13.54), based on independent ratings (Ebner et al., 2018). Half of the participants received list 1 in the static and list 2 in the dynamic task version (see below for details of the two task versions), and the other half of the participants received the reserved presentation order. See the supplemental material for a breakdown. The stimulus presentation order within each list was pseudo-randomized regarding age, gender, emotion, and gaze, with no more than two of the same categories presented in a row. Face stimuli were presented on a gray background in E-Prime using a 726 × 966 dimension.

Task Design

Task Versions

The task comprised two versions: a static and a dynamic. In the *static task format*, we presented still face photographs, one at a time. Each trial started with a fixation cross (1000 ms) in the center of the screen, followed by a face image displaying one of the five facial expressions (happy, angry, fearful, sad, and neutral), with either direct or averted gaze, for a maximum of 4000 ms. The five response options (happy, angry, fearful, sad, and neutral) appeared on the screen below the face.

In the *dynamic task format*, we presented three different photographs of the same face identity in direct succession to simulate an eye-gaze shift (Figure 1), based on previous studies suggesting that this method provides reliable dynamic emotional expression in faces (Graham, Kelland Friesen, Fichtenholtz, & Labar, 2010; Itier & Batty, 2009). As shown in Figure 1a, each direct gaze trial ("approach" trial) started with a fixation cross in the center of the screen, followed by presentation of a face with neutral expression (500 ms) and averted gaze (left or right, counterbalanced across trials). This image was replaced with an image of the same face identity with direct gaze (200 ms), followed by the same face identity

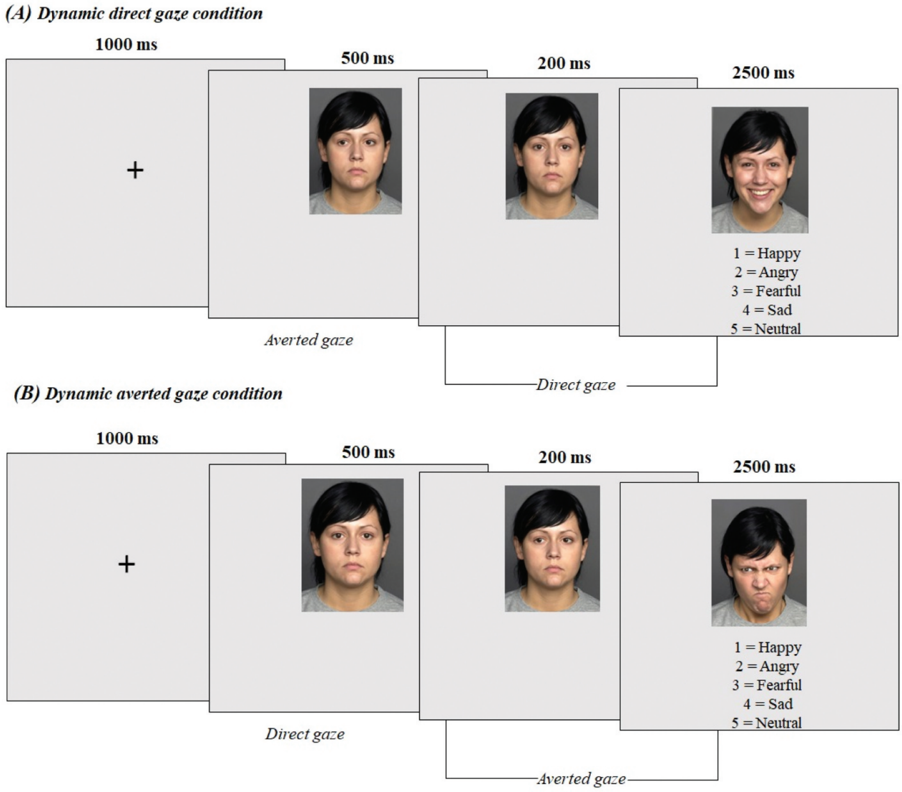

Figure 1. Example stimuli used in the facial expression recognition task. Panel A represents a trial during the dynamic direct gaze condition. After the fixation cross, a face with neutral expression and averted gaze was presented, followed by the same face with neutral expression and direct gaze, and the same face with one of the five facial expressions (happy, angry, fearful, sad, neutral) and continued direct gaze. Panel B represents a trial during the dynamic averted gaze condition. After the fixation cross, a face with neutral expression and direct gaze was presented, followed by the same face with neutral expression and averted gaze, and the same face with one of the five facial expressions and continued averted gaze. Participants were asked to indicate the facial expression by pressing the corresponding key on the keyboard.

