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Understanding the Emotions of Others: Loss or Gain in Aging?

By

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requirements for the degree of
Doctor of Philosophy
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of the
University Of California, Berkeley

Committee in charge:
Professor Robert W. Levenson, Chair
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Abstract
Understanding the Emotions of Others: Loss or Gain in Aging?
by
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Using a cross-sectional sample of young (20-30 years old), middle-aged (40-50 years old), and older adults (60-80 years old), the present study examined age differences in cognitive empathy (i.e., the capacity to know what another is feeling or thinking). Cognitive empathy was measured in terms of: (a) facial emotion recognition using static stimuli; (b) the Eyes test using age-matched and non-age-matched static stimuli; and (c) emotional tracking using age-matched and non-age-matched dynamic interpersonal stimuli. While past studies on cognitive empathy and aging have focused almost exclusively on the former two measures and have found evidence of age-related decline for both, other research suggests that older adults may be able to compensate for such losses with information from other sources, even surpassing the performance of young adults under conditions that mimic real-world social contexts. Consistent with this idea, results revealed an age by task interaction such that older adults performed worse than young adults on facial emotion recognition and aspects of the Eyes test (with middle-aged adults performing in between), but better on emotional tracking of social interactions (with middle-aged adults performing in between). Additionally, I found no evidence for an age-matched advantage on the Eyes test or in emotional tracking. Implications of these findings are discussed in terms of the nature of cognitive empathy and neuropsychological and motivational models of the aging mind.

Introduction

Being able to know what another person is feeling is critical to our social functioning. Our capacity to discern the emotions of others helps us interpret and predict the actions of others, experience shared feelings, and interact effectively. Accordingly, this capacity may be particularly critical for successful aging, given that older adults place heightened importance on fulfilling social and emotionally-meaningful goals (Carstensen, Fung, & Charles, 2003; Carstensen, Isaacowitz, & Charles, 1999; Carstensen & Turk-Charles, 1994; Lawton, 2001; Magai, 2008). Additionally, older adults are particularly susceptible to the negative physical and mental health consequences of social isolation and loneliness (Bath & Deeg, 2005), further suggesting that maintaining the ability to know what others are feeling is especially important for protecting against such risk factors.

Although our capacity to identify what another is feeling (often referred to as "cognitive empathy") remains relevant across the lifespan, age differences in this domain have been studied mainly in childhood and adolescence rather than adulthood and old age. Thus, the existing literature does not provide a complete picture as to whether cognitive empathy skills decline, remain stable, or improve in adulthood. As reviewed below, different theoretical perspectives offer opposing predictions for age-related changes in processes related to cognitive empathy. Models emphasizing loss in aging (e.g., loss of brain volume and loss of relationships) suggest that older adults may exhibit impoverished abilities in processing the emotions of others. On the other hand, models emphasizing gain in aging (e.g., increased neural complexity and increased motivation for pursuing meaning) suggest that older adults may exhibit gains in certain aspects of emotional understanding. The present study examines whether there are different patterns of age differences in different aspects of cognitive empathy. Such research is important in informing our understanding of cognitive empathy as well as the nature of the aging mind.

Cognitive Empathy

At the core of cognitive empathy is some form of perspective taking or top-down cognitive process that enables individuals to detect what others are feeling or thinking (Preston & de Waal, 2003). This construct is distinguished from emotional empathy, or the ability to share or emotionally respond to the feelings of others. Importantly, cognitive empathy does not require an emotional response; an observer can simply process relevant information and come to a conclusion about the feelings of another. To give an extreme example, a torturer may be very skilled at accurately assessing how a victim is feeling, but may not feel any emotional empathy or concern for this victim. At the same time, cognitive empathy skills are seen as important building blocks for emotionally empathizing with and helping others (Lamm, Batson, & Decety, 2007; Preston & de Waal, 2003; Singer, 2006). As stated by Preston and de Waal, cognitive empathy skills can account for "increases in the effectiveness of empathy by helping the subject to focus on the object…remain emotionally distinct from the object, and determine the best course of action for the object's needs" (2003, p. 20).

Types of cognitive empathy. A number of abilities have fallen under the broad umbrella of cognitive empathy in the literature. These include: (a) *emotion recognition*, an information processing ability involving recognition of emotions from facial, vocal, or other stimuli (Ruffman, Henry, Livingstone, & Phillips, 2008); (b) *theory of mind*, or the ability to infer others' mental states (e.g., emotions, thoughts, intentions) and understand that others have mental states different from one's own (Baron-Cohen, 1991; Blair, 2005); and (c) *empathic accuracy*, or the ability to track or detect another's emotions and thoughts accurately in an

interpersonal context (Ickes, 1993).[1] Conceptually, these constructs are related to each other in that they all involve the ability to understand what others are feeling or thinking. Additionally, they are thought to rely on a similar core set of skills, including attentional shift (e.g., attending to another instead of oneself, shifting to relevant emotional cues) and correct interpretation of emotional cues (e.g., down-turned lips indicate sadness, being criticized may make a person feel negative emotions).

Measurement issues. Despite some conceptual overlap, there are significant methodological differences in how these constructs have been measured. Broadly, objective measures of cognitive empathy typically require participants to show appropriate recognition and understanding of (but not necessarily appropriate response to) the mental states of others. Participants are judged on their ability to recognize or infer others' mental states across various modalities, including facial expression, vocal expression, and bodily expression (Elfenbein & Ambady, 2002; Ruffman et al., 2008). Most studies on emotion recognition and theory of mind have used stimuli that focus on an isolated modality of emotional information, usually either visual (e.g., photographs of faces or eyes) or verbal (e.g., stories of emotional situations). In contrast, empathic accuracy tasks typically require participants to track emotions from dynamic interpersonal stimuli that include multimodal forms of information (e.g., videotapes of couples conversing). As argued below, these differing methodologies may be associated with differing predictions for age differences in cognitive empathy.

Cognitive Empathy and Aging: Loss or Gain?

There are neuropsychological and motivational reasons to expect changes in cognitive empathy across adult development. Due to the complexities of these theories, arguments can be made from both to predict both losses and gains. Some neuropsychological models predict that normal age-related atrophy in areas of the brain associated with processing positive and negative emotion (e.g., frontal and temporal brain regions; Bartzokis et al., 2001) may lead to selective losses in emotional processing (Calder, 2003; Phillips, MacLean, & Allen, 2002). Other models predict that increased neural complexity and certain compensatory brain changes in aging (e.g., more bilateral frontal recruitment; Cabeza, Anderson, Locantore, & McIntosh, 2002) may lead to gains in the capacity for relativistic and "big picture" emotional thinking (Cohen, 2006; Prickaerts, Koopmans, Blokland, & Scheepens, 2004; Segovia, del Arco, & Mora, 2009; Sun & Bartke, 2007). In terms of motivational theories, early gerontological models emphasizing social detachment as a primary goal of late life (Banham, 1951; Looft, 1972) suggest that older adults may exhibit diminished cognitive empathy due to decreased motivation to interact and connect with others. On the other hand, more contemporary social cognitive theories propose that aging individuals shift motivational priorities towards interpersonal and emotionally-meaningful goals and away from acquisition goals (Carstensen et al., 2003), suggesting possible gains in cognitive empathy in late life due to increased desire to facilitate meaningful social interactions. Below I review research in support of each of these models.

Age-Related Loss in Cognitive Empathy

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[1] To be consistent with prior literature, I will use "cognitive empathy" as a shorthand term for the measures used in the present study. It may be argued, however, that these measures are more closely aligned with emotion recognition constructs, or more precisely, the ability to identify accurately what others are feeling or thinking.

Early gerontological studies on emotion, which focused primarily on the frail elderly (e.g., nursing home residents), found older adults to be emotionally dampened, socially disengaged, and egocentric (Banham, 1951; Looft, 1972). More recent work has focused on healthy older adults in community settings, helping to separate the impact of age from the impact of dementia and other illness. Nonetheless, there are still indications in recent work that healthy older adults' ability to process and understand emotions may be diminished. Most of these studies have employed emotion recognition and theory of mind tasks in examining whether such processes are affected by age-related neural declines.

In a meta-analysis of 28 studies (705 older adults and 962 young adults) examining age differences in emotion recognition across four modalities (faces, voices, bodies/contexts, and matching of faces to voices), older adults exhibited decreased recognition of at least some of the basic emotions (anger, disgust, fear, happiness, sadness, surprise) in each modality, with certain negative emotions (sadness and anger) and some modalities (face-voice matching) proving most difficult (Ruffman et al., 2008). In terms of theory of mind, some studies have shown worse performance in older adults compared to young adults, although results are mixed. For example, two prior studies (Phillips et al., 2002; Slessor, Phillips, & Bull, 2007) have shown that older adults perform worse than young adults on the Reading the Mind in the Eyes test (abbreviated as the Eyes test, Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001), a widely used measure of theory of mind involving inferring mental states from the eyes.[2] Results are more mixed for the Stories paradigm, another common theory of mind measure requiring participants to read stories and draw inferences about story characters. Older adults perform worse on such tasks under conditions involving high demands to recall information (Maylor, Moulson, Muncer, & Taylor, 2002), but appear to perform equally well on tasks that minimize memory load (Maylor et al., 2002; McKinnon & Moscovitch, 2007; Saltzman, Strauss, Hunter, & Archibald, 2000; Slessor et al., 2007). For example, Slessor and colleagues (2007) found that when story passages remained available to participants when they responded, no age differences in theory of mind performance could be observed. Thus, it is possible that the age-related deficits in this aspect of cognitive empathy result from age-related decline in short-term memory.

