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Empathic reactions of younger and older adults: No age related decline in affective responding☆

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HIGHLIGHTS

- We assessed performance based affective and cognitive empathy in two age groups.
- Cognitive empathy for happiness and sadness was reduced for older adults.
- Older adults' affective empathy was not reduced in comparison to younger adults.
- Older adults outperformed younger adults in the facial mimicry of disgust.
- 20 s long dynamic stimuli produced continuous facial muscle reactions.

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ABSTRACT

Empathy is an important skill in all stages of life. However, previous research suggests that cognitive empathy, i.e. the ability to accurately infer another person's feelings, is reduced for older adults. Here, we suggested that investigating affective empathy in addition to cognitive empathy could provide a more complete picture of how older adults differ from younger adults in their ability to empathize with others. For this, we presented videos of spontaneous facial expressions portraying happiness, anger, sadness and disgust to 39 younger and 39 older adults. Affective responding was measured via facial mimicry and cognitive empathy was measured via decoding accuracy. We did not expect and did not find evidence for impaired affective responding to emotional expressions in old age; however, cognitive empathy was reduced for happiness and sadness. Thus, empathic reactions of older adults might not be as affected as findings based only on decoding accuracy may suggest.

Introduction

Knowing what other people feel is fundamental in all stages of life. Empathic reactions are important for our social relationships and well-being, as lower empathy is associated with reduced social functioning (Bailey, Henry, & von Hippel, 2008; Findlay, Girardi, & Coplan, 2006). However, there is evidence that one aspect of empathy – the ability to decode emotion expressions – is reduced in older compared to younger adults (for overviews see Isaacowitz & Stanley, 2011; Ruffman, Henry, Livingstone, & Phillips, 2008). Yet, there is another, implicit, facet of empathy, which consists of the affective responding to the emotional expressions of others, and which has rarely been studied in older adults. Given that implicit, automatic processes, in contrast to controlled processes, are less affected by aging (e.g., Ruffman, Ng, & Jenkin, 2009), and that emotional information becomes more salient in older age (Carstensen, Fung, & Charles, 2003), there is reason to believe that affective and cognitive empathy may be differentially affected by aging. Spontaneous reactions to emotional images are well preserved across the lifespan (Fleischman, Wilson, Gabrieli, Bienias, & Bennett, 2004; Jennings & Jacoby, 1993; Leclerc & Kensinger, 2008). Importantly, this notion is not in conflict with findings of impaired decoding accuracy for older adults, which relies more on the controlled, deliberate processing that is affected by age (Salthouse, 1996).

The goal of this research was to study empathic reactions of younger and older adults not only through explicit emotion recognition but also through the assessment of implicit affective reactions during the exposure to emotional facial expressions. In what follows, we will define empathy in the framework of this research and discuss evidence for differences between younger and older adults in empathic responding.

Empathy

Empathy is the ability to understand and respond to the emotional messages of others (Decety & Jackson, 2004) and is divided into two components (Lamm, Batson, & Decety, 2007): (1) *cognitive empathy*,

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the ability to accurately infer another person's feelings (e.g., Ickes, 1993) and (2) *affective empathy*, a process where the perception of another's emotional state generates a matching reaction in the perceiver (e.g. De Waal, 2008). Thus, empathy comprises the bottom-up process of affective resonance and top-down processes of understanding, which are influenced by other cognitive processes such as the perceiver's motivation and empathic experience (Decety, 2011). Therefore, investigating affective empathy in addition to cognitive empathy can provide a more complete picture of how younger and older adults differ in their ability to empathize with others.

Cognitive empathy and the elderly

Cognitive empathy is measured as the accuracy with which the perceiver decodes emotion expressions and research suggests reduced decoding accuracy of older perceivers. For example, Malatesta, Izard, Culver, and Nicolich (1987) assessed the decoding of facial expressions of anger, sadness and fear for women of three age-groups and found an age-related decline for all three emotions. Another series of studies found that with increasing age, participants were less accurate in decoding anger, fear and sadness in faces, but showed improved decoding of disgust (Calder et al., 2003). A meta-analytic review on emotion recognition and aging confirmed these findings (Ruffman et al., 2008). Specifically, older individual's ability to decode facial expressions of anger, sadness and fear was reduced, compared to younger individuals. Older individuals were also worse at decoding happiness and surprise, but on a smaller scale. For disgust there was a trend for better decoding in older individuals. In sum, compared to younger individuals, older individuals show reduced cognitive empathy in terms of decoding emotions expressed in faces, with the exception of disgust.

Affective empathy and the elderly

Only few studies have tapped affective empathy in the context of aging. Bailey et al. (2008) measured self-reported and performance based empathy in younger and older adults and found that the two groups differed in self-reported and performance based cognitive empathy, but not in self-reported affective empathy (no performance based measure of affective empathy was included). Even though these findings are evocative, they rely heavily on self-reports of empathy.