displaying one of five emotional expressions for a maximum of 2500 ms with continued direct gaze (i.e., for a total of 3200 ms). As shown in Figure 1b, for averted gaze trials ("avoidance" trial) we used an equivalent procedure, with the difference that the face was first presented with a neutral expression and direct gaze (500 ms), which was then replaced with an image of the same face identity with averted gaze (200 ms, left or right, counter-balanced across trials).

A pilot study determined the presentation duration necessary to assure sufficient time to respond to the facial stimuli in the two task formats, given the speeded nature of the task. In the dynamic task version, the presentation time of the first two images (i.e., 200 ms, 500 ms, respectively) was furthermore based on previous gaze-cuing studies (Lassalle & Itier, 2015; Neath, Nilsen, Gittsovich, & Itier, 2013) to reflect naturalistic change in eye gaze direction and facial expression. The presentation sequence of images in the dynamic task was faster compared those in the static task version to maintain a naturalistic appearance, given that real-life emotions are fast-moving and fleeting (Isaacowitz & Stanley, 2011).

Procedure

Participants were asked to identify basic facial expressions presented with different eye gaze directions and their performance, reflected in both accuracy and RT, was recorded during the task. For both task versions, participants were asked to indicate as quickly and accurately as possible the facial expression displayed by pressing the corresponding key on the keyboard (1 for happy, 2 for angry, 3 for fearful, 4 for sad, and 5 for neutral). Participants were able to respond to both static and dynamic stimuli as soon as facial expressions, and accompanying emotional expression labels, were displayed on the screen (i.e., stimuli presentation ended until participants made a response or the time-limit of the stimulus presentation lapsed). All participants worked on the static task format first to ensure that the gaze manipulation in the dynamic task format had no effect on static facial expression recognition. Accuracy and RT were recorded in both task versions.

Analyses

We conducted two mixed analyses of variance (ANOVAs), one on accuracy and one on RT (correct responses only), with age (younger, older) as between-subjects factor and expression (happy, angry, fearful, sad, neutral), gaze (direct, averted), and format (static, dynamic) as within-subjects factors. These analyses allowed us to investigate age-related differences in facial expression recognition in each of the facial expressions as a function of eye gaze (*Hypothesis 1a – 1 c*). Further, with these analyses we were able to determine the extent to which age-related differences in facial expression recognition were attenuated for the dynamic relative to the static task format (*Hypothesis 2a*), and specifically for negative (i.e., angry) emotions (*Hypothesis 2b*). Additionally, we were interested to examine relationship between theory of mind ability and emotion recognition. A full description of the analyses and results are reported in the supplementary.

Results

Age-related Differences in Facial Expression Recognition as a Function of Facial Expression and Eye Gaze

The interactions between age, expression, and gaze were neither significant for accuracy ($F(2.96, 210.16) = 0.52$, $p = .667$, $\eta_p^2 = 0.007$) nor for RT ($F(4, 316) = 1.43$, $p = .225$, $\eta_p^2 = 0.018$). Thus, *Hypotheses 1a-1 c* were not supported.

