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Empathic accuracy: age differences from adolescence into middle adulthood

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ABSTRACT

This study investigated age differences in empathic accuracy, the ability to correctly perceive others' emotions, in a sample of 151 boys and men from three age groups: adolescents ($M_{\text{age}} = 16$ years, $SD = 1.04$), young adults ($M_{\text{age}} = 29$ years, $SD = 2.78$), and middle-aged adults ($M_{\text{age}} = 50$ years, $SD = 3.07$). All participants viewed nine newly developed film clips, each depicting a boy or a man reliving one of three emotions (anger, sadness, or happiness), while talking about an autobiographical memory. Adolescents and middle-aged men were less accurate than young men, and these age differences were associated with parallel age differences in fluid-mechanical abilities. In addition, age differences in vocabulary, one indicator of crystallized-pragmatic intelligence, were associated with age differences in empathic accuracy in adolescent and young, but not middle-aged, men. Within the limitations of cross-sectional data, this study provides evidence for the idea that empathic accuracy is an effortful task that requires cognitive resources and, thus, may show a normative increase until young adulthood followed by periods of stability and decline in subsequent decades.

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Given that empathic accuracy has been thought to be a key component of effective social functioning across the entire lifespan (Davis, 1994; Eisenberg, 2000; Hoffman, 2000), it is surprising that relatively little is known about how this ability develops beyond childhood and what factors hinder or promote age-related gains. A first objective of this study was to examine age differences in empathic accuracy from adolescence into middle adulthood via a performance-based measure that was developed for this age range. A second goal was to begin to understand the mechanisms that can explain age differences in empathic accuracy. To this end, we tested fluid-mechanical and pragmatic-crystallized abilities as correlates of individual and age-related differences in empathic accuracy.

The definition and assessment of empathic accuracy

In various definitions from different research fields, empathic accuracy has been defined as the ability to

correctly perceive others' emotions (Decety & Jackson, 2004; Ickes, 1997). This cognitive facet of empathy can be differentiated from more affective aspects such as emotional congruence (the degree to which one shares another's feelings) or compassion (the degree to which one feels sympathy for another person).

In questionnaires, participants are typically asked to report how often they take another's perspective and how successful their perspective-taking has been (Davis, 1994). To assess empathic accuracy via performance-based tests, the test taker is asked to observe a target who authentically experiences and expresses a relatively wide range of emotions and to subsequently rate the target's emotions in terms of their quality and intensity (Cohen & Strayer, 1996; Ickes, 1997; Levenson & Ruef, 1992). Empathic accuracy can then be determined by the degree of correspondence between the target's self-reported feelings and the test taker's other-reported feelings. Performance-based tests of empathic accuracy are similar to emotion recognition

tests in that the test taker is instructed to identify emotions. However, emotion recognition tests typically present only one discrete emotion in only one modality and the test taker selects the one correct emotion from a list of emotion terms (Isaacowitz et al., 2007). For two reasons, in this study, we used a performance-based method in the tradition of empathic accuracy research. First, although empathic accuracy questionnaires afford high reliability, they may be vulnerable to impression-formation biases and introspective limits. In fact, the low and sometimes nonsignificant correlations between self-report and performance-based methods have been attributed to the limited validity of global self-report measures (Ickes, 2001). Second, given that emotion recognition tasks present emotions decontextualised and departmentalised, they may not capture many of the processes that are critical for real-world empathic accuracy. Empathic accuracy tasks that present emotional information in multiple modalities, dynamically, and contextualised, may better match real-life emotion recognition than emotion recognition tasks (Sze, Goodkind, Gyurak, & Levenson, 2012). An additional benefit of empathic accuracy tasks is that they typically are more difficult and, thus, less subject to ceiling effects than traditional emotion recognition tasks (Isaacowitz & Stanley, 2011).

Age differences in empathic accuracy: past evidence

Studies that have investigated age differences in empathic accuracy from adolescence into young adulthood were all based on self-report questionnaires. The studies, that analyzed affective and cognitive aspects of empathy separately, consistently suggest a normative increase in self-reported empathic accuracy during adolescence and from adolescence into young adulthood (Davis & Franzoi, 1991; Eisenberg, Cumberland, Guthrie, Murphy, & Shepard, 2005; Hawk et al., 2013).

A somewhat greater number of studies have investigated age differences in empathy within adulthood. These studies have used either self-report measures or emotion recognition tasks. As to self-report studies, however, one-dimensional measures that do not allow separate analyses of the affective and the cognitive aspects of empathy have been utilised. This work suggests either normative decline (Grühn, Rebucal, Diehl, Lumley, & Labouvie-Vief, 2008; Helson, Jones, & Kwan, 2002; Schieman & Van Gundy, 2000) or stability (Diehl, Coyle, & Labouvie-Vief, 1996; Eysenck,

Pearson, Easting, & Allsopp, 1985) in overall empathy during young and middle adulthood. Given that one-dimensional measures of empathy include but are not limited to items assessing the cognitive facets of empathy, it is impossible to draw firm conclusions as to whether empathic accuracy declines, remains stable, or increases with age.

The majority of past age-comparative studies interested in the cognitive facet of empathy have used traditional emotion recognition tasks. This work suggests that, across tasks and emotions, emotion recognition linearly declines across age groups (e.g. Ruffman, Henry, Livingstone, & Phillips, 2008). Studies that have included middle-aged adults further suggest that age deficits are already evident in middle adulthood (Demenescu, Mathiak, & Mathiak, 2014; Mill, Allik, Realo, & Valk, 2009). Negative age differences were also reported in work using more context-rich empathic accuracy tasks (Richter, Dietzel, & Kunzmann, 2010). It is only if empathic accuracy tasks are designed to match older adults' interests and experience that such negative age differences are eliminated (Richter & Kunzmann, 2011; Sze et al., 2012; Wieck & Kunzmann, 2015; for convergent evidence from emotion recognition work see Stanley & Isaacowitz, 2015).