Age-Related Gain in Areas Related to Cognitive Empathy

There have been relatively few studies documenting gains in cognitive empathy among older adults. A few studies have shown older adults to outperform younger adults on facial emotion recognition tasks (recognition of happy faces, Williams et al., 2006; recognition of disgust faces, Calder, 2003). One study found that older adults performed better than young adults on a theory of mind stories task (Happé, Winner, & Brownell, 1998). The discrepancies between these findings and other findings showing decline remain unclear. While the vast majority of aging research on cognitive empathy points toward decline, the literature has caveats in not consistently controlling for demands on memory and speed and not isolating this ability

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[2] The Eyes test resembles facial emotion recognition tests in that participants are required to identify mental states from photographs of emotional expressions. However, the authors (Baron-Cohen et al., 2001) argue that the Eyes test is distinguished from standard emotion recognition tasks in that it requires participants to draw upon a sophisticated mental state lexicon and match the eyes in each picture to examples of eye-region expressions stored in memory and seen in the context of particular mental states. Thus, the authors argue that the Eyes test involves attribution of relevant mental states, not simply recognition of basic facial expressions.

from other general age-related cognitive changes. Further the literature is limited in that no prior behavioral studies (to my knowledge) have assessed age differences in cognitive empathy using naturalistic, social, and emotionally rich stimuli (i.e., the type of stimuli often used in empathic accuracy tasks). Nevertheless, research documenting age-related gains in socioemotional functioning suggests that performance on empathic accuracy tasks might remain intact and perhaps even increase in late life.

A number of studies have shown that older adults perform better or place more priority on certain types of socioemotional tasks compared to young adults. For example, in viewing videotaped excerpts of marital interactions, older adults are more accurate than young adults at judging couples' marital satisfaction (Ebling & Levenson, 2003). In emotionally-salient interpersonal tasks, older adults use strategies that lead to more effective appraisal of the situation and more satisfying choices of action than young adults (Blanchard-Fields, 1986). Older adults are also more likely than young adults to prioritize (relevance?) social interactions that confer emotional satisfaction, as opposed to ones that confer acquisition objectives such as information seeking (Carstensen, 1992; Carstensen et al., 2003; Carstensen et al., 1999; Lang & Carstensen, 1994). Further, older adults show greater improvement in cognitive performance for emotional relative to non-emotional information compared to young adults (Fung & Carstensen, 2003; Rahhal, Colcombe, & Hasher, 2001). Finally, there is some indication that older adults exhibit greater capacity to regulate emotion (Gross et al., 1997; Lawton, Kleban, Rajagopal, & Dean, 1992; McConatha, 1999) and greater tendency to experience mixed emotional states (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Molinari & Reichlin, 1984), processes relevant to navigating complex emotional situations.

Summary of Loss and Gain Models

To summarize, older adults generally show impairment on certain aspects of cognitive empathy, most notably on emotion recognition and theory of mind tasks using single-modality, non-interpersonal stimuli. Studies using such tasks indicate that older adults exhibit some impairment in the recognition of basic emotions, with the strongest evidence of impairment for negative emotions such as sadness and anger. There has been more mixed evidence for theory of mind, with some studies indicating age-related decline (Phillips et al., 2002; Slessor et al., 2007), and other studies indicating no differences (e.g., Saltzman et al., 2000) or even improvement (Happé et al., 1998). Declines in cognitive empathy are consistent with neuropsychological and motivational models of aging predicting loss (e.g., contemporary models emphasizing losses in cognitive functioning and early gerontological models emphasizing increased motivation towards social detachment). At the same time, older adults show a number of gains in socioemotional functioning, such as improved capacity to appraise emotional contexts and regulate emotion. Improvements in socioemotional functioning are consistent with models of aging emphasizing gains (e.g., increased neural complexity in the aging brain and heightened prioritization of social and emotional goals). Such gains support the hypothesis that older adults may be able to compensate for specific losses and exhibit enhanced cognitive empathy performance when provided with interpersonal, multimodal forms of emotional information.

Methodological Limitations of Past Research

In reviewing the literature on aging and objective measures of cognitive empathy, several key limitations emerged. These include: (a) a near exclusive focus on tasks involving single-modality, non-interpersonal forms of emotional information (e.g., photographs of faces or eyes);

(b) a lack of inclusion of middle-aged participants in cross-sectional designs; and (c) a failure to address whether patterns of rater age differences are influenced by age characteristics of target stimuli. Make these points align with the three subheadings below (which should be broadened to refer to the general issue and note that you will be discussing each below.

The "snapshot" approach. Emotion recognition and theory of mind tasks using a single-modality or "snapshot" approach to representing emotion offer advantages in isolating specific processes or domains of impairment (e.g., impairment specific to facial processing, or to a specific emotion). However, such tasks raise concerns in terms of ecological validity. For example, studies have indicated that judgments based on single-modality and decontextualized information yield less accurate judgments than those based on even small amounts of multimodal and contextualized social information (Ambady, Hallahan, & Conner, 1999; Wehrle, Kaiser, Schmidt, & Scherer, 2000). To date, it is unclear whether an individual who exhibits difficulty in recognizing emotions from static facial expressions also exhibits impairment in recognizing emotions under more naturalistic conditions. Given the emphasis on contextual appraisal in definitions of cognitive empathy (De Vignemont & Singer, 2006; de Waal, 2007), it seems especially important to examine cognitive empathy skills in a contextualized manner (e.g., assessing emotional judgments within the context of an interpersonal and emotional situation). Helping to address these issues, measures of cognitive empathy (i.e., empathic accuracy tasks) have been developed that assess real-time emotional tracking of naturalistic social interactions (Ickes, Stinson, Bissonnette, & Garcia, 1990; Levenson & Ruef, 1992).

Middle-aged participants. The vast majority of studies examining cognitive empathy and aging have used a cross-sectional approach that examines only two groups: young (with the majority in their late teenage years to early twenties) and older (with the majority in their 60s and 70s). One recent cross-sectional study that examined three age groups (young, middle-aged, and older) found that middle-aged and older adults showed similar impairment in facial emotion recognition tasks as compared to young adults (Isaacowitz et al., 2007). Many theories regarding age effects appear to suggest linear changes across adult development (e.g., gray matter volume tends to decline from age 20 in a linear fashion throughout the lifespan [Ge et al., 2002]; increased life experience is accumulative across the lifespan). However, other theories may lead to predictions of non-linear change (e.g., increased salience of mortality may be an issue unique to older adults). Studies that include middle-aged participants are needed in capturing a more comprehensive understanding of differences in cognitive empathy across the adult lifespan.

Target characteristics. Surprisingly few studies have considered the age range of target stimuli in examining cognitive empathy and aging. Instead, many studies have used only young and middle-aged adult targets and have not examined possible age-interaction effects. Thus, it is unknown whether people are better at understanding the emotions of others in their own age group compared to that of younger or older age groups. On the one hand, age-matched similarity may increase cognitive empathy by virtue of increased similarity in how emotional signals are displayed by members of one's age group. Further, the mere perception that one belongs to the same group as a target can lead to increased accuracy in emotion recognition (Thibault, Bourgeois, & Hess, 2006). Consistent with these ideas, one prior study that considered target characteristics found age similarity between raters and targets to be associated with greater accuracy (Malatesta, Izard, Culver, & Nicolich, 1987). In a similar vein, a meta-analysis of emotion recognition studies found an in-group cultural advantage such that participants showed greater accuracy when judging emotional facial expressions of the same cultural group (Elfenbein & Ambady, 2002). On the other hand, from an evolutionary perspective, our ability to

recognize the emotional signals of both in-group and out-group members carries great value for the functioning of communities and the ultimate survival of the species (Preston & de Waal, 2003). From this standpoint, our accuracy in understanding the emotions of both in- and out-group members should be largely equivalent. Consistent with this, a recent study in my laboratory found no evidence for an in-group cultural advantage in empathic accuracy (i.e., emotional tracking of dyadic interactions) among four different cultural groups (Soto & Levenson, 2009).