Attenuation of Age-related Differences in Facial Expression Recognition for Dynamic Relative to Static Task Formats, Particularly for Negative Expressions

The three-way interaction between age, expression and format was significant for RT ($F(4, 316) = 5.25$, $p = .001$, $\eta_p^2 = 0.062$), while not for accuracy ($F(4, 284) = 1.106$, $p = .350$, $\eta_p^2 = 0.015$).[4]

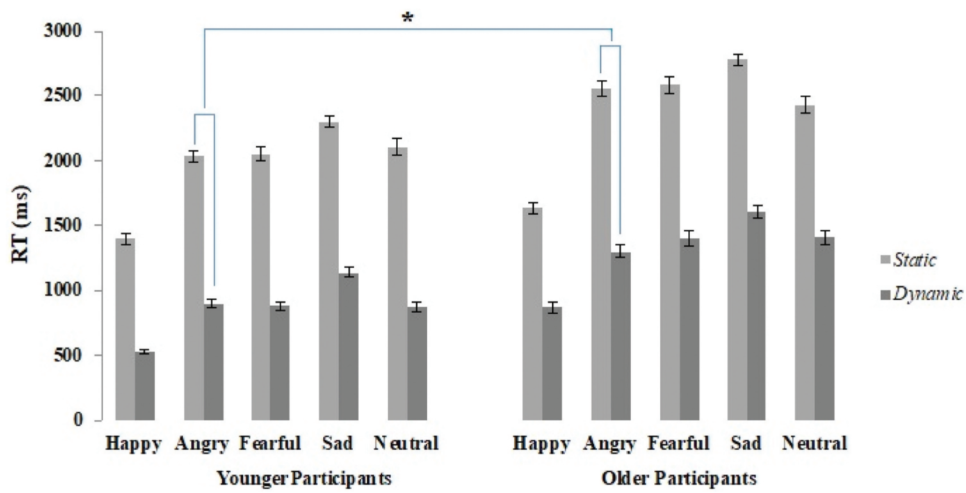

Figure 2. Younger and older participants' mean RTs in the static and dynamic versions of the facial expression recognition task. Both age groups responded faster to dynamic than static stimuli across all facial expressions. However, older compared to younger participants were relatively faster in recognition of angry facial expressions for dynamic relative to static stimuli. Error bars represent standard errors of the age-group mean differences. ** $p < .001$.

In particular, as shown in Figure 2, in both younger ($F(4, 164) = 17.15$, $p < .001$, $\eta_p^2 = 0.295$) and older ($F(4, 152) = 19.52$, $p < .001$, $\eta_p^2 = 0.339$) participants, the interaction between expression and format was significant for RT. Simple effects analysis showed that both younger ($Fs(1, 41) > 602.14$, $ps < 0.001$) and older ($Fs(1, 38) > 219.22$, $ps < 0.001$) participants responded faster to dynamic than static stimuli across all expressions. Direct age comparisons between the static and dynamic task formats for each of the facial expressions furthermore showed that older compared to younger participants responded relatively faster when angry faces were presented in dynamic vs. static format (Older participants: $M(\mathrm{SD})_{\mathrm{angry\ static}} = 2554.84$ (412.58), $M(\mathrm{SD})_{\mathrm{angry\ dynamic}} = 1296.89$ (321.40), $t(38) = 22.31$, $p < .001$; Younger participants: $M(\mathrm{SD})_{\mathrm{angry\ static}} = 2029.93$ (290.44), $M(\mathrm{SD})_{\mathrm{angry\ dynamic}} = 898.75$ (230.38); $t(41) = 29.68$, $p < .001$). Thus, while *Hypothesis 2a* of a general benefit from the dynamic relative to the static task format for older adults was not supported, *Hypothesis 2b* was partially supported, in that age-related RT deficits in recognition of negative (i.e., angry) expressions were attenuated for dynamic relative to static facial displays.[5]

As shown in Figure 3, the four-way interaction between age, expression, gaze, and format was neither significant for accuracy ($F(4, 316) = 1.08$, $p = .359$, $\eta_p^2 = 0.015$) nor for RT ($F(4, 316) = 0.936$, $p = .437$, $\eta_p^2 = 0.012$). Thus, eye gaze did not modulate the observed effects under *Hypotheses 2a&b*. Follow-up analyses suggested significant three-way interactions between expression, gaze, and format for accuracy ($F(4, 284) = 11.90$, $p < .001$, $\eta_p^2 = 0.144$) and for RT ($F(4, 1316) = 3.291$, $p < .012$, $\eta_p^2 = .04$); this effect did not survive multiple comparison correction for RT as outcome measure, however.