First research goal and set of predictions

A first goal of this study was to investigate age differences in empathic accuracy within a sample of adolescents, young adults, and middle-aged adults. To minimize biases related to introspective limits and impression management, we used a performance-based rather than self-report measure. To enhance external validity, our paradigm was in the tradition of empathic accuracy approaches and, thus, covered tasks that present emotions on multiple modalities, dynamically, and contextually embedded. To enhance age-fairness, our paradigm consisted of a similar number of protagonists from each of the three participant age groups. To be able to generalise across emotions and to not only study negative emotions, we developed tasks that focused on one of the three most often studied emotions in past work, that is, anger, sadness, or happiness.

Notably, the majority of past age-comparative studies did not use performance-based context-rich and dynamic tests of empathic accuracy, but rather context-poor and often static single-modality emotion recognition tests or self-report measures. Although it is possible that different types of measures will yield different results regarding age trajectories in

empathic accuracy, given the lack of consistent prior evidence or theoretical ideas motivating such measure-differential predictions, we formulated a prediction that is consistent with the majority of past findings reviewed above. More specifically, age differences in empathic accuracy should be curvilinear with greater empathic accuracy in young adults than in both adolescents and middle-aged adults.

Age differences in empathic accuracy: the role of intellectual functioning

Given that individuals, who attempt to accurately perceive another's emotions, are typically faced with multiple, short-lived, and often conflicting emotion-relevant cues (e.g. facial expressions, voice tone, and verbal content), it is easy to see how high levels of intellectual functioning could contribute. More specifically, two types of intelligence, the biology-based cognitive mechanics (comparable to fluid intelligence) and the culture- and experience-based cognitive pragmatics (comparable to crystallized intelligence) should facilitate empathic accuracy. At the core of the cognitive mechanics is the capacity to process incoming information of any kind fast and accurately, to think logically, and solve problems in novel situations (Baltes, Lindenberger, & Staudinger, 2006). Thus, fluid-mechanical abilities such as processing speed or logical reasoning should facilitate empathic accuracy by helping the individual to discriminate, compare, categorise, and integrate emotion-relevant cues so as to make adequate inferences and form accurate judgments about another's feelings.

It is also easy to see the advantages for empathic accuracy of crystallized-pragmatic abilities. Individuals who have available experience- and knowledge-related abilities may better understand the causes and implications of emotional situations such as the death of loved ones, financial hardships, or serious interpersonal conflicts; they may have a sense of how they would feel and a general understanding of how most people would feel in such situations; and they may know how people regulate and express their feelings. Thus, crystallized-pragmatic abilities should facilitate an understanding of emotion-arousing situations and how they cause particular emotions in particular individuals.

Empirical evidence for an association between cognitive abilities and empathic accuracy is relatively sparse. To begin, Davis and Kraus (1997) analyzed the findings from studies conducted between 1950

and 1994 and examined 21 effects reflecting the association between a measure of intellectual functioning and a measure of accuracy (78% of the latter measures tapped accuracy at judging emotions). The authors interpreted the mean effect size of .23 as suggesting that intelligence contributes in a reliable and modest fashion to empathic accuracy. Given that type of cognitive ability was not analyzed as a moderator of the effect size, the relative contribution of specific cognitive abilities could not be determined. There is also relevant evidence for a positive link between fluid cognitive abilities and emotion recognition (Bailey & Henry, 2008; Sullivan & Ruffman, 2004a). Notably, however, past studies using emotion recognition tasks have provided somewhat mixed evidence with more than one study suggesting no significant relationship between cognition and emotion recognition (e.g. Ruffman et al., 2008). Many factors may be responsible for these inconsistencies, including the relatively low difficulty level of emotion recognition tasks, potentially masking the effects of cognitive functioning.

Age and cognition

Consistent with the idea that fluid-mechanical abilities are largely biology-based (e.g. Baltes et al., 2006), they have been shown to increase during adolescence, peak in young adulthood, and begin to decline as early as in the second or third decade of life (Salt-house, 2000; Schaie, 2005). Cattell's investment theory proposes that, given their biological basis, fluid-mechanical abilities develop earlier than pragmatic-crystallized abilities and are being "invested" into the acquisition of the latter (Cattell, 1987). Further, fluid-mechanical abilities should decline earlier than crystallized-pragmatic abilities, but this decline should only compromise the functioning of crystallized-pragmatic abilities in old and very old age when it exceeds a certain functional threshold (e.g. Hertzog, Kramer, Wilson, & Lindenberger, 2009). In fact, many aging researchers had hoped for maintenance of crystallized-pragmatic abilities well into old and very old age (e.g. Baltes, 1987). The evidence is equivocal, however. Although both the peak of performance and the age at which significant average decline is first noted occurs later for crystallized-pragmatic abilities than for fluid-mechanical abilities, depending on the particular ability that is being considered, age-related deficits in crystallized-pragmatic abilities can occur as early as in late middle adulthood (Schaie, 2005).

Cognitive functioning as a mediator of the effects of age on empathic accuracy

Only few studies to date have investigated the idea that age differences in cognitive abilities are associated with age differences in empathic accuracy. These studies are limited in that they are based on samples of young and older adults (i.e. they omitted adolescents and middle-aged adults), focused on selected fluid-mechanical abilities (i.e. they did not include crystallized-pragmatic cognitive abilities), and used emotion recognition tasks that are typically designed so as to reduce cognitive demand, making the identification of reliable correlates of individual and age-related differences in emotion recognition difficult.