Gender Differences in Cognitive Empathy

In addition to age differences, there is some evidence to suggest gender differences in cognitive empathy. On self-report questionnaires, women reliably report higher levels of cognitive and emotional empathy (for a review, see Eisenberg & Lennon, 1983). However, few reliable gender differences have been found in studies using objective measures of cognitive empathy (Eisenberg & Lennon, 1983; Russell, Tchanturia, Rahman, & Schmidt, 2007). Past research has found women to show higher performance than men in identifying negative facial expressions (Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005), but comparable performance in identifying positive facial expressions (Montagne et al., 2005). Results have also been mixed for theory of mind: while men and women showed comparable performance on the revised Eyes test (Baron-Cohen et al., 2001), men outperformed women on a different test of theory of mind, the Happé's cartoon task in which participants make inferences about protagonists' feelings and thoughts in nonverbal cartoons (Russell et al., 2007). In terms of empathic accuracy, a previous study from my laboratory found no gender differences in the accuracy of rating positive or negative emotion using a task in which participants tracked emotions in dyadic interactions (Levenson & Ruef, 1992). A meta-analysis on empathic accuracy found that while women and men showed comparable performance for most studies (10 of 15), women tended to be more accurate than men if they were also asked to make repeated self-estimates of their own empathic accuracy (Ickes, Gesn, & Graham, 2000). These latter findings suggest that differences in performance may reflect motivational differences rather than simple differences of ability between men and women.

The Present Study

The present study examined age differences in cognitive empathy in a sample of healthy young, middle-aged, and older participants. Cognitive empathy was measured in terms of: (a) facial emotion recognition using static stimuli; (b) attribution of mental states to eyes using age-matched and non-age-matched static stimuli; and (c) emotional tracking of social interactions using age-matched and non-age-matched dynamic interpersonal stimuli. This study addressed limitations in prior research by: (a) including a more naturalistic and social measure of cognitive empathy (the emotional tracking task); (b) including middle-aged participants in addition to young and older participants; and (c) examining whether patterns of rater age differences are influenced by age characteristics of target stimuli.

Hypotheses

I proposed three hypotheses: (a) older adults would perform worse than young adults on the facial emotion recognition task, with middle-aged adults in between; (b) older adults would perform worse than young adults on the Eyes test, with middle-aged adults in between; and (c) older adults would perform better than young adults in emotional tracking of social interactions,

with middle-aged adults in between. Hypotheses regarding performance on the facial emotion recognition task and the Eyes test were derived from the prior literature (facial emotion recognition: for a review, see Ruffman et al., 2008; Eyes test: Phillips et al., 2002; Slessor et al., 2007). My hypothesis regarding emotional tracking was derived from literature demonstrating age-related increases in socioemotional functioning and motivation (e.g., Blanchard-Fields, 1986; Ebling & Levenson, 2003; Fung & Carstensen, 2003). For the Eyes test and the tracking task (i.e., the tasks that included young, middle-aged, and older targets), I predicted an age-matched advantage such that each rater age group would demonstrate superior accuracy for age-matched targets. These hypotheses were based on literature demonstrating in-group advantages in emotion recognition (Elfenbein & Ambady, 2002; Malatesta et al., 1987). Finally, I planned to examine associations among measures and predictors of measures on an exploratory basis.

Methods

Participants

    A total of 216 participants were studied. Seventy-four young participants (age range, 20-30 years, $M = 23.27$, $SD = 2.70$), 72 middle-aged participants (age range, 40-50 years, $M = 44.63$, $SD = 2.87$), and 70 older participants (age range, 60-80 years, $M = 67.43$, $SD = 5.77$) were recruited using flyers and online postings in the local community and from a research participant database administered by the University of California, Berkeley. Age ranges were selected so that a large portion of adulthood (viz., 60 years) was included, each age group differed by approximately a generation, and the older group extended in age beyond the "young-old"[3]. Participants had to be in good health and sufficiently mobile to travel to the laboratory. The recruitment was designed to ensure that gender and ethnicity were stratified evenly across the three age groups. In terms of gender, 65.7% of the participants were women and 34.3% were men. In terms of ethnicity, the sample was 68.5% percent Caucasian American, 12.5% Asian American, 7.4% African American, 3.2% Latino American, and 5.1% other. Participants reported their annual household income using the following income brackets: 0 = < $10,000; 1 = $10,000—$19,999; 2 = $20,00—$29,999; 3 = $30,000—$49,999; 4 = $50,000—$74,999; 5 = $50,000—$74,999; 6 = $100,000—$200,000; 7 = over $200,000. Participants also reported education level (1 = Some High School; 2 = High School Diploma; 3 = Some College; 4 = Bachelor's Degree; 5 = Master's; 6 = Doctoral degree). As would be expected, the groups differed in income, with older and middle-aged participants reporting higher incomes than young participants. The groups also differed in education, with older and middle-aged participants reporting higher education than young participants. Means, SDs, effect sizes, and pairwise comparisons among age groups for income and education are presented in Table 1.

General Procedure

    Laboratory assessment. On arrival, participants were greeted by a female experimenter and seated in a chair in a 3 X 6 m experimental room. Participants were informed that they were participating in a study of emotion, during which their physiological reactions would be monitored and behavioral reactions would be videotaped. After signing the consent form, and while a female assistant attached the physiological sensors, participants completed the self-

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[3] Gerontologists often group older adults into different categories, including "young-old" (59-69 years old), "middle-old" (70-75 years old), and "old-old" (over 75 years old) (Gildengers et al., 2002).

reported emotional experience questionnaire. The experimental protocol (2 hours) consisted of a series of tasks designed to assess a number of aspects related to empathic functioning. Cognitive empathy tasks (described below) were presented in the following order: (a) Block I of the emotional tracking task; (b) the Eyes test; (c) the facial emotion recognition task (trials counterbalanced); and (d) Block II of the emotional tracking task (Blocks I and II were counterbalanced).

All stimuli were presented to the participant on a 21-inch computer screen. The participant sat alone in the experimental chamber and the experimenter sat in an adjacent room where she could view the participant on a monitor and communicate over an intercom system. Participants were videotaped throughout the experimental tasks using a remote-controlled, high-resolution video camera that was partially concealed behind a bookcase located in the experimental chamber. Participants were informed prior to the start of the session about the video recording.

At-home questionnaires. Three to seven days prior to their laboratory visit, participants completed a questionnaire packet that included measures of personality, functioning, and emotional experience. The measures utilized in the present study are described below.

Stimulus Materials and Apparatus

Faces stimuli. Participants were presented with five sequences of seven color photographs from the a set of faces (developed by Paul Ekman and provided to our laboratory for use in this research) that were morphed into different levels of intensity for the following emotions: (a) anger, (b) happiness, (c) fear, (d) disgust, and (e) sadness. Each set depicted the same young woman. For each sequence, each subsequent photograph represented 6.25% (1/16th) greater intensity of the emotional expression.

Eyes stimuli. For the revised eyes test (Baron-Cohen et al., 2001) participants were presented with 12 still pictures of eyes expressing different mental states. The full eyes test comprises 36 pictures; we chose a subset of pictures that were most reliably rated as young, middle-aged, and older by a group of four independent raters, thus resulting in 12 total pictures (three male and one female per age group).

Social interaction stimuli. For the emotional tracking task, each participant viewed 12 videotapes of conversations about important marital topics between spouses (each were 3.75 min) of three age ranges: four younger couples, four middle-aged couples, and four older couples (same age criteria as used for participants). One of the members of the target couple was designated as the target person (in half the couples it was the wife and in half it was the husband). To keep ethnicity constant, all targets were Caucasian American. The stimuli for the task were selected by a procedure developed in previous research using this empathic accuracy task (Levenson & Ruef, 1992). The goals of the selection procedure were to select interactions in which the target spouse: (a) experienced a sufficient amount of emotion (i.e., rated themselves as feeling positive or negative for at least half the time); (b) experienced a relatively balanced amount of positive versus negative emotion; and (c) rated his or her own emotion in a way that was reasonable and not unduly idiosyncratic. For more details on this selection procedure, see Appendix A.

Furthermore, to enable examination of tracking accuracy by emotional valence, the valence of each second of each social interaction was designated based on Specific Affect (SPAFF Version 2.0; Gottman, 1989) coding system ratings. Specifically, positive, negative, and neutral emotion moments were determined by observational coding of videotapes of each

interaction using the Specific Affect coding system (SPAFF Version 2.0; Gottman, 1989). In coding the emotional valence of each target, there were five positive codes (interest, affection, humor, validation, joy), nine negative speaker codes (anger, contempt, disgust, belligerence, domineering, defensiveness, fear/tension/worry, sadness, whining), and a neutral speaker code indicating that no affective behavior was present.

Rating dial. The emotion rating dial (Ruef & Levenson, 2007) used in the emotional tracking task consisted of a mechanical dial that moved over a 180-degree scale divided into nine divisions ranging from *very negative* (-4) to *neutral* (0) to *very positive* (+4). A computer sampled the dial position every 5 ms and averaged these readings into 1-second measurement periods using a program written by one of the authors (R.W.L.). This rating dial was used to obtain ratings from the participants on the tracking task and was used previously by target individuals to rate their own emotions as part of their original study protocol.

