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Brief Communication

Social cognition and healthy aging: Cross-sectional associations of emotion perception, theory of mind, and emotional empathy

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Abstract

Objective: Older adults are identified to have reduced social cognitive performance compared to younger adults. However, few studies have examined age-associations throughout later life to determine whether these reductions continue with advancing age. **Method:** This study assesses cross-sectional associations of emotion perception, cognitive and affective theory of mind (ToM), and emotional empathy in a healthy sample of 157 adults aged 50–89 years ($M = 65.31$, $SD = 9.00$, 68% female sex). Emotion perception, cognitive ToM, and affective ToM were measured using The Awareness of Social Inference Test Short Form (TASIT-S), while affective ToM was also measured using Reading the Mind in the Eyes Revised (RME-R). Emotional empathy was measured using the Empathy Quotient. **Results:** Multiple regression analyses, adjusting for multiple comparisons, revealed a moderate negative association between age and emotion perception for all emotions combined, as well as for sad and revolted expressions, but not happy, neutral, anxious, or angry expressions. Age had a negative, moderate association with first-order cognitive, second-order cognitive, and affective ToM measured using TASIT-S, but not RME-R. Age was not significantly associated with emotional empathy. **Conclusions:** This study contributes to the limited understanding of age-related associations of social cognitive performance throughout later life. This knowledge can inform future research examining the clinical utility of including social cognitive measures in neuropsychological screening and diagnostic tools for later-life neurological disorders.

Keywords: Social cognition; emotion perception; affective theory of mind; cognitive theory of mind; emotional empathy; cognitive aging theory

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Introduction

Social cognition is an umbrella term for a broad range of cognitive abilities underlying social interactions (Mitchell & Phillips, 2015) and includes emotion perception, affective theory of mind (ToM), cognitive ToM, and emotional empathy. Emotion perception involves identifying other people's emotions through verbal and non-verbal cues (Mitchell & Phillips, 2015). Affective ToM concerns inferring others' emotions, affective states, or feelings (Duval et al., 2011) and differs from emotion perception in that it requires more complex reasoning abilities and is more context and culture-dependent (Mitchell & Phillips, 2015). Cognitive ToM involves understanding others' cognitive states, beliefs, thoughts, or intentions and can be further separated into first-order and second-order dimensions, in which the perspectives of one versus two individuals are adopted (Duval et al., 2011). Emotional empathy is the emotional response to those expressed by others (Baron-Cohen & Wheelwright, 2004).

Extensive research has explored age-related associations of non-social cognitive abilities, such as processing speed, memory, and reasoning, and has uncovered that these abilities linearly decline throughout later life (Salthouse, 2010). Prior research indicates that older adults have reduced emotion perception, affective ToM, and first- and second-order cognitive ToM performance compared to younger adults (Duval et al., 2011; Ruffman et al., 2008), but do not differ on emotional empathy (Grainger et al., 2023). However, few studies have examined age-associations throughout later life to determine whether these identified performance reductions continue with advancing age like non-social cognitive abilities do. In particular, there is limited research examining performance in adults over the age of 75 years. Given that a recent meta-analysis identified that various neurological disorders which are prevalent after this age exhibit significant social cognitive impairments (Cotter et al., 2018), this is an important gap in cognitive aging theory.

Of the few studies that have examined social cognitive performance throughout later life and inclusive of adults over the age of 75 years, the majority have examined a single social cognitive domain only. Given social cognition is known to be a multidimensional construct, comparing performance between domains within the same sample is essential. This approach provides a more complete understanding of how social cognitive

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performance broadly is associated with age, rather than when performance is compared between samples.