By contrast, the spontaneous emotional response to facial expressions provides a performance based assessment of affective empathy. Specifically, the tendency to imitate facially, vocally or posturally the people with whom we are interacting is referred to as mimicry (e.g., Hess, Philippot, & Blairy, 1999). Facial mimicry is an unconscious and automatic process that is difficult to suppress (Dimberg, Thunberg, & Elmehed, 2000). Mimicry is an important aspect of empathic responding (Lamm, Porges, Cacioppo, & Decety, 2008) and part of the empathic process (e.g., Decety & Jackson, 2004). Given that facial muscle activation does not differ as a function of age (Reminger, Kaszniak, & Dalby, 2000), facial mimicry is a possible index for the comparison of affective empathy between younger and older adults. To our knowledge, only two studies compared facial mimicry in those age groups (Bailey & Henry, 2009; Bailey, Henry, & Nangle, 2009). Bailey and colleagues measured facial mimicry of younger and older adults to anger and happiness expressions and found no differences in muscle activity between the two age groups. Bailey et al. (2009) however also found that older adults' corrugator responses to anger expressions at 500–800 ms of stimulus exposure were associated with reduced anger recognition in a subsequent Go/NoGo task and suggested that these results might be indicative of difficulties in the labeling of angry expressions. Thus, the extant evidence on anger mimicry of older adults' is mixed. Furthermore, as these studies only focused on mimicry of happiness and anger, and as decoding accuracy differs across emotions (Ruffman et al., 2008), it would be desirable to extend this line of research to a broader range of emotions.

An ecological approach

Age-related decoding differences have previously been explained by a general cognitive decline, specific neuropsychological changes and changes in affectivity (Ruffman et al., 2008). A recent review however suggested the use of static images as another possible source for the age-related differences, pleading for an ecological approach in the assessment of decoding accuracy (Isaacowitz & Stanley, 2011). Older adults have more experience with natural expressions than with static images, thus a great improvement in this investigation would be the use of natural emotion expressions such as encountered in real life.

It is also worth noting that dynamic expressions facilitate facial mimicry compared to static images (Rymarczyk, Biele, Grabowska, & Majczynski, 2011; Sato, Fujimura, & Suzuki, 2008). However, little is known about the characteristics of facial mimicry toward natural dynamic facial expressions over time. It is particularly interesting what happens with facial muscle reactions toward spontaneous expressions, as the intensity of the emotional expressions varies over time. Although no general pattern for the onset and variation of intensity of the stimuli during the 20 s long sequences can be formulated, the length of the videos allowed us to investigate in an explorative manner, how facial muscle reactions to natural expressions develop over time.

To these ends we assessed decoding accuracy and performance based affective empathy in the form of facial mimicry, toward a range of natural dynamic emotion expressions shown by younger and older adults. We expected that older adults would not show impaired empathy in terms of automatic affective responding. Thus, we expected comparable levels and time characteristics of facial muscle reactions for younger and older adults, whereas decoding accuracy of older adults should be reduced.

Method

Participants

Thirty-nine older (aged 62 to 85 years) and thirty-nine younger (aged 18 to 30 years) women participated individually in the study. They were recruited at Humboldt-Universität zu Berlin via a participant database and the Third Age University and screened for psychiatric and neurological diseases. Participants received 10 € per hour.

We used the PANAS (Positive and Negative Affect Schedule, Watson, Clark, & Tellegen, 1988; German version: Krohne, Egloff, Kohlmann, & Tausch, 1996), with short-term instruction ("How do you feel right now?") to assess current mood. As is typically found (e.g., Charles, Reynolds, & Gatz, 2001), younger participants reported less positive and more negative affect compared to the older participants. Older participants scored higher in crystallized intelligence assessed by the WST (Wortschatztest, Schmidt & Metzler, 1992), a German test in which a target word has to be identified among five pseudo-words, whereas the younger adults showed higher levels of fluid intelligence assessed by the reasoning subtest of the LPS (Leistungsprüfsystem, Horn, 1983), in which non-matching figures have to be identified among logically related figures. The two groups did not differ in educational attainment, measured by the highest educational qualification achieved. Table 1 shows the basic characteristics of the two age groups.

Stimuli

Thirty-two soundless spontaneous facial expressive sequences of 20 second length were taken from a set of such stimuli developed and validated by Fölster, Hess, Hühnel, and Werheid (submitted for publication). The expressions were filmed while younger and older participants narrated an emotional event from their life. We selected videos that had achieved the highest accuracy ratings in the validation study. This selection comprised four younger (2 female, 2 male) and four

Table 1
Participant characteristics.