Laboratory Measures

Facial emotion recognition task. After viewing each photograph, participants selected their answers from eight responses choices: anger, disgust, fear, happiness, sadness, and three fillers, neutral, embarrassment, and proud. Faces within each sequence were shown in order, from 0% (neutral) to 44%. The five emotion sequences were shown in two different counterbalanced orders across participants. The task was self-paced, and participants were instructed to take as much time as they needed.

Eyes test. After viewing each photograph, participants selected which of four words best described the thoughts or feelings expressed in the picture (e.g., "playful / comforting / irritated / bored").

Emotional tracking task. For each trial, participants used the rating dial to rate continuously how they thought the *target person was feeling during the interaction* on a 9-point Likert scale (1 = *very negative*; 5 = *neutral*; 9 = *very positive*). To minimize participant fatigue, the 12 trials were organized in two blocks (six trials each) that were counterbalanced across participants. Within each block, the trials were ordered such that age groupings of targets were not repeated on adjacent trials.

Questionnaires

Trait Cognitive Empathy (Perspective Taking). Trait cognitive empathy was assessed using the perspective taking subscale of the Interpersonal Reactivity Index (Davis, 1980). Sample items included: "I try to look at everybody's side of a disagreement before I make a decision" and "When I'm upset at someone, I usually try to "put myself in his shoes" for a while". Internal consistencies were adequate for this scale (alpha = .80).

Cognitive Functioning. Cognitive functioning was assessed using 10 items selected from three questionnaires: (a) Functional Assessment Questionnaire (Pfeffer, Kurosaki, Harrah, Chance, & Filos, 1982); (b) Attentional Control Scale (Derryberry & Reed, 2002); and (c) Primary Care Evaluation of Mental Disorders (Spitzer et al., 1994). Sample cognitive functioning items included: "I have been bothered by having my thoughts come slower than usual or seem more mixed up than usual" and "When I need to concentrate and solve a problem, I have trouble focusing my attention". Internal consistency was adequate for this scale (alpha = .71). For a complete list of the items used in this measure, see Appendix B.

Data Reduction

Facial emotion recognition. For each target emotion, two scores were computed: (a) the total number of faces identified correctly; and (b) the most subtle level for which the participant identified the correct emotional expression for two consecutive photographs (i.e., if the participant identified Face 4 and 5 correctly but not 1 through 3, the score was 4). If the most subtle expression identified correctly was the last photograph (Face 7), the score was calculated as a 7; if no faces were identified correctly, the score was calculated as an 8. A composite was computed by reverse scoring the latter variable and averaging the two variables, so that greater numbers of correct responses and recognition at more subtle levels of emotional expression indicated greater ability in facial emotion recognition. Mean performance scores for positive (happy) and negative (anger, fear, disgust, and sadness) expressions were also created to allow examination by valence.

Theory of mind. Greater numbers of correct responses (i.e., higher scores) on the Eyes test indicated greater ability on the task.

Emotional tracking accuracy. For each tracking trial, the target's own second-by-second ratings of his or her emotional experience provided the accuracy criterion for that target's emotional experience. For every second during each trial, accuracy was calculated as the absolute difference between the participant's rating and the criterion's rating. Thus, a smaller difference score indicated *higher* accuracy. Measures of overall accuracy for positive, negative, and neutral emotion moments were then calculated by separately averaging the accuracy scores (i.e., second-by-second absolute difference scores) for the seconds classified as positive, negative, and neutral based on SPAFF coding.

Overview and General Analytic Approach

Primary analyses were conducted using ANOVA, with rater age (young, middle-aged, older) and rater gender (male, female) treated as between-subject factors. When no main or interaction effects with gender were found, analyses are presented collapsed across rater gender and noted as such. In the first analysis presented, task (facial recognition, Eyes test, and emotional tracking) was treated as a within-subjects factor to evaluate the predicted interaction between rater age and type of cognitive empathy task. To break down this analysis, I then conducted analyses separately by task. In these analyses, presentation order was initially included as a between subjects for the facial emotion recognition and emotional tracking tasks; because there were no significant main effects or interactions involving order, analyses are presented collapsed across this factor. Where possible, target emotion (type and/or valence) and target age (young, middle-aged, and older) were included as within-subjects factors. For the facial emotion recognition task, target age was not examined because all targets were young. For the Eyes test, target emotion was not examined because many of the mental states included in this task are not easily categorized in terms of emotional type or valence (e.g., fantasizing, shy, convinced) and because response choices vary for each target (e.g., for some targets response choices are all negative whereas for others they are of mixed valences). In addition, follow-up multiple regression analyses were conducted to determine whether any age differences in performance on cognitive empathy tasks were separable from age differences in related variables (i.e., trait cognitive empathy, self-reported cognitive functioning, and education). Bonferroni adjustments for multiple comparisons were used to protect against the risk of Type I error.

Results

Age differences in cognitive empathy. Group differences in cognitive empathy were assessed with a 3 X 3 ANOVA[4], with rater age (young, middle-aged, older) as a between-subjects factor and task (standardized scores for facial recognition, Eyes test, and emotional tracking [reverse-scored]) as a within-subjects factor. As hypothesized, there was a significant interaction between rater age and task, $F(2, 426) = 5.11$, $p < .01$, $\eta_p^2 = .05$, suggesting that age differences in cognitive empathy differed by task. Thus, I conducted follow-up ANOVAs to examine age differences separately by task.

<u>Hypothesis 1:</u> Rater age differences in facial emotion recognition will be observed such that young adults will perform best, middle-aged adults intermediate, and older adults worst.

Rater age differences in facial emotion recognition. Group differences in facial emotion recognition were assessed with a 3 X 2 X 2 ANOVA, with rater age (young, middle-aged, older) and rater gender (male, female) as between-subjects factors and emotional valence (positive, negative) as a within-subjects factor. This analysis revealed a main effect of rater age, $F(2, 217) = 3.12$, $p < .05$, $\eta_p^2 = .03$. As hypothesized, there was a significant linear relationship for group, contrast estimate = .05, $p = .01$, with young adults performing best, middle-aged intermediary, and older adults performing worst. There was no rater age by emotional valence interaction, $F(2, 217) < 1$, $\eta_p^2 = .00$, indicating that the age effect held across positive and negative expressions. To assess age differences in recognition of specific emotions, a 3 X 2 X 5 ANOVA was conducted with rater age and rater gender as between-subjects factors and specific emotion (anger, disgust, fear, happiness, and sadness) as a within-subjects factor. Results revealed a significant rater age by emotion interaction, $F(8, 856) = 2.45$, $p < .05$, $\eta_p^2 = .02$. Follow-up univariate ANOVAs revealed an effect of rater age for sadness, $F(2, 220) = 7.99$, $p < .01$, $\eta_p^2 = .08$, and disgust, $F(2, 220) = 6.09$, $p < .01$, $\eta_p^2 = .05$. Similar linear relationships for group were found for sadness and disgust, with young adults performing best, middle-aged intermediary, and older adults performing worst (contrast estimates = -1.75, -1.26, respectively, $ps < .01$). Means, SDs, pairwise comparisons, and effect sizes by specific emotion are presented in Table 2.

Rater gender differences in facial emotion recognition. There was no main effect of rater gender, $F(1, 217) < 1$, $p = .38$, $\eta_p^2 = .00$, and no rater age by rater gender interaction, $F(1, 217) = 2.22$, $p = .11$, $\eta_p^2 = .02$. However, there was a rater gender by emotional valence interaction, $F(1, 217) = 7.26$, $p < .01$, $\eta_p^2 = .03$. Follow-up univariate ANOVAs revealed that women performed better than men in the recognition of negative facial expressions, $F(1, 222) = 5.02$, $p < .05$, $\eta_p^2 = .02$, but in contrast, men performed better than women in the recognition of positive facial expressions, $F(1, 222) = 3.95$, $p < .05$, $\eta_p^2 = .02$.

Summary. Hypothesis 1 was supported in that facial emotion recognition was highest for young adults, intermediary for middle-aged adults, and lowest for older adults. This pattern of findings held across negative and positive facial expressions. In terms of specific emotions, significant age differences were found for recognition of sadness and disgust. Additionally, a rater gender by emotional valence interaction was found such that women were better than men at rating negative facial expressions, and men were better than women at rating positive facial expressions.

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[4] The same analysis with rater gender included as a between-subjects variable was conducted and revealed no main effects or interaction effects with gender. Therefore, rater gender was excluded as a variable of interest.

Hypothesis 2a: Rater age differences on the Eyes Test will be observed such that young adults will perform best, middle-aged adults intermediate, and older adults worst.

Hypothesis 2b: Additionally, there will be a rater age by target age interaction such that young adults will perform relatively better rating young eyes, and older adults will perform relatively better rating older eyes.