Follow-up analyses of the accuracy data for each emotional category showed that the gaze by format interaction was significant for angry ($F(1, 78) = 10.52$, $p = .002$, $\eta_p^2 = 0.119$), sad ($F(1, 80) = 17.60$, $p < .001$, $\eta_p^2 = 0.180$), and neutral ($F(1, 78) = 33.26$, $p < .001$, $\eta_p^2 = 0.299$) expressions (but not for fearful and happy expressions; all $Fs < 1$). In particular, both younger

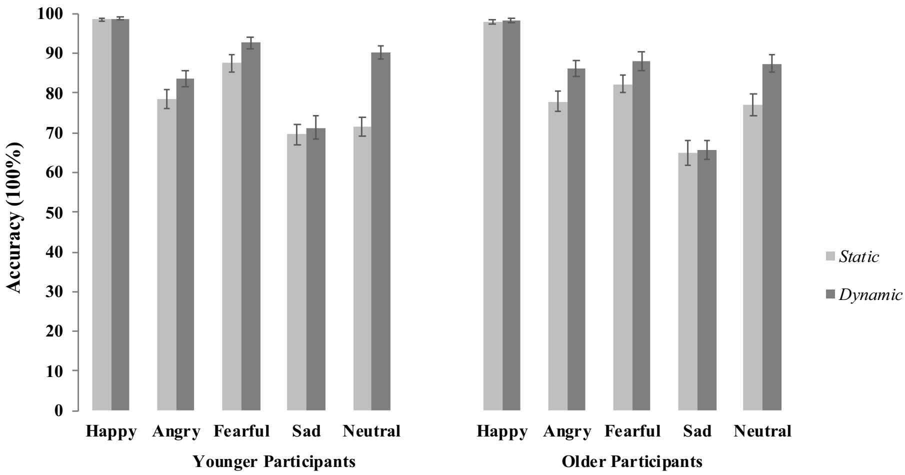

Figure 3. Younger and older participants' mean accuracy in the static and dynamic versions of the facial expression recognition task. Both age groups performed better with dynamic than static stimuli across all facial expressions. Error bars represent standard errors of the age-group mean differences.

and older participants recognized dynamic angry expressions more accurately for faces with direct (M = 88.23, SD = 14.39) compared to averted (M = 78.35, SD = 15.56) gaze. In contrast, both age groups recognized static sad and neutral expressions more accurately for faces with direct (Sad: M = 71.60, SD = 19.00; Neutral: M = 79.75, SD = 15.10) compared to averted (Sad: M = 63.21, SD = 19.35; Neutral: M = 68.48, SD = 22.14) gaze (see Table 2 for descriptive data).

Discussion

The primary goal of this study was to extend the currently still limited knowledge on age effects in facial expression recognition when directly contrasting dynamic and static faces, also under consideration of the specific facial expression displayed and the eye gaze direction. The study generated several novel findings as discussed next.

Age-Related Expression Recognition Deficits Did Not Vary by Facial Expression or Eye Gaze

Our data did not show age-related expression recognition deficits as a function of the facial expression displayed and/or eye gaze direction (not supporting *Hypotheses 1a-c*). This finding is inconsistent with previous research demonstrating that younger compared to older adults were more sensitive to direct vs. averted gaze when viewing expressions of anger and happiness in a non-speeded/non-classification task. In fact, Bindemann et al. (2008) states that the integration of facial cues according to a "shared signal" may only happen at later processing stages, which would not be captured in speeded classification tasks such as applied in the present context. Also, different from our approach, Slessor et al. (2010) observed age-related differences in recognition of facial cues by measuring perceived intensity of facial expressions. These methodological differences between studies limit final conclusions and warrant additional research on the topic.