	Younger ($N = 38$)		Older ($N = 37$)		Younger - Older		
Variable	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*
Age	23.7	2.8	71.4	4.3		–	–
Positive Affect	25.3	5.3	32.7	5.7	−5.86	73	<.001
Negative Affect	12.8	2.7	10.5	1.2	4.64	52[a]	<.001
Crystallized intelligence	31.6	3.4	33.4	3.4	−2.34	73	.022
Fluid intelligence	29.2	4.1	20.6	4.9	8.30	73	<.001
	Younger ($N = 38$)		Older ($N = 37$)		Younger - Older		
	Mdn		*Mdn*		*U*		*p*
Educational Attainment	39.2	–	36.8	–	657	–	.593

[a] *df* were corrected due to unequal variances.

older actors (2 female, 2 male) with one video each for happiness, anger, sadness and disgust expressions (see Fig. 1).

Dependent measures

Facial EMG

Facial mimicry was assessed using facial EMG at the *Corrugator Supercilii*, *Orbicularis Oculi*, the *Levator Labii Alesque Nasii* and the *Zygomaticus Major* sites following placements suggested by Fridlund and Cacioppo (1986). Activity was measured on the left side of the face using bipolar placements of Easycap Ag/AgCl miniature surface electrodes filled with Signa gel (Parker Laboratories). The skin was cleansed with lemon prep and 70% alcohol. Raw EMG data were sampled using a bioamplifier (MindWare BioNex 3711-08) with a 50 Hz notch filter at 1000 Hz. The signals were band pass filtered between 30 and 300 Hz.

Decoding accuracy

Participants rated the emotion expressions on the following 7-point scales, anchored with *0 — not at all intense* and *6 — very intense*: happiness, anger, fear, sadness, disgust and surprise. Responses were considered as accurate if the rating on the target emotion scale (i.e., anger for a person showing an angry expression) was higher than the ratings on the remaining scales.

Procedure

After providing informed consent, participants reclined in a comfortable chair while physiological sensors were attached. The experimenter then left the room, monitored the experiment via a video camera and communicated with the participant via intercom. Younger and older participants were presented with the same instructions on the screen, explaining that they would see soundless videos of persons talking about emotional events and that their task was to rate the intensity of the emotions expressed by the person after each video presentation. After the participants had read the instructions, they could ask questions. If the participant was older, the experimenter went back into the room to check whether the participants had understood how to use the keyboard and the mouse. The experimenter did not do this for younger participants as we assumed that they were used to using computers.

Following this, a 3.5-minutebaseline period for EMG measures was taken while participants watched a relaxing video. Then the stimuli were presented without sound for 20 s with a preceding 2 second fixation period. After each presentation, participants rated the emotion expression. The stimuli were presented in two separate blocks of younger and older actors. The order of the blocks was counterbalanced across participants. Following this task, PANAS, WST and LPS were completed using paper and pencil.

Artifact control and data preparation

The data were offline rectified and smoothed. All video records were inspected for movements such as a yawning and sneezing that could disrupt the EMG measures. Periods corresponding to such movements were set missing and excluded from further analyses (percentage missing: younger adults: 2.98%, older adults: 3.18%). Within subject z-transformed difference scores (trial − baseline) were calculated for each trial.

Fig. 1. Example sample frames of two video clips, showing one younger male actor expressing happiness and one older female actor expressing disgust.

Results

Data for one younger and two older participants were removed from the analyses because they reported vision problems during debriefing.

Facial mimicry

We expected the same level of affective empathy in terms of facial mimicry to all facial expressions for younger and older participants. To test this for happiness, anger and sadness, we conducted a 2 actor age (younger, older) by 3 muscle site (Corrugator Supercilii, Orbicularis Oculi, Zygomaticus Major) by time (seconds 1 to 20) by 2 participant age (younger, older) ANOVA on the EMG values. This analysis across muscle sites is allowable as facial EMG data were previously transformed to z-scores and the data were thus on the same scale. To assess mimicry, expected patterns of muscle activity were specified as a function of each measured muscle's role in the production of facial expressions. Corrugator Supercilii produces the drawing together of the eyebrows in a frown, which is found in expressions of anger but also in expressions of sadness. Orbicularis Oculi produces the wrinkles in the corners of the eyes and Zygomaticus Major, which raises the lip corners when smiling. Consequently, mimicry of happiness expressions is indicated by higher levels of Zygomaticus major and Orbicularis Oculi activity compared to Corrugator Supercilii activity. Mimicry of angry expressions as well as of sad expressions is reflected by comparatively higher levels of Corrugator Supercilii activity than Zygomaticus Major and Orbicularis Oculi. To test for those muscle patterns, we used a planned contrast to compare the level of activity of the Corrugator muscle with the mean level of Orbicularis and Zygomaticus activity.