Rater age effects on the Eyes test. Rater age effects on the Eyes test were assessed with a 3 X 2 X 3 repeated measures ANOVA, with rater age (young, middle-aged, older) and rater gender (male, female) as between-subjects factors and target age (young, middle-aged, older) as a within-subjects factor. There was a significant rater age by target age interaction, $F(4, 434) = 3.58$, $p < .01$, $\eta_p^2 = .03$. Thus, to test Hypothesis 2a, rater age effects were analyzed separately for each target age group using a series of 3 X 2 (Rater Age X Rater Gender) ANOVAs. A main effect of rater age was found for older eyes only, $F(2, 213) = 4.40$, $p = .01$, $\eta_p^2 = .04$. As predicted, there was a significant linear relationship for group, contrast estimate $= -.31$, $p = .01$, with young adults performing best, middle-aged intermediary, and older adults performing worst. In contrast, rater age differences for young and middle-aged eyes were not significant, $F(2, 213) = 2.36$, $p = .10$, $\eta_p^2 = .02$ and $F(2, 213) < 1$, $\eta_p^2 = .00$, respectively.

Age-matched target effects on the Eyes test. To test Hypothesis 2b, the rater age by target age interaction was also broken down separately for each rater age group using a series of 3 X 2 (Target Age X Target Gender) ANOVAs. As shown in Table 3, Bonferroni-adjusted comparisons revealed that each rater age group performed worst on rating middle-aged targets, suggesting that these targets were harder to rate overall. Interestingly, and contrary to prediction, results also revealed an age "mismatch" effect in which young adults performed better at rating *older* eyes versus younger eyes, older adults performed better at rating *young* eyes versus older eyes, and middle-aged adults performed equally at rating older versus younger eyes. Means, SDs, and pairwise comparisons are presented in Table 3.

Gender differences on the Eyes test. While there was no main effect of rater gender, $F(1, 217) < 1$, $p = .57$, $\eta_p^2 = .00$, or rater gender by target age interaction, $F(2, 217) < 1$, $p = .73$, $\eta_p^2 = .00$, there was a significant rater age by rater gender interaction effect, $F(2, 217) = 3.89$, $p < .05$, $\eta_p^2 = .04$. Decomposing analyses separately by rater *gender*, the lack of a main effect of rater age differences held for both men, $F(2, 72) = 2.34$, $p = .10$, $\eta_p^2 = .06$, and women, $F(2, 213) = 1.91$, $p = .15$, $\eta_p^2 = .03$. Decomposing analyses separately by rater *age* revealed that for middle-aged adults only, men performed better than women on the Eyes test, $F(1, 72) = 5.46$, $p < .05$, $\eta_p^2 = .07$.

Summary. Hypothesis 2a was only partially supported. While the expected age differences were found for some targets (i.e., older eyes), with young adults performing best, middle-aged adults performing intermediary, and older adults performing worst, these age differences were not found for all targets (i.e., young and middle-aged eyes). Additionally, Hypothesis 2b predicting an age-matched advantage was not supported. Rather, an unexpected interaction was observed such that young adults performed better at rating older eyes than young eyes, older adults performed better at rating young eyes than older eyes, and middle-aged adults performed equally well at rating both age targets. Finally, among middle-aged raters only, men performed better than women.

Hypothesis 3a: Age differences in emotional tracking of social interactions will be observed such that young adults will perform worst, middle-aged adults intermediate, and older adults best. Hypothesis 3b: Additionally, there will be a rater age by target age interaction such that young adults will perform better rating young targets, and older adults will perform better rating older targets.

Rater age effects on emotional tracking. Group differences in tracking positive, negative, and neutral moments in social interactions were assessed with a 3 X 3 X 3 ANOVA[5], with rater age (young, middle-aged, older) as a between-subjects factor, and target age (young, middle-aged, older target) and emotional valence (positive, negative, and neutral) as within-subjects factors. A main effect of rater age was found, $F(2, 212) = 3.23$, $p < .05$, $\eta_p^2 = .03$. As predicted, there was a significant linear relationship for group, contrast estimate = .12, $p < .01$, with young adults performing worst, middle-aged intermediary, and older adults performing best. No interaction between rater age and emotional valence was found, $F(4, 848) = 1.87$, $p = .12$, $\eta_p^2 = .02$, indicating that this rater age effect was consistent across positive, negative, and neutral moments.

Age-matched target effects on emotional tracking. Contrary to prediction, there was no rater age by target age interaction, $F(4, 848) < 1$, $\eta_p^2 = .02$, indicating that age differences in tracking were consistent across all target age groups. Means, SDs, and pairwise comparisons are presented in Table 3.

Summary. Hypothesis 3a was supported in that emotional tracking of social interactions was lowest for young adults, intermediary for middle-aged adults, and highest for older adults. Hypothesis 3b was not supported in that performance was not enhanced for age-matched targets. Additionally, there were no gender differences in emotional tracking performance.

Exploratory Analyses

Valence Recognition of Facial Expressions

One key difference between the facial emotion recognition task and the emotional tracking task is that the former required participants to identify discrete emotions whereas the latter required participants to identify moment-to-moment changes in emotional valence. I hypothesized that older adults would exhibit advantages in tracking emotions in social interactions based on literature demonstrating certain increases in social and emotional functioning with age. However, an alternative explanation is that older adults performed better in the tracking task not because they fare better when provided with social, naturalistic sources of information, but because they are simply better at identifying emotional valence (and at the same time, worse at identifying discrete emotions, as evidenced in the facial emotion recognition task). To explore this idea further, I reran analyses on facial emotion recognition performance to determine age effects on recognition of general valence rather than discrete emotion. That is, if a participant responded with any negative emotion term (anger, disgust, embarrassment, fear, sadness) for a negative expression or any positive emotion term (happy, proud) for a positive expression, this response was scored as correct. Group differences in valence recognition were assessed with a 3 X 2 ANOVA, with rater age (young, middle-aged, older) and rater gender (male, female) as between-subjects factors.

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[5] The same analysis with rater gender included as a between-subjects variable was conducted and revealed no main effects or interaction effects with gender. Therefore, rater gender was excluded as a variable of interest.

Results revealed no age differences in valence recognition, $F(2, 217) < 1$, $\eta_p^2 = .01$. In other words, neither age differences suggestive of loss (as observed for discrete emotion recognition of facial expressions) nor age differences suggestive of gain (as observed for valence tracking of social interactions) emerged for valence recognition of facial expressions. These results suggest that rater age effects may indeed differ as a function of discrete versus valence emotion recognition abilities.

Correlations Among Cognitive Empathy Measures by Rater Age Group

Because performance on the different cognitive empathy measures was predicted to be differentially affected by rater age, correlations among measures were examined separately for each rater age group. Consistent with prior research (Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; Phillips et al., 2002), the cognitive empathy tasks were not strongly correlated with one another (see Table 4). According to Cohen's (1988) criteria, for young adults, performance on the facial emotion recognition and emotional tracking tasks was modestly positively correlated; for middle-aged adults, performance on the facial emotion recognition and Eyes test was moderately positively correlated; and for older adults, performance on the facial emotion recognition and Eyes test was only marginally positively correlated.

What Factors May Contribute to Rater Age Differences in Cognitive Empathy Performance?

Predicted rater age differences were found for facial emotion recognition (age-related impairment in recognition of facial expressions), the Eyes test (age-related impairment in recognition of older targets), and emotional tracking of social interactions (age-related improvement in emotional tracking). In order to evaluate possible factors contributing to these age differences, I examined two participant characteristics that have been associated cognitive empathy in past research: (a) trait cognitive empathy (e.g., Shamay-Tsoory, Harari, Szepsenwol, & Levkovitz, 2009) and (b) cognitive functioning (e.g., Phillips et al., 2002). In these studies, individuals with higher levels of trait empathy and cognitive functioning have demonstrated better performance on measures of cognitive empathy. Due to age differences in education, I also examined education as a predictor. Research has been mixed for education, with some studies finding a positive relation with cognitive empathy (Keightley et al., 2006) and others finding no relation (Orgeta & Phillips, 2008; Phillips et al., 2002).

To test these alternative explanations, I first examined zero-order correlations between the above participant characteristics and each cognitive empathy measure. As Table 5 indicates, higher self-reported cognitive functioning was associated with better recognition of older eyes and better tracking accuracy. Trait cognitive empathy and education were not significantly associated with any measure of cognitive empathy. Thus, I constructed two separate multiple regression analyses on eyes test performance and tracking accuracy, respectively, in which the significant cognitive empathy predictor (i.e., self-reported cognitive functioning) was entered in the first step and age entered in the second step. As Table 6 indicates, self-reported cognitive functioning was a significant predictor of both recognition of older eyes and emotional tracking; however, rater age predicted additional variance beyond this factor for both performance measures. Thus, although differences in self-reported cognitive functioning contributed to performance on both measures, they did not account fully for age differences.