Table 2. Descriptive data for accuracy by age, expression, gaze, and format and age-group differences.

	Younger participants		Older participants	
	M	*SD*	*M*	*SD*
Happy				
Static				
Direct	98.46	3.77	98.235	4.09
Averted	98.72	3.31	98.235	3.89
Dynamic				
Direct	99.23	2.61	98.235	3.66
Averted	98.46	3.97	97.647	4.09
Angry				
Static				
Direct	78.97	18.27	79.12	18.82
Averted	79.74	15.23	78.24	16.44
Dynamic				
Direct	88.46	15.15	88.24	13.55
Averted	80.26	16.09	84.71	12.73
Fearful				
Static				
Direct	86.41	16.40	82.94	18.78
Averted	88.21	13.27	83.53	13.09
Dynamic				
Direct	92.32	12.08	87.94	20.22
Averted	93.08	10.19	90.88	15.57
Sad				
Static				
Direct	74.36	18.62	70.00	19.30
Averted	65.13	18.24	62.94	20.49
Dynamic				
Direct	70.51	21.63	61.47	16.18
Averted	71.54	22.15	68.53	22.03
Neutral				
Static				
Direct	79.74	15.01	80.59	15.21
Averted	65.39	20.85	72.35	25.19
Dynamic				
Direct	90.00	14.13	87.35	15.23
Averted	90.77	10.68	87.94	14.05

Age-Related Deficits in Angry Expression Recognition were Attenuated for Dynamic Faces

We did not find evidence of a general age-related attenuation in facial expression recognition for dynamic compared to static stimuli (not supporting *Hypothesis 2a*). So, while our findings were generally in line with Grainger et al. (2015) who found that use of dynamic images did not reduce age-related deficits in facial expression recognition across different emotions, the present study also qualified this previous data pattern by demonstrating attenuation of age-related deficits in recognition of angry expressions for dynamic relative to static facial stimuli (partially confirming *Hypothesis 2b*). Thus, our findings align with the emerging notion that older adults may be less impaired than previously anticipated when processing more ecologically valid (i.e., dynamic compared to static) face stimuli (Isaacowitz & Stanley, 2011; Phillips & Slessor, 2011; Sze et al., 2012), at least for negative (i.e., angry facial expressions). These attenuated deficits may be related to older adults' greater experience with processing dynamic (more naturalistic) compared to static angry faces. However, this effect did not hold for all negative expressions (e.g., fearful or sad faces). One could speculate that increased sensitivity to dynamic anger expressions is due to the particular adaptive value of physical and social threat signals such as depicted in angry faces (Marinetti, Mesquita, Yik, Cragwall, & Gallagher, 2012). More research is needed to confirm these differences among dynamic negative expressions and to determine the underlying adaptive mechanisms of the observed effects.

Facial Recognition Pattern Varied by Gaze Direction in Both Younger and Older Adults

While we did not observe age-related differences in the ability to recognize dynamic over static facial expressions, stimulus format affected participants' overall ability in facial expression recognition. Also, across both age groups, facial expression recognition was not enhanced for direct (relative to averted) gaze for static angry faces, but it was enhanced for dynamic angry stimuli with direct as opposed to averted gaze, supporting the notion that eye gaze direction, in interaction with facial expression, modulates facial expression recognition ability. These findings were largely in support of the shared signal hypothesis (Adams & Kleck, 2003). This may be because being able to recognize an approaching angry face quickly and accurately in a dynamic setting can be particularly crucial for survival.

Of note, across both age groups, effects for sad faces were opposite to those for angry faces, in that expression recognition of sad faces was enhanced for static faces with direct relative to averted gaze. While this finding is inconsistent with Adams and Kleck (2003), it lines up with Bindemann et al. (2008) who showed that for sad expressions, at early stages, the processing of gaze was prioritized over the processing of static facial expressions in a speeded classification task. Expanding on Bindemann et al. (2008), however, our results showed that the addition of dynamic stimuli modified these gaze effects, such that participants were equally sensitive to direct and averted gaze during recognition of sad faces. Consistent with Bindemann et al., a perceiver's attention may first follow the eyes as the gaze shifts to left or right, and then hold on the poser's face for facial expression recognition, as can be systematically tested in future studies using eye tracking and event-related potentials.