Given these limitations, it does not come as a surprise that past relevant evidence is mixed at best. Some studies have found age differences in emotion recognition to be reduced (e.g. Sullivan & Ruffman, 2004b) or nonsignificant (e.g. Bailey & Henry, 2008) after statistical control of age differences in fluid abilities. However, other studies using emotion recognition tasks did not find such effects (Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; Sullivan & Ruffman, 2004a). Notably, however, in two studies that both assessed empathic accuracy via relatively complex and difficult film-based tasks, older adults' deficits in empathic accuracy were significantly reduced after statistical control of two indicators of fluid intelligence, namely, logical reasoning (Richter et al., 2010) and processing speed (Wieck & Kunzmann, 2015). Although this evidence is promising, two limitations are that the authors did not test the role of crystallized-pragmatic abilities in empathic accuracy and only compared young and older adults. Thus, there is a need for future studies testing the effects of different types of cognitive abilities in studies with samples that cover the transition from adolescence into adulthood.

Second research goal and set of predictions

Proceeding from the idea that empathic accuracy tasks require both fluid-mechanical and crystallized-pragmatic abilities, we predicted positive associations between both types of cognitive abilities and empathic accuracy. Further, given that fluid-mechanical and crystallized-pragmatic abilities should increase during adolescence, peak in young adulthood, and begin to decrease during young adulthood (fluid-mechanical abilities) or late middle adulthood (crystallized-pragmatic abilities), we tested the idea that age differences in cognitive functions are linked to age differences in

empathic accuracy. Put differently, we tested for indirect effects of age on empathic accuracy through fluid-mechanical and crystallized-pragmatic cognitive abilities.

Method

Participants

The sample comprised 151 male participants (age range: 14–55 years).¹ All participants were Caucasian and German native speakers. The 50 adolescents (14–17 years, $M = 15.78$, $SD = 1.04$) were pupils from schools in and around Leipzig. Schools were contacted in written form and asked to announce the study among their pupils. Prior to the participation, informed consent from the parents was required. The 51 young (25–35 years, $M = 29.35$, $SD = 2.78$) and 50 middle-aged (45–55 years, $M = 50.42$, $SD = 3.07$) men were recruited via newspapers and notices/flyers that were given out in public places and sent to local firms and facilities.

Age differences were found in partnership status, $\chi^2(4, N = 149) = 31.12$, $p < .001$. As to be expected, young (53%) and middle-aged men (62%) were more likely to be in a stable partnership than adolescents (29%), who were more likely to be single (71%) than young (45%) and middle-aged men (22%). Additionally, age differences were observed in educational level as indicated by the highest academic degree, $\chi^2(4, N = 151) = 126.26$, $p < .001$. The vast majority of adolescents (90%) had not achieved a degree yet, whereas approximately one third of the young (37%) and the middle-aged men (42%) had a university degree.²

The age groups neither differed in positive affect, $F(2,148) = .13$, $p = .88$, nor in negative affect, $F(2,148) = 1.13$, $p = .33$ (positive affect: adolescents, $M = 3.62$, $SD = .51$; young adults, $M = 3.58$, $SD = .62$; middle-aged adults, $M = 3.64$, $SD = .68$; negative affect: adolescents, $M = 2.88$, $SD = .70$; young adults, $M = 2.76$, $SD = .68$; middle-aged adults, $M = 2.67$, $SD = .72$). Positive and negative affect during the past six months was assessed using the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988). The response scale ranged from 1 (*never*) to 4 (*very often*).

Film stimuli

Development

To assess empathic accuracy in the three age groups *in vivo* and under standardised laboratory conditions, we developed new tasks consisting of nine films that were recorded in our laboratory at the University of

Leipzig. The films were created using a procedure developed in past research (Richter & Kunzmann, 2011; Wieck & Kunzmann, 2015). More specifically, in individual sessions, the protagonists were asked to recall a situation during which they experienced one of the following three emotions: anger, sadness, or happiness. In a semi-structured interview, protagonists were encouraged to remember details, circumstances, and the respective feelings. After a 60-s resting period, participants were instructed to relive the target emotion for 10 s and to then describe the corresponding emotion-evoking situation, while being videotaped. Subsequently, the protagonists rated the emotions they had felt while they were being videotaped on a list of 20 emotional adjectives: angry, upset, mad, sad, downhearted, distressed, happy, glad, content, afraid, worried, scared, proud, relieved, hostile, frustrated, contemptuous, disappointed, ashamed, guilty (response scale ranged from 0 “not at all” to 6 “extremely”).

Given that our newly recorded videos varied in duration among our protagonists, members of our team cut the original videotapes so as to ensure that each clip (a) had a length of one minute, (b) was representative of the original video, and (c) did not entail any direct reference to the target emotion. The protagonists returned to our laboratory a few days later to view the edited versions of their video clip and rated the emotions they had felt during the one-minute phases on the list of 20 emotional adjectives described above. These ratings did not substantially differ from the initial ratings pertaining to the original version of the video.

Validation

Using the validation procedure developed in our past research (Richter & Kunzmann, 2011; Wieck & Kunzmann, 2015), we selected nine film clips of nine

Table 1. Target emotion and reported film topics by protagonists.

Protagonist's age	Target emotion	Film topic
Adolescents	Anger	Being treated unfairly during a football match
	Sadness	Receiving a bad grade in school
	Happiness	Kissing with an acquaintance during a concert
Young	Anger	Disputing with girlfriend
	Sadness	Separating from long-time girlfriend
	Happiness	Receiving the request to be the godfather of best friends' newborn
Middle-aged	Anger	Witnessing the inappropriate behavior of the state parliament candidate
	Sadness	Death and dying of best friend due to cancer
	Happiness	Receiving a ceremonial promotion

Table 2. Protagonists' emotional reactions separated by age group.