Discussion

The primary goal of this study was to examine age differences in cognitive empathy abilities. Contrasting models were considered: (a) neuropsychological and motivational models of aging predicting loss (contemporary models emphasizing neurodegeneration in brain regions related to emotional processing and early gerontological models emphasizing increased motivation towards social detachment); and (b) neuropsychological and motivational models predicting gain (models suggesting increased neural complexity and compensatory shifts in the aging brain and others emphasizing heightened prioritization of social and emotional goals). Previous studies have attempted to examine age differences in cognitive empathy using single-modality, non-interpersonal stimuli (e.g., photographs of faces, nonverbal video clips of faces) and one-time emotion judgments. Along with using this former approach, the present study included multimodal and interpersonal emotional stimuli and continuous, real-time emotion judgments to examine this question under different and arguably more naturalistic conditions.

Using a sample of young, middle-aged, and older adults, I found support for the hypotheses that: (a) older adults show worse performance than young adults on certain cognitive empathy tasks involving recognition of specific mental states from isolated stimulus modalities (i.e., recognition of facial emotions and attribution of mental states to older eyes from photographs); and (b) at the same time, older adults show better performance than young adults on a cognitive empathy task involving tracking of naturalistic and interpersonal information (i.e., tracking moment-to-moment changes in emotional valence in social interactions). Furthermore, on all three tasks showing age differences in performance, middle-aged adults performed at a level in between that of young and older adults. While cognitive functioning predicted performance on the Eyes test and emotional tracking task, age predicted additional variance beyond this factor for both measures. Further, consistent with past research (Keightley et al., 2006; Phillips et al., 2002), only minimal associations were found among cognitive empathy measures within each age group. Finally, I found no evidence for an age-matched advantage in cognitive empathy (i.e., for both the Eyes test and emotional tracking task).

Evidence for Reduced Cognitive Empathy Abilities Among Older Adults

Results supported the hypothesis that overall performance on recognition of facial expressions would be highest for young adults, intermediary for middle-aged adults, and lowest for older adults. In terms of specific emotions, this pattern of age differences was found for recognition of sadness and disgust. These results are largely consistent with past research documenting impairment among healthy older adults compared to young adults in the ability to recognize emotions from static facial expressions. Current models emphasizing loss suggest that aging adults' difficulties might be due to normal age-related neurodegeneration in the ''social brain'', and in particular, frontal and temporal brain regions (Calder et al., 2003; Isaacowitz et al., 2007; Phillips et al., 2002; Ruffman et al., 2008). Evidence from functional imaging research suggests that frontal and temporal regions are implicated in identifying facial expressions of emotion (Davis & Whalen, 2001; Winston, Strange, O'Doherty, & Dolan, 2002), and these regions show reductions in volume among healthy older adults (Bartzokis et al., 2001; Raz et al., 2005). Moreover, research has shown that patients with frontotemporal lobar dementia show significant reductions in the ability to recognize emotional expressions in faces, particularly negative emotional faces (Lavenu et al, 1999; Keane, 2002; Rosen et al, 2004; Fernandez-Duque & Black 2005; Lough et al, 2006; Kessels et al, 2007; Diehl-Schmid et al, 2007). The present results are compatible with these findings.

Additionally, results only partially supported the hypothesis that theory of mind as assessed by the Eyes test would be lower among older adults. For older eyes targets only, age differences were found such that older raters performed worse than young raters, with middle-aged adults in between. It is unclear why this pattern did not generalize to overall performance on the Eyes test. Based on post hoc power analyses computed by GPower 3 (Faul, Erdfelder, Lang, & Buchner, 2007), I had power levels of .98 and .99 to detect the moderate ($\eta_p^2 = .08$, or f = .29) and large ($\eta_p^2 = .15$, or f = .42) effect sizes reported by two prior studies that found overall impairment on the Eyes test among older adults (Phillips et al., 2002 and Slessor et al., 2007, respectively). Thus, according to these estimates, I had ample power to detect such effects. Importantly, a key difference between the prior two studies and the present one is the average education level of the older participants: for the prior studies it was secondary level, whereas for the present study it was undergraduate level. The present findings therefore suggest that performance on the Eyes test may remain relatively intact in older adults with advanced levels of education (it should be noted however that education was not a significant predictor of Eyes test performance in the present study). In combination with past research using verbal and pictorial theory of mind tasks that have also found no age differences in performance (Keightley et al., 2006; Maylor et al., 2002; McKinnon & Moscovitch, 2007; Saltzman et al., 2000; Slessor et al., 2007), the present findings raise the possibility that middle-aged and older adults may have abilities in theory of mind that are relatively comparable to that of young adults.

Evidence for Enhanced Cognitive Empathy Abilities Among Older Adults

Results supported the hypothesis that performance on an empathic accuracy task (i.e., emotional tracking of social interactions) would be lowest for young adults, intermediate for middle-aged adults, and highest for older adults. This pattern of age differences was consistent across positive, negative, and neutral moments. These findings appear to represent a quite different trajectory from the age-related declines on other cognitive empathy measures found in the present study and past studies (for a review, see Ruffman et al., 2008). That is, while older adults evidence certain specific deficits in emotional processing, they show enhanced performance when tracking moment-to-moment emotional changes under conditions that mimic real-world social contexts.

The superior emotional tracking observed among older adults is compatible with current neuropsychological and motivational models predicting age-related certain gains in socioemotional functioning. From a neuropsychological perspective, aging is associated with more complex dendritic branching (Prickaerts et al., 2004; Segovia et al., 2009; Sun & Bartke, 2007), which is thought to reflect accumulated learning over the lifespan. Some of this learning is likely social; that is, through increased interpersonal experience may come increased interpersonal knowledge that may aid in aging adults' abilities to understand the emotions of others. In addition to increased neural complexity, two compensatory changes in brain activity have been documented in healthy older adults: (a) a more bilateral pattern of frontal recruitment across right and left hemispheres (Cabeza, 2002; Cabeza et al., 2002; Pujol et al., 2002; Reuter-lorenz et al., 2000); and (b) a relative shift involving less posterior (i.e., occipitotemporal) and more anterior (i.e., frontal) brain activity (Davis, Dennis, Daselaar, Fleck, & Cabeza, 2008). Moreover, these shifts are associated with increased performance among older adults on certain cognitive tasks (e.g., working memory tasks in Cabeza et al., 2002; episodic retrieval and visual perception tasks in Davis et al., 2008), suggesting a mechanism for how older adults may compensate for specific losses by engaging more areas of the brain. Some researchers argue that

such shifts render the aging brain more capable of relativistic, dualistic, and "big picture" thinking (Cohen, 2006), skills important to navigating complex emotional situations. From a motivational perspective, better ability to track emotions in social interactions may come from age-related shifts in the desire to maximize the meaningfulness of environmental events and input, over and above the need for acquisition (Carstensen and Lockenhoff, 2003). Of note, there is evidence that empathic accuracy performance can be enhanced by increased motivation (e.g., giving participants money for greater accuracy), suggesting that older adults' greater motivation in socioemotional tasks might offer an advantage in such tasks (Klein & Hodges, 2001). In identifying a particular area of strength in the emotional processing of older adults, the present findings lend empirical support to a diverse set of theories about the nature of adult development and socioemotional functioning.

Middle-Aged Adults in the Middle

Interestingly, linear patterns were found for all age effects on cognitive empathy. Given the cross-sectional nature of the present study, it is impossible to know whether the age differences found truly reflect linear patterns of decline and improvement in specific cognitive empathy abilities across the adult lifespan. However, the present findings suggest that differences in cognitive empathy observed among older adults may appear not just in old age, but rather may emerge in middle age, if not earlier. This is perhaps not surprising given that many aging theories are suggestive of gradual change over the course of adulthood (e.g., gradual declines in gray matter volume after age 20 [Ge et al., 2002]; gradual accumulation of life experience over the lifespan).

Lack of Age-Matched Advantage

Hypotheses regarding an age-matched advantage were not supported. One prior study found an age-matched advantage on a task in which participants watched brief videotapes of emotional facial expressions and then made discrete emotion judgments (Malatesta et al., 1987). There are several possible reasons why this age-matched advantage did not generalize to the Eyes test or emotional tracking of social interactions.

Intriguingly, for the Eyes test an unexpected age "mismatch" effect was found such that young adults performed better at rating older eyes versus young eyes, older adults performed better at rating young eyes versus older eyes, and middle-aged adults performed equally well at rating both age targets. These findings bear resemblance to the assimilation effect (Saudino, McGuire, Reiss, Hetherington, & Plomin, 1995), or the tendency to overestimate similarity and use projection as a heuristic strategy for knowing what another is feeling or thinking. For example, monozygotic twins have been found to commit more assimilation errors (i.e., incorrectly project their own thoughts and feelings onto their twin) than dizygotic twins on emotional judgment tasks (Neyer, Banse, & Asendorpf, 1999). As a theory of mind measure, the stimuli of the Eyes test are intended to be more ambiguous and draw more on inferential reasoning than standard emotion recognition tasks. Future studies should examine systematically whether certain contexts (e.g., ambiguous, inferential tasks) are associated with greater assimilation error in detecting what another is feeling.