Of note, some of our findings are not fully aligned with the shared signal hypothesis (Adams & Kleck, 2003), a dominant theory on the integration of eye gaze and emotional expression. Previously, predictions from this theory have been confirmed in work with younger adults, but the theory has not been systematically tested in older adults yet. In fact, our findings contribute to emerging evidence (see also Slessor et al., 2010; Ziaei et al., 2016) that the theory may not fully apply to processes in older adults, and highlight the importance of additional work into circumstances under which older adults succeed in correct recognitions of emotion expressions, also as a function of eye gaze direction.

Limitations

The present study had a few limitations that need to be considered when interpreting the results and suggest relevant future research avenues. In particular, the current design was complex, also in relation to the available sample size. Nevertheless, the present study findings offer a first important insight into possible relationships between emotion and eye gaze in facial expression recognition in aging and constitute a basis for future independent replication in a larger sample size. Future research would also benefit from inclusion of older adults with varying levels of cognitive function, as opposed to the generally healthy, largely high-functioning individuals included in the present study, to determine the extent to which cognitive capacity moderates the interaction between emotion and eye gaze in facial expression recognition.

The current study presented the static before the dynamic task version, using the same face identities for both formats, which could have resulted in familiarity effects on expression recognition performance in the dynamic task version. This was done to ensure that eye gaze shift in the dynamic format had no impact on facial expression recognition in the static format. Future studies with a larger sample could test the familiarity account by systematically varying presentation order across participants and could investigate the extent to which presentation order affects speed and accuracy, as well as their trade-off, in static vs. dynamic facial emotion recognition among younger vs. older adults.

Conclusion

Our data supported a reduced age-related deficit in the recognition of dynamic compared to static angry faces. These findings suggest that older compared to younger adults may be less disadvantaged when recognizing angry facial expressions in more naturalistic displays. Findings from this study qualify and extend previous research and theory on age-related differences in facial expression recognition and have practical impact on study design by supporting the use of dynamic faces in aging research.

Notes

1. As a secondary aim in this study, we were interested to exploring the relationship between theory of mind (ToM) ability and emotion recognition. The rationale behind this analysis, the methods, results and discussion are reported in the supplementary materials.
2. Our sample size was based on sample sizes used in comparable studies in the field of emotion and aging (Campbell, Murray, Atkinson, & Ruffman, 2015; Grainger et al., 2015). Also, although controversial, we conducted a post-hoc power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) to determine whether our design had sufficient power to detect an age interaction on static vs. dynamic facial expression recognition. This analysis showed that for response time, the estimated power was above the recommended level of 0.80 (Cohen, 1988). For accuracy, however, based on the effect size of d = 0.47 that we observed in this study, a sample size of approximately 175 participants would have been needed to obtain power at the recommended level of 0.80. Thus, the observed results pertaining to accuracy must be interpreted with caution.
3. These background measures were used as covariates in additional analyses to determine their impact on the results. No significant main effect or interaction between covariates with task performance was found. Results are reported in the Supplementary material.
4. Applying Greenhouse-Geisser correction resulted in the same findings as reported.
5. Note that RTs were not overall faster to dynamic than static stimuli and thus could not have been solely driven by differences in presentation times across the static vs. dynamic task formats but were (at least in part) a function of the different emotion expression displays. To further address differences in presentation times for static vs. dynamic stimuli, we applied log transformation to normalize the RT data by dividing all RTs in the static condition by 4000 ms and all RTs in the dynamic by 3200 ms (duration of image presentation during static and dynamic formats, respectively). Re-analysis of the data with these transformed scores yielded comparable results. Additional analyses using log transformation on RTs also revealed comparable results.

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Disclosure statement

Authors declare no conflict of interest.

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