System	Target emotion					
	Anger		Sadness		Happiness	
Self-report	4.33	(0.58)	4.67	(1.53)	4.33	(1.53)
Facial	3.33	(0.76)	4.76	(0.29)	4.50	(1.32)
Vocal	3.33	(0.58)	4.33	(0.58)	3.83	(1.04)

Note: Means and standard deviations in brackets. The response scales for each emotional reaction system ranged from 0 = “not at all” to 6 = “extremely”.

different protagonists, differing in age (adolescents, young adults, middle-aged adults) and target emotion (anger, sadness, happiness; Table 1 depicts the nine film topics).³

In all nine clips, protagonists clearly experienced and nonverbally expressed the designated target emotion as the analysis of the protagonists' self-reported emotions and the coding of the videotapes revealed. To this end, two independent young student raters coded the presence and intensity of five emotions (fear, anger, sadness, disgust, happiness) via a coding manual for the description of discrete emotions in facial and vocal expressions (Richter & Kunzmann, 2011; Wieck & Kunzmann, 2015). Correspondence between the raters, indicating categorical agreement on whether or not the target emotion was dominant on a film-by-film basis was $\kappa = .70$ for the facial ratings and $\kappa = .91$ for the vocal ratings.

As seen in Tables 2 and 3, The intensity of the self-reported target emotions was comparable across the three age groups and the three target emotions (all F 's < 1). There were no age differences in the intensity of behavioural expressions of the target emotions (although, on a descriptive level, middle-aged protagonists' facial and vocal expressivity was somewhat lower). Finally, the intensity of behavioural expressions was comparable for sadness and happiness and somewhat lower for anger. The protagonists' age groups (adolescents, $M = 17$, $SD = 1.53$; young adults, $M = 29$, $SD = 6.08$; middle-aged adults, $M = 45$, $SD = 3.61$) roughly corresponded with those of the participants.

Table 3. Protagonists' emotional reactions separated by target emotion.

System	Age group of protagonists					
	Adolescence		Young adulthood		Middle adulthood	
Self-report	3.89	(1.84)	4.56	(0.51)	4.11	(0.84)
Facial	4.33	(0.76)	4.50	(0.50)	3.50	(1.32)
Vocal	4.00	(1.00)	3.83	(0.29)	3.67	(1.15)

Note: Means and standard deviations in brackets. The response scales for each emotional reaction system ranged from 0 = “not at all” to 6 = “extremely”.

Measures

Empathic accuracy

After each film clip, participants were asked to rate the intensity of the protagonist's emotions using the emotional adjective list that the protagonists also completed (see above). As a measure of empathic accuracy, "consistency" Intraclass-Correlations between the protagonists' self-reported emotions and the participants' other-reported emotions for the 20 adjectives were calculated. For all statistical analyses, Intraclass-Correlation coefficients were r to Z transformed to be normally distributed (Fisher, 1956). However, to facilitate interpretation, the findings are presented as correlation coefficients.

Cognitive measures

This study included two prominent measures of fluid-mechanical intelligence. A first, speed, was assessed via the *Zahlen-Verbindungstest* (ZVT; Oswald & Roth, 1987), in which the numbers 1–90 are presented in pseudo-randomized order. Participants are asked to connect the numbers in the correct order as fast as possible within 30 s. Speed is represented by the number of processed digits per second ranging in the present sample from 1.06 to 3.92 ($M = 2.54$, $SD = .51$).

A second fluid-mechanical indicator was logical reasoning, assessed by 16 items of the Advanced Progressive Matrices (APM; Raven, 1971). The number of correct answers served as indicator of logical reasoning ($M = 8$, $SD = 3.84$, range: 0 to 16). As expected, speed and logical reasoning showed a moderate positive correlation ($r = .49$, $p < .001$). Given that our hypotheses were not ability-specific, both values were z -standardized and aggregated to build a composite score indicating fluid-mechanical intelligence.

As a measure of crystallized-pragmatic intelligence, this study assessed verbal ability via the *Wortschatztest* (WST, Schmidt & Metzler, 1992). In this test, 37 rows, each consisting of six words, were presented. In each row one target word has to be identified among five pseudo-words. Verbal ability ranged from 10 to 36 ($M = 26.87$, $SD = 5.12$) correct responses.

Procedure

Participants were tested in two 2-hr group-sessions. The groups were predominantly age-homogeneous and ranged in size between two to ten persons. In the first session, participants completed the film task. The nine clips were presented in randomised order

on a computer screen and after each film, participants rated the protagonists' emotions. In a second session, participants completed the three cognitive tests as well as additional questionnaires that were not part of the present study.

Results

Our prediction-relevant analysis involved a repeated-measures analysis of variance (ANOVA). Participants' age group served as a between-subject factor (adolescent vs. young vs. middle-aged) and emotional quality of the film (anger vs. sadness vs. happiness) served as a within-subject factor. Empathic accuracy scores were used as dependent variables. F values were computed on the basis of Wilks's lambda. For the significant effects, partial eta squares, representing the portion of explained variance, are reported. All pairwise comparisons were Bonferroni corrected to avoid family wise errors.

Hierarchical multiple regression analyses were conducted to analyze the effects of age on cognition, and the effects of cognition on empathic accuracy. Although we are aware of the problem that we did not have data from individuals falling outside of this study's three age groups, age was used as a continuous rather than categorical variable. To estimate the size and nature of the effects, standardised (β) regression-coefficients as well as R^2 were calculated. Given that the effects of age on empathic accuracy and cognition were nonlinear, to test the indirect effect of age on empathic accuracy through cognition, the bootstrapping approach *Medcurve* (Hayes & Preacher, 2010) was used.⁴

Preliminary analyses

Psychometric characteristics of the empathic accuracy measure

Prior to the prediction-relevant analyses, we tested the psychometric qualities of our newly developed empathic accuracy measure. Cronbach's alpha across the nine film-based tasks was satisfactory ($\alpha = .73$), suggesting that empathic accuracy represents an ability that is consistent across different targets. Further, we computed three mean values, representing empathic accuracy during anger, sadness, and happiness films respectively. Considering that, for each mean value, only three accuracy scores were aggregated, Cronbach's alphas were satisfactory and comparable to other studies using similar aggregate-measures

Table 4. Descriptive statistics of the film-based empathic accuracy scores.