In contrast, no interaction between rater age and target age was found for the emotional tracking task. As noted previously, I used a method for assessing emotional tracking that attempted to maximize ecological validity. In this kind of dynamic, interpersonal context, it may be that the need to perceive another person accurately supersedes any age-matched effect.

Another possibility is that the design was not powerful enough to detect an in-group advantage that did exist. Given the minute effect size of the rater age by target age interaction ($\eta_p^2 = .00$) and the decent sample size (with 216 participants, the present design had a power of .91 to detect a moderate effect size), this possibility seems unlikely.

Relations Among Tasks and Predictors of Performance

Only minimal associations were found among cognitive empathy measures, consistent with findings from past studies on normal adults (Keightley et al., 2006; Phillips et al., 2002). For young adults, performance on the facial emotion recognition and emotional tracking tasks was positively correlated; for middle-aged adults, performance on the facial emotion recognition and Eyes test was positively correlated; and for older adults, performance on the facial emotion recognition and Eyes test was only marginally positively correlated. The low to moderate effect sizes (Cohen, 1988) associated with these correlations suggest that these processes, while all associated with the capacity for understanding what others are feeling, may be largely independent from one another. It is possible that these processes may be functionally distinct, exhibiting different associated neural circuitry. In terms of methodological implications, the low correlations suggest that these tasks are clearly not interchangeable, and results cannot be aggregated across methods. Moreover, the differences among age groups suggest that these processes may be differentially associated across the adult lifespan. Most notably, among middle-aged and older adults, although performance on the facial emotion recognition and Eyes tasks were associated, neither was associated with performance on the tracking task. This is perhaps not surprising given the divergent effects of age on cognitive empathy abilities in the present study: while older adults evidenced some deficits on cognitive empathy tasks involving isolated stimulus modalities, they exhibited better performance than young adults in tracking moment-to-moment emotional changes in social interactions.

Further, while self-reported cognitive functioning was a significant predictor of both recognition of older eyes and emotional tracking, it did not account fully for age differences on these tasks. This suggests that the age effects on these tasks capture something beyond general differences in cognitive functioning. This finding, along with the different patterns of age effects found across different measures of cognitive empathy, provide evidence against the idea of a strong general factor of emotional intelligence and highlight the multidimensional nature of the broad construct of cognitive empathy. Education and trait cognitive empathy did not predict performance on any task.

Gender Differences in Cognitive Empathy

Although it is a commonly held stereotype that women exhibit greater empathic abilities than men, relatively few gender differences have been found in studies using objective measures of cognitive empathy (Eisenberg & Lennon, 1983; Russell et al., 2007). Consistent with past research (Montagne et al., 2005), women performed better than men at rating negative facial expressions. Intriguingly, however, men performed better than women at rating positive (i.e., happy) facial expressions. While a prior study found no gender differences in rating happy expressions (Montagne et al., 2005), this study also reported a very strong ceiling effect for recognition of happy faces (i.e., mean accuracy for correct identifications was 100% for both men and women). In the present study, which included happy facial expressions at more subtle levels of expression, performance did not reach ceiling for any groups, making it more possible to examine potential group differences. While the present gender by valence interaction in facial

emotion recognition is novel, it is consistent with other gender by valence interactions found in emotion literature (Sarlani & Greenspan, 2002; Wrase et al., 2003). For example, neuroimaging research indicates that holding arousal constant, women show relatively stronger brain activity for negatively valenced pictures and men show relatively stronger brain activity for positively valenced pictures (Wrase et al., 2003).

For the Eyes test, a rater age by rater gender interaction was found such that only middle-aged adults showed gender differences on the Eyes test, with men outperforming women. A recent study also found that men outperformed women on a different test of theory of mind (Russell et al., 2007), and the authors suggested that this might be related to a male advantage that has been observed on certain inferential decision-making tasks (Reavis & Overman, 2001). However, this prior study, which included adults ages 20-45, did not examine age in conjunction with gender. Further studies are needed to determine the extent and reliability of interaction effects between age and gender on theory of mind tasks.

Finally, there were no gender effects in emotional tracking of social interactions, suggesting that under conditions that mimic real-world interpersonal contexts, men and women perform equally well at tracking moment-to-moment emotional changes. This is consistent with our prior research with this kind of tracking task (Levenson & Ruef, 1992) and a meta-analysis by Ickes and colleagues (2000) indicating that unless participants are primed to evaluate their performance, men and women perform equally well on tasks of empathic accuracy.

Overall, the present findings add to an increasing body of literature in which mixed results regarding gender differences in cognitive empathy have been found. While a reliable female advantage in cognitive empathy abilities has been found for infants, children, and adolescents (for facial emotion recognition see McClure, 2000; for theory of mind see Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991), it appears increasingly likely that these relatively straightforward gender differences do not extend into adulthood. Rather than supporting a model of simplistic and uniform gender differences in cognitive empathy abilities, the present findings highlight the importance of considering factors such as age, valence, and task type in understanding the nuances of gender effects in this domain.

Limitations

There are several limitations in the present study worthy of note. First, the cross-sectional design makes it impossible to determine whether differences among the three age groups were truly related to aging or were due to cohort or survivorship effects. For example, members of our older cohort grew up during the post-WWII era, and their experiences with widespread suffering and distress might have had an impact on their attunement to social interactions. Given that the present study is the first to my knowledge to assess age differences in moment-to-moment tracking of social interactions, it will be especially important to determine whether the present findings generalize to other populations (e.g., from different regional or educational backgrounds).

Second, as noted earlier, the emotional tracking task was designed to maximize ecological validity by using a task that more closely resembles the way emotions are communicated in the real world (i.e., real-time judgments from naturalistic behavior). However, one limitation of using naturalistic stimuli is the inevitable variability in individual targets and conversations. While the social interaction stimuli were selected using rigorous selection criteria designed to standardize the stimuli in key ways (e.g., demographic characteristics, positive to

negative emotion periods, ratability, etc.), there was no way to ensure that the conversations representing each age group were equivalent in all ways. Nonetheless, given that the older adults' advantage in emotional tracking held consistently across all age targets, it seems unlikely that the rater age effect was driven by certain idiosyncratic target stimuli.

A separate limitation of the tracking task was that in order to capture real-time emotional judgments of complex social interactions, emotional tracking was assessed in terms of moment-to-moment tracking of dimensional and not discrete emotion (as in the facial emotion recognition task). In exploratory analyses I found that neither impairment in older adults (as observed for discrete emotion recognition of facial expressions) nor enhancement in older adults (as observed for valence tracking of social interactions) could be observed for valence recognition of facial expressions. These results suggest that older adults may have relatively spared abilities in rating emotional valence compared to rating discrete emotion. However, these findings do not fully explain the *enhancement* in older adults observed in emotional tracking of social interactions, which I have argued may be explained in terms of a socioemotional theories of adult development. To further increase comparability across tasks, it would be helpful to administer a combined design in which observers rated both discrete emotions and emotional valence within the same task.

Fourth, the present study captured the broad construct of cognitive empathy using three specific tasks that assessed the ability to identify the emotions of others. Future studies should assess other components of empathy in the context of aging, including affective and prosocial components, as well as other aspects of cognitive empathy (e.g., the ability to interpret the thoughts or intentions of others). The modest correlations among tasks used in the present study also highlight the limitations of any singular task in fully capturing the complex, multidimensional construct of cognitive empathy.

Fifth, self-report data on cognitive functioning were collected from the present study. While expected relationships between self-reported cognitive functioning and cognitive empathy abilities were found, future studies would ideally include objective measures of cognitive functioning given the known limitations of self-report questionnaires (e.g., self-enhancement effects and other reporting biases).

Conclusion

As more research is conducted studying the psychological aspects of aging, it becomes increasingly clear that different aspects of functioning evidence different trajectories of change. Traditionally, research on aging has focused on themes of loss: loss of physical health, loss of loved ones, loss of cognitive abilities such as memory and executive functioning (Craik & Salthouse, 2007). More recently, a number of studies have documented robust areas of functioning in the socioemotional realm among older adults. In the present study, older adults showed evidence of both impairment and enhancement in aspects of cognitive empathy, indicating that divergent patterns may occur even within a single umbrella construct. Specifically, older adults performed worse than young adults on certain cognitive empathy tasks involving recognition of specific mental states from isolated stimulus modalities, but better on a cognitive empathy task involving tracking of naturalistic social interactions. In terms of real world implications, it is possible that older adults' selective deficits in cognitive empathy, particularly in the realm of discrete facial emotion recognition, may lead to interpersonal misunderstandings or difficulties in everyday life. If so, older adults could potentially benefit from trainings that directly address these known deficits. At the same time, emotional

information in everyday life is typically perceived not from static representations of facial expressions but rather from multiple modalities of dynamic information (e.g., intonation, nonverbal behavior, verbal content). Thus, if older adults possess intact and even enhanced skills in contexts where they can rely on information from multiple sources, this may offer certain benefits in terms of interpersonal functioning. This latter possibility may help to explain why overall emotional wellbeing appears to be preserved, and even enhanced, well into late life (Mroczek & Kolarz, 1998).