For disgust expressions we conducted a 2 actor age (younger, older) by 2 muscle site (Levator Labii Alesque Nasii, Zygomaticus Major) by time (seconds 1 to 20) by 2 participant age (younger, older) analysis of variance on the EMG values. Levator Labii Alesque Nasii is involved in the pulling up of the upper lip in expressions of disgust. During the mimicry of disgusted facial expressions, people should show more Levator Labii Alesque Nasii activity than Zygomaticus major activity. A *t*-test was used to assess this contrast.

Muscle activity patterns

Significant main effects of muscle site emerged for all expressions (happiness: $F(1, 109) = 294.16$, $p < .001$, $\eta_p^2 = .80$, anger: $F(1, 94) = 157.56$, $p < .001$, $\eta_p^2 = .69$, sadness: $F(1, 100) = 93.84$, $p < .001$, $\eta_p^2 = .56$, disgust: $F(1, 72) = 8.79$, $p = .004$, $\eta_p^2 = .11$). As expected, the planned contrast was significant for happiness, anger and sadness expressions ($F(1, 73) = 365.25$, $p < .001$, $\eta_p^2 = .83$; $F(1, 72) = 181.99$, $p < .001$, $\eta_p^2 = .71$; $F(1, 73) = 112.86$, $p < .001$, $\eta_p^2 = .61$), such that activity of the Corrugator Supercilii differed significantly from activity of the Orbicularis Oculi and Zygomaticus Major in the expected direction (see Figs. 2A, B & C). Thus both age groups mimicked happiness, anger and sadness.

For disgust, the effect of muscle site was qualified by a muscle site by participant age interaction, $F(1, 72) = 9.51$, $p = .003$, $\eta_p^2 = .12$. Post hoc analyses revealed an effect for muscle site for older participants, $F(1, 35) = 18.63$, $p < .001$, $\eta_p^2 = .35$, with higher Levator activity ($M = -0.02$) compared to Zygomaticus activity ($M = -0.11$), $t(74) = 2.88$, $p = .005$. For younger participants this effect was not significant, $F(1, 37) = 0.01$, $p = .933$, $\eta_p^2 = .000$. Thus only older adults mimicked expressions of disgust (see Fig. 2D).

Muscle patterns over time

We predicted that mimicry patterns over time would not differ between younger and older participants. As shown in Fig. 2, a main effect of time emerged for all expressions (happiness: $F(5, 342) = 45.66$, $p < .001$, $\eta_p^2 = .39$, anger: $F(6, 404) = 2.75$, $p = .014$, $\eta_p^2 = .04$, sadness: $F(5, 363) = 4.14$, $p = .001$, $\eta_p^2 = .05$, disgust: $F(5, 337) = 8.79$, $p < .001$, $\eta_p^2 = .11$), as well as a muscle site by time interaction (happiness: $F(6, 464) = 51.53$, $p < .001$, $\eta_p^2 = .41$, anger: $F(8, 553) = 8.84$, $p < .001$, $\eta_p^2 = .11$, sadness: $F(9, 644) = 8.62$, $p < .001$, $\eta_p^2 = .11$, disgust: $F(5, 354) = 4.93$, $p < .001$, $\eta_p^2 = .06$), and the muscle activity within the mimicry patterns varied over time for all expression.

A three-way interaction between muscle site, time and participant age emerged for happiness, $F(6, 464) = 2.33$, $p = .029$, $\eta_p^2 = .03$ and anger, $F(8, 553) = 2.51$, $p = .012$, $\eta_p^2 = .03$, and each expressions' post hoc muscle contrasts for both younger and older participants were significant from second 2 onward in the expected direction ($p < .05$). Thus, although the absolute difference between the muscle sites varied over time causing the three-way interactions, the mimicry patterns over time did not differ between the age groups.

Additional findings revealed a significant three-way interaction between muscle site, time and actor age for happiness, $F(11, 823) = 3.81$, $p < .001$, $\eta_p^2 = .05$, and sadness, $F(12, 873) = 3.27$, $p < .001$, $\eta_p^2 = .043$ (see Fig. 3). For both expressions, post hoc muscle contrasts for both younger and older actors were significant from second 2 onward in the expected direction ($p < .05$), although the absolute difference between the muscle sites varied over time. Importantly, the mimicry patterns over time did not differ between younger and older actors.