Film	Empathic accuracy			
	<i>M</i>	<i>SD</i>	Min	Max
<i>Anger</i>				
Adolescence	0.58	0.30	−0.33	0.86
Young adulthood	0.62	0.23	−0.46	0.83
Middle adulthood	0.46	0.31	−0.29	0.83
<i>Sadness</i>				
Adolescence	0.56	0.21	−0.24	0.83
Young adulthood	0.65	0.34	−0.32	0.93
Middle adulthood	0.55	0.24	−0.28	0.94
<i>Happiness</i>				
Adolescence	0.91	0.49	−0.35	0.99
Young adulthood	0.82	0.28	0.00	0.97
Middle adulthood	0.75	0.24	−0.02	0.95

($\alpha_{\text{anger films}} = .65$; $\alpha_{\text{sadness films}} = .56$; $\alpha_{\text{happiness films}} = .64$; e.g. Richter & Kunzmann, 2011). As seen in Table 4, all Intraclass-Correlations for empathic accuracy were positive and of moderate size, suggesting that it was possible to identify the protagonists' emotional profile, although there were sizable interindividual differences (for similar evidence see Cohen & Strayer, 1996; Richter & Kunzmann, 2011).

Age differences in the familiarity with the film topics

After each film, the participants completed a single item asking for the degree of familiarity with the film topic (response scale ranged from 0 "not at all" to 6 "extremely"). A repeated-measures analysis of variance (ANOVA) with age of participants as a between-subject factor (adolescent vs. young adults vs. middle-aged) as well as age of protagonist (adolescent vs. young adult vs. middle-aged) and emotional quality of the film (anger vs. sadness vs. happiness) as within-subject factors revealed significant main effects of age

of participant, age of protagonist, and emotion. All possible two-way interaction effects were also significant, but qualified by a three-way interaction among age of participants, age of protagonist, and emotion, $F(8,592) = 4.03$, $p < .01$, $\eta_p^2 = .10$ (see Online Supplementary Material, Tables 1–3 for test statistics pertaining to the main and two-way interaction effects).

Follow-up analyses of the significant three-way interaction effect revealed significant two-way interaction effects between age of participant and age of protagonist in all three emotional tasks (anger: $F(8,296) = 10.34$, $p < .01$, $\eta_p^2 = .10$, sadness: $F(8,292) = 8.46$, $p < .01$, $\eta_p^2 = .10$, happiness: $F(8,292) = 8.81$, $p < .01$, $\eta_p^2 = .06$). Further film-specific follow-up analyses, depicted in Table 5, suggested that participants rated the topics of protagonists of their own age in five out of nine films as being particularly familiar. Given the age-specific greater familiarity with at least some topics, we analyzed the variable "familiarity" in all prediction-relevant analyses as a covariate. These analyses revealed the same pattern of findings as the familiarity-uncontrolled analyses reported below.

Age differences in empathic accuracy

Results of the 3×3 ANOVA revealed main effects of emotion, $F(1.7, 252.1) = 547.44$, $p < .01$, $\eta_p^2 = .79$, and age group, $F(2,148) = 4.35$, $p = .02$, $\eta_p^2 = .06$. The two-way interaction effect between emotion and age group was nonsignificant, $F(2,148) = .21$, $p = .93$. Consistent with past work (Ruffman et al., 2008), our follow-up analyses of the significant effect of emotion indicated that empathic accuracy was higher when happiness was the dominant emotion than when anger or sadness were the dominant

Table 5. Age differences in familiarity with age-specific film topics.

Protagonist's age	Age of participant			Sig. of contrast ^a
	Adolescent	Young	Middle-aged	
<i>Sadness films</i>				
Adolescent	3.92 (1.55)	4.33 (1.48)	2.82 (1.85)	<i>p</i> = .23
Young	3.90 (1.87)	4.37 (1.40)	3.72 (1.83)	<i>p</i> = .06
Middle-aged	3.32 (2.13)	4.28 (1.76)	4.62 (1.59)	<i>p</i> = .05
<i>Anger films</i>				
Adolescent	3.90 (1.98)	2.90 (1.83)	3.64 (1.82)	<i>p</i> = .05
Young	3.16 (1.85)	4.02 (1.33)	3.32 (1.81)	<i>p</i> = .00
Middle-aged	1.68 (1.52)	1.77 (1.39)	2.88 (1.83)	<i>p</i> = .00
<i>Happiness films</i>				
Adolescent	3.78 (1.99)	4.78 (1.32)	4.30 (1.43)	<i>p</i> = .00
Young	1.90 (1.88)	2.94 (1.58)	3.78 (1.87)	<i>p</i> = .74
Middle-aged	2.16 (1.68)	3.49 (1.62)	3.84 (1.87)	<i>p</i> = .00

Note: Means and standard deviations in brackets.

^aContrasts with the participants' age group that matched the protagonist's age group as the reference variable.

emotions (anger vs. happiness, $t(150) = -26.06$, $p < .001$; sadness vs. happiness, $t(150) = -26.67$, $p < .001$). The difference in empathic accuracy in anger films vs. sadness films was smaller but also significant (anger vs. sadness, $t(150) = -3.52$, $p = .001$).