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Table 1

Group Means and Standard Deviations for Demographic Variables and Covariates

	Mean (SD)			Age effect		
	Young	*Middle-Aged*	*Older*	*F*	*p* value	η_p^2
Income (1-8)	2.22$_a$	2.99$_b$	3.31$_b$	6.24	<.01	.06
	(2.04)	*(1.90)*	*(1.82)*			
Education (1-6)	3.41$_a$	4.01$_b$	4.37$_b$	19.42	<.01	.15
	(.88)	*(.93)*	*(1.02)*			
Functional Health	1.11$_a$	1.29$_b$	1.29$_b$	8.29	<.01	.07
Problems	*(.20)*	*(.38)*	*(.32)*			
Cognitive	2.89	2.97	2.98	1.08	.34	.01
Functioning	*(.37)*	*(.41)*	*(.44)*			
Psychological	.55	.68	.47	2.90	.06	.03
Symptoms	*(.48)*	*(.56)*	*(.50)*			
Trait Perspective	3.70	3.67	3.62	<1	.80	.00
Taking	*(.69)*	*(.74)*	*(.74)*			

Note. Within each row, different subscripts denote significantly different means at *p* < .05.

Table 2

Facial Emotion Recognition Scores: Summary of ANOVA Results and Mean Scores by Response Emotion and Age Group

	Mean (SD)			Age effect		
	Young	*Middle-Aged*	*Older*	*F*	*p* value	η_p^2
Anger	5.51 (4.01)	6.35 (3.48)	6.39 (3.40)	1.27	.28	.011
Disgust	*8.45ₐ (3.35)*	*7.21 (3.39)*	*6.67ᵦ (3.22)*	6.09	<.01	.052
Fear	5.41 (3.00)	4.56 (3.09)	4.57 (3.28)	1.98	.14	.018
Happiness	7.78 (4.68)	7.07 (4.44)	7.11 (4.65)	<1	.43	.01
Sadness	7.74ₐ (3.40)	6.51 (3.60)	5.27ᵦ (3.66)	7.99	<.01	.068

Note. Within each row, different subscripts denote significantly different means at *p* < .05.

Table 3
The Eyes Test and Tracking Task: Mean Scores by Rater Age Group

	Mean (SD)		
	Young	*Middle-aged*	*Older*
The Eyes Test			
Young Target	2.85 (.96)	3.08 (.82)	3.17 (.96)
Middle-aged Target	2.50 (.95)	2.40 (.94)	2.50 (1.10)
Older Target	3.22_a (.85)	2.92 (.96)	2.77_b (.95)
Tracking Inaccuracy			
All Age Targets	2.40_a (.37)	2.29 (.35)	2.25_b (.31)

Note. Because there was no Rater Age by Target Age interaction for tracking performance, means are presented collapsed across target age. Within each row, different subscripts denote significantly different means at $p < .05$.

Table 4

Correlations Among Cognitive Empathy Tasks

		Mean (SD)		
		Young	*Middle-aged*	*Older*
Facial Recognition	Eyes Test	0.11	.33**	0.22†
Eyes Test	Tracking Accuracy	.24*	0.00	0.00
Tracking Accuracy	Facial Recognition	-0.03	0.16	0.04

Note. For ease of interpretation, tracking deviation (i.e., inaccuracy) scores were reverse scored (multiplied by -1) so that positive correlations would indicate that higher performance on one measure was associated with higher performance on another measure.

† $p < .10$. * $p < .05$. ** $p < .01$.

Table 5

Correlations between Participant Characteristics and Cognitive Empathy Measures.

Participant Characteristics	Facial Emotion Recognition	Eyes Test Performance	Tracking Accuracy
Education	-.07	-.06	.13†
Cognitive Functioning	.05	.16*	.14*
Trait Perspective Taking	.11	.09	.05

Note. For ease of interpretation, tracking deviation (i.e., inaccuracy) scores were reverse scored (multiplied by -1) so that positive correlations would indicate that higher performance on one measure was associated with higher performance on another measure.

† *p* < .10. * *p* < .05. ** *p* < .01.

Table 6

Self-Reported Cognitive Functioning and Age as Predictors of Eyes Test Performance and Emotional Tracking

	Eyes Test Performance	Emotional Tracking Accuracy
Cognitive functioning: β	.15*	.14*
R^2 increment	.022	.019
F increment with Covariate	4.96*	4.23*
Df	221	213
Age: β		
O vs. Y and M	-.08	.08
Y vs. M and O	.17*	-.12
R^2 increment with Age	.049	.031
F increment with Age	5.78**	3.43*
Df	219	211

Notes. For ease of interpretation, tracking deviation (i.e., inaccuracy) scores were reverse scored (multiplied by -1) so that positive associations would indicate that higher performance on one measure was associated with higher performance on a different measure. O, M, and Y = Older, Middle-aged, and Young participants, respectively.

* $p < .05$. ** $p < .01$

Appendix A
Stimuli selection Procedure for the Dyadic Empathic Accuracy Task

The stimuli for the task were selected by a procedure developed in previous research using this empathic accuracy task (Levenson & Ruef, 1992). Stimuli were selected from a pool of video recordings of 15-min conversations between married spouses from recordings obtained in previous studies of marital interaction conducted in this laboratory. The goals of the procedure were to choose 3.75-min segments of interactions in which the target spouse: (a) experienced a sufficient amount of emotion (i.e., rated themselves as feeling positive or negative for at least half the time); (b) experienced a relatively balanced amount of positive versus negative emotion; and (c) rated his or her own emotion in a way that was reasonable and not unduly idiosyncratic. For more details on this selection procedure, see Appendix A. To accomplish the first two goals, we made use of a scheme for reducing the rating dial data (Levenson & Ruef, 1992) in which the continuous ratings are averaged into 10-second periods. A parallel set of normalized rating dial data for the 15-minute interaction period was created using the means and standard deviation during the 5-minute pre-interaction period. Using these raw rating and normalized rating data each 10-second period during the pre-interaction and interaction was classified as negative, neutral, or positive (e.g., to be negative a period has to have an average raw rating dial position of 4 or less and a z-score of -.5 or less). Using these counts of negative, neutral, and positive periods, an eligible segment had to have at least half the periods classified as positive or negative and a ratio of positive-negative periods between .33-3.0.

To accomplish the second goal of selecting target segments with non-idiosyncratic ratings, we had the tapes of potential targets viewed by a panel of four judges (all of whom were trained in behavioral coding of emotion). These judges viewed the tape in real time, using the rating dial to rate how they thought *the target spouse was feeling during the interaction*. We selected 12 conversation segments for which there was general agreement between the emotional ratings provided by the target and the averaged ratings provided by the four judges. Agreement between the mean judges' ratings and the target's ratings was determined using lagged cross-correlation analysis. Specifically, we calculated the maximum cross-correlation between the mean judges' ratings and the target's ratings within lags of –5 s to +5 s. This time window allowed for possible temporal differences in rating dial usage. Following Cohen's (1988) criteria, correlations between the mean judges' ratings and target's ratings had to be greater than +0.3, indicating a positive correlation of at least a moderate effect size.

Appendix B
Cognitive Functioning Scale (10 items)

Self-reported cognitive functioning was assessed by 10 items taken from three self-report measures: (a) Functional Assessment Questionnaire (Pfeffer et al., 1982); (b) Attentional Control Scale (Derryberry & Reed, 2002); and (c) Primary Care Evaluation of Mental Disorders (Spitzer et al., 1994).

1. I am experiencing difficulty or need help with writing checks, paying bills, or balancing a checkbook. (FAQ12)
2. I am experiencing difficulty or need help with shopping alone for clothes, household necessities, or groceries. (FAQ13)
3. I am experiencing difficulty or need help with remembering appointments, family occasions, holidays, medication. (FAQ14)
4. It's very hard for me to concentrate on a difficult task when there are noises around. (ACS01)
5. When I need to concentrate and solve a problem, I have trouble focusing my attention. (ACS02)
6. I can quickly switch from one task to another. (-) (ACS10)
7. It is easy for me to read or write while I'm also talking on the phone. (-) (ACS14)
8. I have trouble carrying on two conversations at once. (ACS15)
9. It is easy for me to alternate between two different tasks. (-) (ACS19)
10. I have been bothered by having my thoughts come slower than usual or seem more mixed up than usual. (PRIME-MD®26)

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