As the effects of muscle site for disgust was qualified by participants' age, simple effects analysis over time was conducted separately for the age groups. For younger participants significant effects of time, $F(6, 215) = 3.41$, $p = .003$, $\eta_p^2 = .084$ and muscle site by time, $F(5, 197) = 3.60$, $p = .003$, $\eta_p^2 = .09$, emerged. Analyses for each second ($p < .05$) revealed a reversed mimicry pattern of higher Zygomaticus than Levator activity in second 2, and higher Levator than Zygomaticus in seconds 19 and 20. No differences in muscle activity emerged for the other seconds for younger adults. For older adults a significant effect of time emerged, $F(4, 128) = 6.13$, $p < .001$, $\eta_p^2 = .149$, and muscle activity increased over time. The muscle site by time interaction did not reach significance, $F(4, 136) = 2.30$, $p = .064$, $\eta_p^2 = .062$. Thus, only older adults consistently mimicked expressions of disgust (see Fig. 2D).

In sum, the findings suggest that mimicry patterns for happiness, anger and sadness did not differ between younger and older participants, and that both age groups showed similar time characteristics of those patterns. However, mimicry of disgust was consistently shown only by older adults.

Decoding accuracy

We expected that older adults would show reduced decoding accuracy compared to younger adults. To assess this, we computed hit rates, i.e., the proportion of accurate responses for the respective target emotion. Responses were considered as accurate, if the rating on the target emotion scale was higher than the ratings on the remaining scales. Table 2 shows the hit rates for younger and older participants and actors.

To assess overall decoding accuracy we conducted a 2 actor age (younger, older) by 4 emotions (happiness, anger, sadness, disgust) by 2 participant age (younger, older) ANOVA on the hit rates. All ANOVA results are shown in Table 3. We found a significant main effect of emotion with the highest hit rate for happiness and the lowest for disgust. Hit rates for anger and sadness lay in between. As expected, we found a main effect of participant age. This effect was moderated by an emotion by age of participant interaction, as well as an emotion by age of actor interaction.

Post hoc analyses for each emotion expression separately revealed that older participants performed less well when decoding happiness and sadness expressions. No differences as a function of participant age emerged for anger and disgust expressions. Further, younger actors' expressions of happiness and disgust were better recognized than those shown by older actors. By contrast, sad expressions were better recognized when shown by older actors. No differences as a function of actor age emerged for anger expressions.