As follow-up tests of the main effect of age, we specified three contrasts. In a first contrast, adolescents were compared with young adults. In a second contrast, we ignored adolescents and compared young and middle-aged adults. Finally, in a third contrast, young adults were ignored, and we compared adolescents' and middle-aged adults' empathic accuracy. As expected, the first, $t(148) = 3.23$, $p = .002$, and the second contrast became significant, $t(148) = 2.25$, $p = .01$, suggesting that young adults' empathic accuracy ($M = .71$, $SD = .07$) was significantly higher than adolescents' ($M = .66$, $SD = .11$) and middle-aged adults' ($M = .67$, $SD = .08$). The third contrast was nonsignificant, $t(148) = .67$, $p = .50$, suggesting that adolescents and middle-aged adults did not significantly differ in empathic accuracy.⁵

A hierarchical multiple regression analysis with linear age (step one) and age squared (step two) as two independent variables was computed to further test our prediction about the curvilinear effect of age on empathic accuracy. The linear effect of age on empathic accuracy was not significant, $R^2 = .00$, $F(1,150) = .06$, $p = .81$, however, as predicted, age squared significantly accounted for variance in empathic accuracy, $\Delta R^2 = .06$, $F(1,149) = 8.72$, $p = .004$. The significant negative quadratic effect, $\beta = -.25$, $t(149) = -2.95$, $p = .004$, displayed in Figure 1, suggests a small positive trend in empathic

accuracy in adolescence and a small negative trend in empathic accuracy in middle adulthood.

Mediation analyses

To establish a mediational model, in a sequence of regression analyses, we first analyzed age as predictor of each mediator and each mediator as a predictor of empathic accuracy. For all predictors, linear and quadratic effects were tested.

Preliminary analyses

A first hierarchical multiple regression analysis of fluid-mechanical intelligence revealed a significant negative linear effect of age, $R^2 = .16$, $F(1,149) = 28.64$, $\beta = -.40$, $t(149) = -5.35$, $p < .001$, as well as a significant negative quadratic effect of age, $\Delta R^2 = .16$, $F(1,148) = 34.85$, $\beta = -.42$, $t(149) = -5.90$, $p < .001$. Two follow-up regression analyses revealed a significant positive effect of age on fluid-mechanical intelligence in adolescents and young adults, $R^2 = .08$, $F(1,100) = 8.18$, $\beta = .28$, $t(100) = 2.86$, $p = .005$, and a significant negative effect of age on fluid-mechanical intelligence in young and middle-aged adults, $R^2 = .42$, $F(1,100) = 71.69$, $\beta = -.65$, $t(100) = -8.47$, $p < .001$ (see Figure 2).

A second hierarchical multiple regression analysis of vocabulary revealed a significant and positive linear effect of age, $R^2 = .40$, $F(1,149) = 99.90$, $\beta = .63$, $t(149) = 9.99$, $p < .001$, as well as a significant negative curvilinear effect of age, $\Delta R^2 = .12$, $F(1,148) = 35.02$, $\beta = -.36$, $t(148) = -5.92$, $p < .001$. Two follow-up regression analyses revealed a significant positive effect of age on vocabulary in adolescents and young

Figure 1. The association between age and empathic accuracy. Tests statistics are reported in the main text.

Figure 2. The association between age and fluid-mechanical cognitive ability (speed and logical reasoning) and empathic accuracy. Tests statistics are reported in the main text.

Figure 3. The association between age and vocabulary (an indicator of crystallized-pragmatic intelligence) and empathic accuracy. Tests statistics are reported in the main text.

adults, $R^2 = .46$, $F(1,100) = 85.48$, $\beta = .68$, $t(100) = 9.25$, $p < .001$, whereas the effect of age on vocabulary was nonsignificant in young and middle-aged adults, $R^2 = .04$, $F(1,100) = 2.71$, $\beta = .11$, $t(100) = 1.65$, $p > .05$ (see Figure 3).

Two separate regression analyses testing the mediators as predictors of empathic accuracy revealed significant and positive linear effects of both fluid-mechanical abilities and vocabulary on empathic accuracy (fluid-mechanical abilities, $R^2 = .07$, $F(1,149) = 11.14$, $\beta = .26$, $t(149) = 3.34$, $p = .001$; vocabulary, $R^2 = .08$, $F(1, 149) = 13.65$, $\beta = .29$, $t(149) = 3.65$, $p < .001$). For neither of the mediators a quadratic effect was found.

Main analyses

Given that there was evidence for curvilinear effects of age on empathic accuracy, fluid-mechanical intelligence, and vocabulary in our hierarchical multiple regression analyses, we used *Medcurve* to estimate the indirect effect of age on empathic accuracy through the cognitive mediators. In contrast to traditional approaches, *Medcurve* allows for testing mediations when the paths between the variables are nonlinear by providing estimates for the indirect effect (θ) of the predictor on the dependent variable through the mediator on low, moderate, and high values of the predictor.

As predicted, after the inclusion of fluid-mechanical intelligence, the indirect effect of age on empathic accuracy was significant, indicating that fluid-mechanical intelligence was a significant mediator of the effect of age on empathic accuracy in adolescents

($\theta_x = 17.37 = .002$, 95% CI = .001 to .005), young ($\theta_x = 31.83 = -.001$, 95% CI = $-.002$ to $-.000$), and middle-aged adults ($\theta_x = 46.30 = -.004$, 95% CI = $-.004$ to $-.001$). More specifically, in adolescents, the indirect effect of age on empathic accuracy was positive, suggesting that an increase in age would lead to an increase in empathic accuracy through its positive age effect on fluid-mechanical intelligence. In young and particularly in middle-aged adults, however, the indirect effect of age on empathic accuracy was negative, suggesting that an increase in age would lead to a decrease in empathic accuracy through its negative age effect on fluid-mechanical intelligence.⁶

Vocabulary also served as a significant mediator of the effects of age group on empathic accuracy in adolescents ($\theta_x = 17.37 = .007$, 95% CI = .003 to .012) and young adults ($\theta_x = 31.83 = .003$, 95% CI = .002 to .006), however, vocabulary was no significant mediator in middle-aged adults ($\theta_x = 46.30 = -.001$, 95% CI = $-.002$ to .001). For adolescents and, to a lesser degree, for young adults, the indirect effect of age on empathic accuracy was positive, suggesting that positive age differences in vocabulary were associated with positive age differences in empathic accuracy.

Discussion

The primary goal of this study was to investigate age differences in empathic accuracy using a newly developed test that closely resembles how emotions are perceived in the real world. Given that doubts have been raised as to whether empathic accuracy can be conceptualised as a general ability (e.g. Ickes, 2001), a first important finding of this study was that our new test showed high internal consistency across the specific tasks. It is only because empathic accuracy can be conceptualised as a domain-general ability that questions such as “what makes a ‘good’ vs. ‘poor’ perceiver?” can be addressed. It also deserves note that the present empathic accuracy test’s difficulty level was moderate and individual differences in performance-levels were sufficiently large, circumventing concerns about ceiling or floor effects that make the interpretation of age differences difficult and potentially hinder the identification of reliable correlates of empathic accuracy.

As expected, the effects of age on empathic accuracy were curvilinear, suggesting that young adults were more accurate than both adolescents and middle-aged adults. Although these age differences were small, they were consistent with our theoretical idea that empathic accuracy increases from

adolescence into young adulthood and then begins to show an age-related decline. Past work, focusing on either adolescence (Eisenberg et al., 2005) or adulthood (Isaacowitz et al., 2007) provided consistent findings. It deserves note, however, that this is the first study to assess empathic accuracy in a sample of adolescents, young, and middle-aged adults on the basis of a context-rich and age-fair film-based test.

Middle-aged adults' deficits in empathic accuracy found in this study may be surprising in view of work, suggesting that many social and emotional competencies improve well into old age (Carstensen, Isaacowitz, & Charles, 1999). However, our findings fit well with those of studies demonstrating negative age differences in social judgments and decision making (Hess & Smith, 2014). As discussed in social cognition research, social judgments, including inferences about other people's feelings and thoughts, are likely to be influenced by basic cognitive mechanisms (Fiske & Taylor, 2013), and these same cognitive mechanisms vary with age. Consistent with this idea as well as past studies interested in the cognitive underpinnings of empathic accuracy (Davis & Kraus, 1997), in the present study, individual and age-related differences in fluid-mechanical intelligence correlated positively with individual and age-related differences in empathic accuracy.

This and past evidence for positive effects of age on empathic accuracy in adolescence (e.g. Eisenberg et al., 2005) fit well with past work suggesting improvement in related social cognitive skills, including theory of mind and perspective taking (e.g. Steinberg, 2005). Our findings are also consistent with the idea that, during adolescence, individuals show marked improvement in fluid cognitive abilities (Schaie, 2005) and executive functions (Diamond, 2013). Further, our findings suggest that age-related gains in fluid cognitive abilities and empathic accuracy are positively associated.⁷

Extending past work, this study provided evidence for the idea that not only fluid-mechanical but also crystallized-pragmatic abilities predict individual and age-related differences in empathic accuracy. One qualification deserves note, however. The association between age and vocabulary was nonsignificant when analyzing middle-aged adults, suggesting that vocabulary remains stable and does not mediate the effects of age on empathic accuracy in this period of the lifespan. The finding of stable levels of vocabulary during middle adulthood is consistent with studies, focusing on so-called normative knowledge-based abilities that individuals acquire through their early socialisation (e.g.

Schaie, 2005). Notably, however, the evidence for age differences in other more idiosyncratic pragmatic cognitive abilities has been more mixed; for example, several past studies suggested that abilities related to knowledge about difficult life problems, the self, and emotions do already decline during middle adulthood (Labouvie-Vief, 2003; Thomas & Kunzmann, 2013). Several explanations for these unexpected early age deficits have been discussed, one suggesting that earlier theories may have underestimated the role of age-sensitive fluid-mechanical abilities in the maintenance of crystallized-pragmatic abilities (Schaie, 1989). Other explanations have focused on non-cognitive developmental changes that may also compromise the further development and maintenance of certain crystallized-pragmatic abilities, for example, openness to new experiences begins to decline relatively early in midlife (Mickler & Staudinger, 2008).

Given that pragmatic knowledge about real-life situations, the self, and emotions (e.g. their causes, dynamic, and consequences) may be important predictors of empathic accuracy, future research that supplements this study's focus on normative crystallized abilities is needed. Additionally, it would be desirable to investigate samples that cover old and very old age to address the question of whether age-related decline in crystallized-pragmatic abilities will be associated with decline in empathic accuracy more comprehensively. Ideally, given the limitations of cross-sectional studies, this future work would be based on longitudinal designs suited to assess within-person intraindividual change.

It is also important to mention, that the effects of age and cognitive functioning on empathic accuracy were small and that there were large individual differences in empathic accuracy within each of the three age groups. It is clear that empathic accuracy is not reducible to fluid or crystallized intelligence and age differences in empathic accuracy are not simply a function of age differences in cognitive abilities. Thus, an important question concerns how cognitive abilities interact with other person- and context-related factors in determining individual and age-related differences in empathic accuracy.

For example, a full account of the ways in which the cognitive changes of adolescence affect empathic accuracy must examine adolescents' interests and motives that may mature at different rates than their cognitive abilities (e.g. Steinberg, 2005). According to Erikson (1968), an important developmental task in adolescence is identity formation that involves the

development of independence from others and a strong sense of the self. This self-focus may limit adolescents' willingness to allocate their developing cognitive resources into understanding other people's emotions. Further, empathic accuracy arguably requires emotion regulatory abilities, particularly the ability to down-regulate own negative emotions that potentially limit the ability to correctly interfere another's emotions (Eisenberg, 2000). Thus, a comprehensive understanding of the mechanisms that underlie age-related change in empathic accuracy during adolescence requires consideration of how developing cognitive, motivational, and emotional characteristics interact and together influence empathic accuracy.

The same may apply to adulthood and old age. For example, there is evidence for the idea that, in old age, high motivational engagement can compensate for losses in cognitive resources. More specifically, if empathic accuracy tasks are particularly relevant to older adults' interests and experience, age-related deficits in empathic accuracy do not occur and fluid cognitive abilities lose their power in predicting older adults' empathic accuracy (Wieck & Kunzmann, 2015). Thus, future lifespan research is needed that will test theoretically derived hypotheses about the interactive effects of age-related changes in cognitive, motivational, and emotional characteristics on empathic accuracy at different age periods.