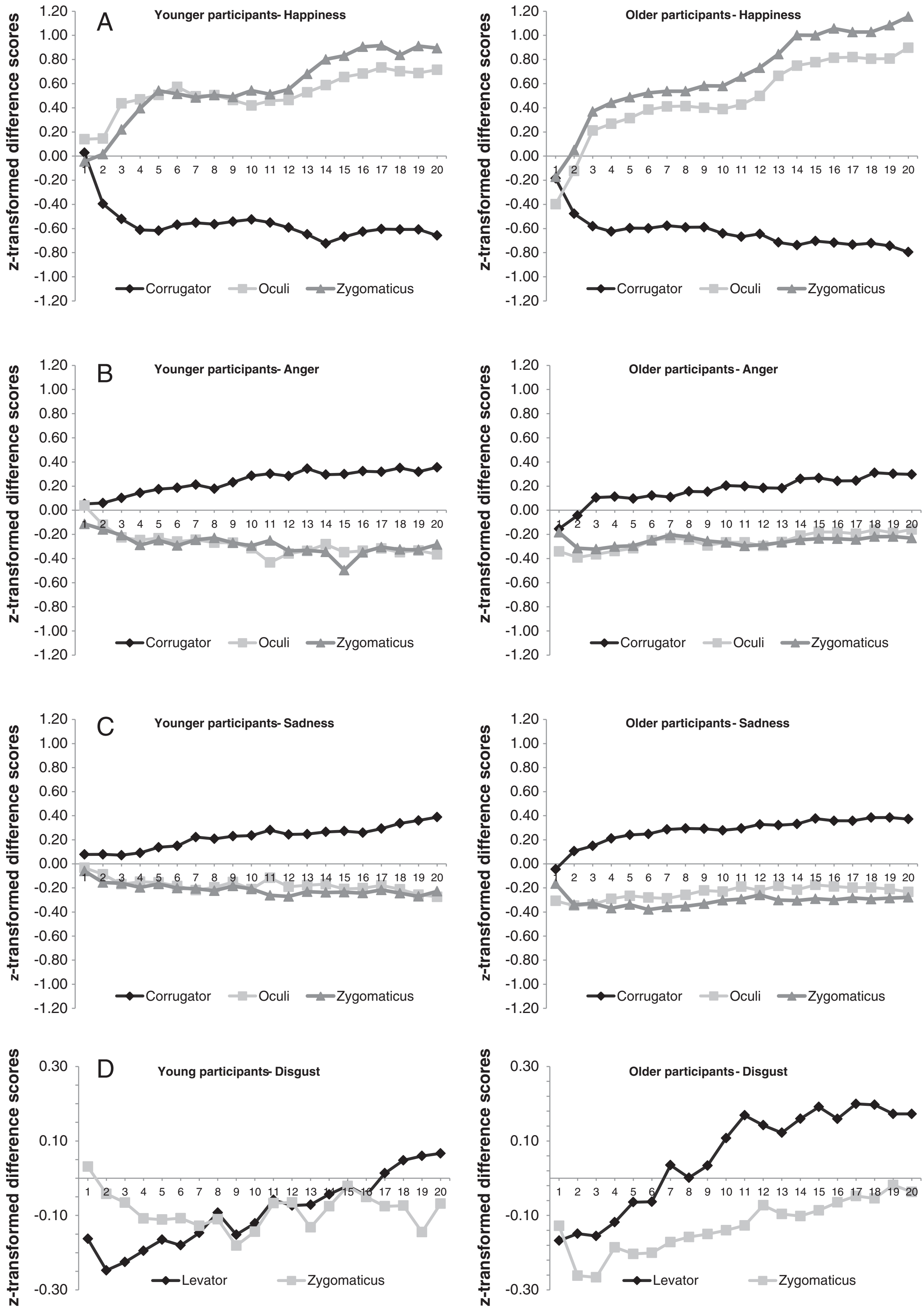

Fig. 2. Facial EMG over 20 s time toward expressions of happiness (A), anger (B), sadness (C) and disgust (D) separately for younger and older participants.

In sum, decoding accuracy of older compared to younger adults was reduced for expressions of happiness and sadness, but not for anger and disgust. Happiness and disgust expressions were more accurately recognized in younger compared to older actors. The reverse was the case for sadness expressions. No interactions between actor age and participant age were found.

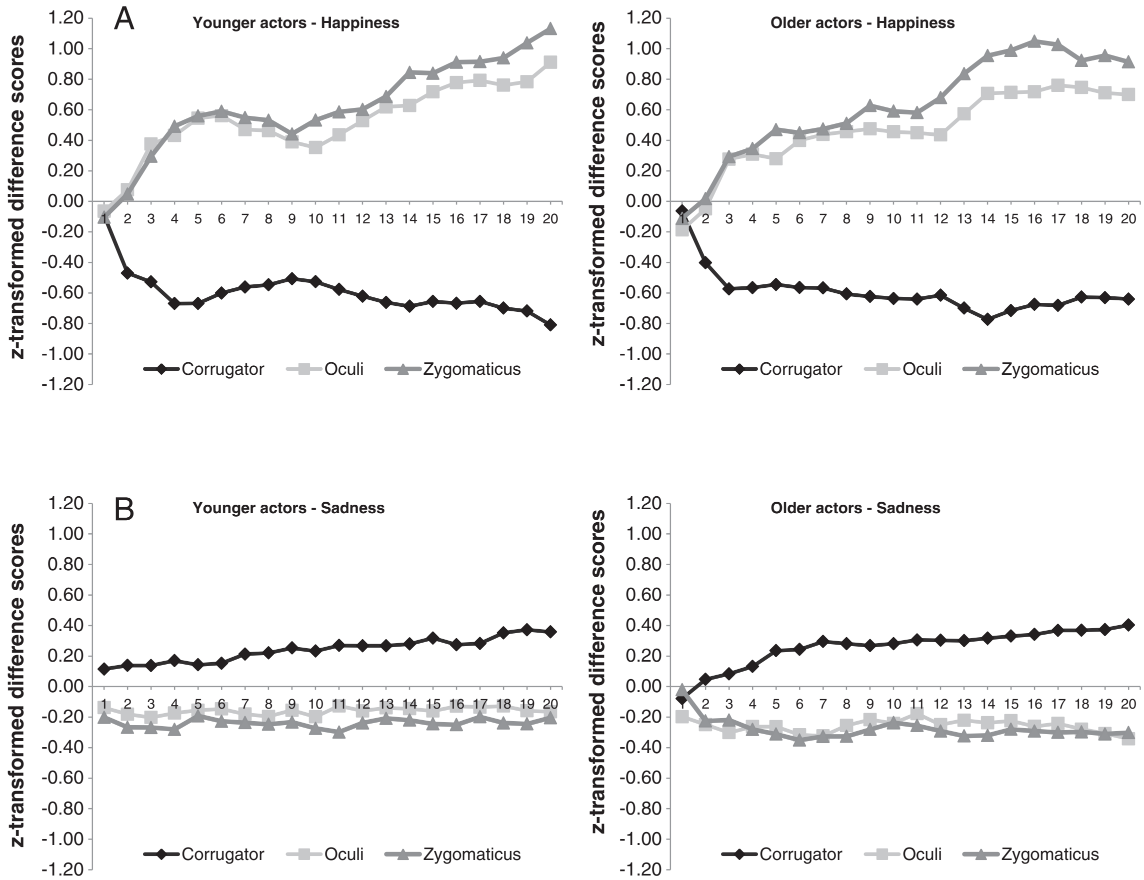

Fig. 3. Facial EMG over 20 s time toward expressions of happiness (A) and sadness (B) separately for younger and older actors.