Limitations and outlook

A first limitation of the present study is our focus on male protagonists and participants. This decision was made for pragmatic reasons and because past studies that used performance-based tests do not speak for systematic gender differences in empathic accuracy (Isaacowitz et al., 2007; Sze et al., 2012). However, we identified only two cross-sectional studies that analyzed the interactive effects of age and gender on different facets of empathy (O'Brien, Konrath, Grünh, & Hagen, 2013; Richter & Kunzmann, 2011). These studies did not find interaction effects between gender and age, suggesting that age differences in empathic accuracy may be invariant across women and men. Given the limitations of cross-sectional designs, however, one task for future work is to study the effects of gender on age differences in empathic accuracy longitudinally.

A second limitation refers to the limited number of cognitive measures. Using a more comprehensive assessment of cognitive abilities will be an important

task for future research interested in the cognitive mechanisms underlying empathic accuracy. As a source for predictions about the relative importance and interplay of specific cognitive abilities in determining empathic accuracy, it will be important to develop theoretical models that conceptualise empathic accuracy as a process rather than an outcome. At this point, and as discussed above, we can only speculate that fluid-mechanical abilities such as processing speed, working memory, and inhibition as well as pragmatic-crystallized abilities such as knowledge about emotions and social relationships will be important candidates to consider.

A third limitation was our focus on only three emotions, happiness, anger, and sadness. Given that age differences in empathic accuracy may be emotion-specific, there is a clear need for future research studying a larger number of negative, but also positive emotions. It is entirely possible that the general pattern of age-related growth during adolescence and decline during later periods in the lifespan will not hold for all types of emotions (e.g. Ruffman et al., 2008).

Finally, although our sample covered a comparable wide age range from adolescence to middle-adulthood, from a life-span developmental perspective, it would be desirable to extend this work such as to include younger children and older adults. A requirement for such an approach is, of course, the development of performance-based empathic accuracy measures that are appropriate for such a wide age range in that they do not favour or discriminate particular age groups. It also deserves note that we analyzed distinct age groups rather than a sample with a continuous age range that would have allowed us to track age differences in empathic accuracy with greater precision. Perhaps even more critical, our cross-sectional design cannot disentangle the effects of age and cohort, and it does not permit any conclusions about intraindividual changes. This limitation also concerns the validity of our mediational analyses (Lindenberger, von Oertzen, Ghisletta, & Hertzog, 2011). Thus, there is a clear need for future research using longitudinal designs.

Conclusions

On the basis of a newly developed performance-based test, which shows satisfying psychometric characteristics, we investigated, for the first time, age differences in empathic accuracy in a sample of adolescents, young adults, and middle-aged adults.

Our findings are consistent with the idea that empathic accuracy increases during adolescence, peaks in young adulthood, and begins to decline in middle adulthood. The same fluid-mechanical cognitive abilities that mediated positive age differences in empathic accuracy during adolescence, mediated negative age differences in empathic accuracy during middle adulthood. This study also presented evidence for the idea that pragmatic-crystallized cognitive abilities are related to individual and age-related differences in empathic accuracy, particularly during adolescence and young adulthood. Within the constraints of cross-sectional data, the present pattern of findings confirms the conceptualisation of empathic accuracy as a cognitively demanding process that requires fluid-mechanical and pragmatic-crystallized cognitive abilities and that shows a similar age trajectory as cognitive abilities do.

Notes

1. Following previous relevant studies (e.g., Blanke, Rauers, & Riediger, 2015; Richter et al., 2010; Wieck & Kunzmann, 2015), we focused on one gender such as to reduce the complexity of our empathic accuracy test (see discussion section for further details).
2. The only sample characteristic that significantly predicted empathic accuracy was educational level. Given that there were no significant differences between young and middle-aged adults in this variable and given that almost all adolescents did not have a degree yet, we refrained from analyzing this variable as a covariate in the prediction relevant analyses.
3. The newly developed film clips will be made available to researchers. Requests can be send by email to the first author (kunzmann@uni-leipzig.de).
4. Applying the outlier labeling rule which is based on multiplying the Interquartile Range (IQR) by a factor of 2.2 (Hoaglin & Iglewicz, 1987), we identified three participants (one adolescent, one young and one middle-aged men) who reached empathic accuracy scores that fall outside the range. Thus, we replaced the three outlier scores with the respective minimum value in the specific age group. The results remained unchanged when including these three cases in additional analyses.
5. The analyses of age group of protagonist as an additional factor suggested that none of three participant age groups was systematically favored or penalized by any level of the protagonists' age group factor, thus, there were no systematic own-age biases in this study.
6. Separate analyses for perceptual speed and logical reasoning revealed the same pattern of findings as the analyses based on the composite score.
7. Despite the parallel age differences of and positive links between empathic accuracy and the present measures of fluid-mechanical intelligence, it deserves note that social cognitive neuroimaging work suggests domain-specific

brain regions of social cognitive skills (e.g., Decety & Jackson, 2004). At first sight, this domain-specificity speaks against the idea that empathic accuracy draws on the functioning of brain regions that are associated with basic cognitive processes. However, the common approach to studying the neural basis of social cognitive skills, namely, the use of baseline conditions that require closely matched reasoning about non-social situations may obscure the potentially important role of basic cognitive processes in social cognition (e.g., Schurz & Tholen, 2016). Although this approach is vital for identifying brain regions such as the medial prefrontal cortex that might be specific to social cognitive skills, it risks subtracting out functionally critical processes that are shared with other tasks, including basic cognitive processes that are associated with different brain regions, particularly the dorsolateral prefrontal cortex. Seen from this perspective, empathic accuracy should certainly not be reduced to basic cognitive processes; however, the latter may still play a role in the former.

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