Discussion

The goal of this research was to investigate how affective empathy on one hand and cognitive empathy on the other are affected by age. To this end, we assessed decoding accuracy as a measure of cognitive empathy and facial mimicry as a measure of affective empathy.

Affective empathic responding

We found that even though older participants showed some deficits in the decoding of happiness and sadness, they did not show any reduction in facial mimicry for these expressions. In fact, they mimicked all four facial expressions, including disgust, which was not mimicked by the younger participants. This indicates that affective empathic responding toward emotional facial expressions in terms of facial mimicry does not decline with age. Rather, affective responding seems to be sustained and in the case of disgust was even enhanced in older age, in line with the observation that implicit automatic processes are not affected by aging (Fleischman et al., 2004; Jennings & Jacoby, 1993; Leclerc & Kensinger, 2008).

Older adults seem to be more empathic than younger adults when it comes to the mimicry of disgust. It seems in fact that disgust is rarely mimicked by younger adults, as previous research on facial mimicry found disgust mimicry only in one study (Lundqvist & Dimberg, 1995; see Hess & Fischer, 2013, for a review). On one hand this may be because disgust signals a lack of affiliation (Hess, Blairy, & Kleck, 2000; Knutson, 1996) and thus does not lend itself to be mimicked, as mimicry itself signals affiliative intent (Hess et al., 1999). Yet, anger, for which the same lack of affiliativeness applies, is often mimicked and was mimicked in this study. On the other hand, disgust expressions are also closely related to notions of food aversion, bad tastes and smells and feelings of revulsion (Rozin, Lowery, & Ebert, 1994) and viewing films of disgust expressions can activate regions of the insula associated with disgust experiences (Wicker et al., 2003). This may lead younger individuals to a more superficial engagement with the stimulus in order to protect themselves. By contrast, older individuals entrain lower cognitive costs when regulating emotions in general (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) and disgust in particular (Scheibe & Blanchard-Fields, 2009) and hence may be more willing to engage with disgust stimuli. Another explanation might be that younger adults confused

Table 2
Decoding accuracy hit rates for younger and older participants and actors.

Target emotion	Younger participants ($N = 38$)				Older participants ($N = 37$)			
	Younger actors		Older actors		Younger actors		Older actors	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Happiness	0.89	0.17	0.85	0.18	0.78	0.25	0.66	0.25
Anger	0.45	0.23	0.49	0.28	0.47	0.25	0.41	0.25
Sadness	0.34	0.26	0.68	0.22	0.12	0.17	0.43	0.29
Disgust	0.32	0.24	0.11	0.15	0.22	0.26	0.09	0.16

Table 3
Results of ANOVAs on decoding accuracy as a function of emotion, participant age, actor age and their interactions.

	Factors	*df*	*F*	*p*	η_p^2
Accuracy (overall)	Emotion	3, 219	163.72	<.001	.69
	Emotion ∗ participant age	3, 219	5.24	.002	.07
	Emotion ∗ actor age	3, 219	39.14	<.001	.35
	Emotion ∗ actor age ∗ participant age	3, 219	1.58	.200	.02
	Participant age	1, 73	25.99	<.001	.26
	Actor age	1, 73	1.39	.243	.02
	Actor age ∗ participant age	1, 73	1.69	.198	.02
Happiness	Participant age	1, 73	12.38	.001	.15
	Actor age	1, 73	9.9	.002	.12
	Actor age ∗ participant age	1, 73	2.78	.100	.04
Anger	Participant age	1, 73	0.76	.387	.01
	Actor age	1, 73	0.07	.786	.00
	Actor age ∗ participant age	1, 73	1.65	.204	.02
Sadness	Participant age	1, 73	30.85	<.001	.30
	Actor age	1, 73	83.78	<.001	.53
	Actor age ∗ participant age	1, 73	0.39	.533	.01
Disgust	Participant age	1, 73	2.64	.108	.04
	Actor age	1, 73	32.51	<.001	.31
	Actor age ∗ participant age	1, 73	2.33	.131	.03

disgust expressions with anger. In fact, for younger participants a planned contrast for anger mimicry was significant ($p = .002$) for disgust expressions by older actors and marginally significant for disgust expressions by younger actors ($p = .057$), suggesting that they showed in fact an anger expression in response to disgust.

Cognitive empathy

As mentioned above, compared to younger adults, older adults were less accurate when decoding expressions of happiness and sadness. In contrast to previous findings, we did not find differences between younger and older adults for the decoding of anger and disgust (Calder et al., 2003; Ruffman et al., 2008; Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). In order to explain this, a few findings are worth mentioning. There is evidence for differences in anger attributions made by the two age groups: Younger adults tend to see more anger in non-angry faces compared to older adults (e.g., Bucks, Garner, Tarrant, Bradley, & Mogg, 2008; Phillips & Allen, 2004; Suzuki & Akiyama, 2013) and specifically attribute anger to disgust expressions (Du & Martinez, 2011; Ebner, He, & Johnson, 2011; Suzuki et al., 2007), which could explain younger adults' advantage for anger recognition and their disadvantage for disgust recognition in previous studies. Furthermore, we employed dynamic stimuli, which convey functionally distinct information inherent in the temporal properties of the facial expressions (Krumhuber & Kappas, 2005), and increase decoding accuracy (e.g., Bassili, 1979; Wehrle, Kaiser, Schmidt, & Scherer, 2000) compared to static displays. Thereby they might also reduce false attributions. In fact, our younger and older participants did not differ in their attributions of anger to other emotion expressions in general ($p = .342$) and to disgust expressions in particular ($p = .957$). At last, a recent study found that older adults' reduced decoding accuracy for happiness, sadness, surprise and fear was related to a general age-related cognitive decline, whereas decoding differences in anger and disgust could not be explained by cognitive decline (Suzuki & Akiyama, 2013). Taken together, it seems that our dynamic stimuli did not manage to cancel out age-related differences in happiness and sadness recognition, as these seem to be affected by a general cognitive decline; however we may assume that the dynamic stimuli reduced possible false anger attributions of younger adults, thus leading to no age-differences in anger and disgust recognition. Future research should directly examine anger attributions by younger and older adults in a study that employs both dynamic and static stimuli.

Limitations of the study

One limitation regarding our results is their basis on women only. It is not uncommon that facial mimicry results rely on female participants only (e.g. Hess & Blairy, 2001). There are a number of advantages to restrict facial EMG measurement to women only, which are related to characteristics of the skin and the absence of facial hair. Also, studies that have tested both younger male and female participant did not report gender differences in mimicry (e.g. Blairy, Herrera, & Hess, 1999; Rymarczyk et al., 2011). However, since there could be gender differences in older age, future research should ideally include older men.

Another concern is the relatively low hit rates, in particular for disgust expressions. This might seem peculiar as we used previously validated spontaneous stimuli (Fölster et al., submitted for publication). One likely explanation for the lower hit rates in this study is the response format used. The validation study employed a forced choice format, where raters were asked to focus on the principal emotion they detected in the 20 second long stimuli. In contrast, we used an emotion profile, where participants indicated for each of 6 emotions the intensity with which they had perceived this emotion. The use of such scalar ratings allowed a more differentiated judgment (Matsumoto, 2005). Hence, the participants in the present study were invited to focus the complexity of the stimuli rather than the one dominant emotion, which might have led to a complex rating with correspondingly lower hit rates.

Summary

The present study demonstrates that affective empathy to the emotional messages of the video clips was shown by both age groups for all expressions, apart from disgust, which was only mimicked by older participants. The affective reactions occurred even though decoding accuracy was in parts relatively low.

To our knowledge, ours is the first study to present a second by second analysis of facial muscle reactions toward natural facial expressions over a longer period of time. The explorative analysis of facial reactions over time revealed that both younger and older participants showed similar levels of continuous facial reactions, which were significant from second 2 onward. Although these data are impressive on a descriptive level, they raise the question for the cause of the facial reactions at later time frames. Do these reactions indicate continuous facial mimicry, a more general affect induction or possibly an interaction of facial mimicry reactions and affect induction? This question should be followed up in future research, as this would shed more light onto the phenomenon of emotion communication in ecologically more valid settings. Nonetheless, we believe that the facial reactions of younger and older adults are indicative of affective empathy, which is defined as a process where the perception of another's emotional state generates a matching reaction in the perceiver (e.g. De Waal, 2008). These reactions occurred quite quickly, no later than 2 s and continued throughout the video. Thus, as soon as the participants caught the message, they continuously reflected it back. Given the importance of emotional facial reactions for a smooth and harmonious interaction (Hess & Fischer, 2013; Hess et al., 1999; Yabar & Hess, 2007) our study suggests that older as well as younger individuals signal back the "gist" of the emotional interaction, which would be the more important aspect of emotional processing compared to the mere cognitive decoding of the expressions.

In sum, our results propose that empathic reactions and therefore social functioning might not be as affected by older age as findings based only on decoding accuracy may suggest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jesp.2013.09.011.

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