Limited studies have examined two social cognitive domains. Kelly et al. (2022) examined total emotion perception and emotional empathy performance and found that older (66–94 years), compared with younger (17–35 years) and middle (36–65 years) adults had reduced emotion perception performance. Regarding emotional empathy, when examined using a questionnaire measure there was no effect of age, but when examined using picture stimuli, middle adults had significantly reduced emotional empathy than younger or older adults who did not differ (Kelly et al., 2022), although only with a small effect size. A different study by Baksh et al. (2018) examined cognitive and affective ToM and found that both were negatively associated with age. One study that has examined three out of four social cognitive domains is by McDonald et al. (2018) who examined total emotion perception, affective ToM, first-order cognitive ToM, and second-order cognitive ToM also using TASIT-S and reported reduced performance across all domains. However, McDonald et al. (2018) did not examine whether there were differential age associations for individual emotions. Given the meta-analysis comparing emotion perception performance of younger versus older adults by Ruffman et al. (2008) identified performance varied for individual emotions this is a considerable limitation. Specifically, Ruffman et al. (2008) found that age had a moderate, negative association with angry, sad, and fearful emotions, a small, negative association with surprised and happy emotions, and a non-significant association with disgust. Additionally, few studies have examined ToM performance within different types of social exchanges, which is important to consider given that inferring sarcastic but not sincere exchanges seems to be maintained with age (Martin et al., 2022). Therefore, this is the first known study to examine such a comprehensive examination of social cognition in a single sample of older adults over 75 years.

The present study aimed to investigate the cross-sectional associations between age and emotion perception, affective and cognitive ToM, and emotional empathy. Reading the Mind in the Eyes (RME) (Baron-Cohen et al., 2001) is a widespread measure of affective ToM that has been reported to have weak psychometric properties (Higgins et al., 2023). Despite these validity concerns, the RME is still a highly used ToM measure that was recommended in 2016 by the United States National Institute of Mental Health (NIMH) to assess ToM and has a continued high citation rate as of 2021 (Kim et al., 2024). Therefore, we wanted to examine whether affective ToM when measured using RME-R and TASIT-S, a highly ecologically valid measure (Honan et al., 2016), had a similar pattern of results. These measures demonstrating differential results would provide support for these psychometric concerns, specifically construct validity, of RME-R. As research indicates that sex (Demenescu et al., 2010), education level (Demenescu et al., 2010), depression (Bora & Berk, 2016), non-social cognitive functioning (Salthouse, 2010), hearing loss (Saatci et al., 2021), and social engagement (Kotwal et al., 2016) can impact social cognitive performance, these will be controlled for in analyses. It was hypothesized that affective ToM, first-order cognitive ToM, second-order cognitive ToM, emotion perception across all emotions, and the perception of happy, neutral, sad, anxious, and angry expressions would be negatively associated with age. The perception of disgusted expressions and emotional empathy was not hypothesized to be associated with age.

Materials and methods

Participants

The sample consisted of 157 adults aged 50–89 years ($M = 65.31$, $SD = 9.00$, 68% female sex) recruited from Australia and tested in person (55%) or via Zoom (45%). Exclusion criteria for the current sample included: non-Australian residents; less than 50 years of age; non-proficient English speakers; a diagnosed severe psychiatric, neurological, or neurodegenerative disorder; hearing or vision difficulties not currently fixed with the use of aids; and a diagnosed learning disorder. Participants received an honorarium of $20 AUD each. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The University of South Australia's Human Research Ethics Committee approved this study.

Design

A cross-sectional quantitative observational design was used. Informed consent was obtained from all participants before any data was collected. For those conducting their testing session in person, they completed testing at a University of South Australia campus. All participants first answered demographic questions (age, sex, and years of education), then completed questionnaire measures. Participants completed all behavioral measures in a counterbalanced order (TASIT-S, RME-R, and ACE-III), with testing typically lasting around two hours.

Measures

Emotion perception

Emotion perception was measured using The Awareness of Social Inference Test Short Form (TASIT-S) (Form A) Part 1, The Emotion Evaluation Test (Honan et al., 2016). This task required participants to watch ten short video vignettes of trained actors and name the strongest identifiable emotion in the scene from the following emotions: happy (score of 0–1), sad (score of 0–1), neutral (score of 0–2), anxious (score of 0–2), angry (score of 0–1), and revolted (score of 0–3). A total correct score (0–10) for each emotion and total emotion was examined, with higher scores representing better emotion perception.

Cognitive and affective ToM

First-order cognitive, second-order cognitive, and affective ToM was measured using The Awareness of Social Inference Test Short Form (TASIT-S) (Form A) Part 2, Social Inference Minimal, and Part 3, Social Inference Enriched (Honan et al., 2016). Participants were required to watch short video vignettes of trained actors and infer their thoughts, intentions, and feelings through "think" (first-order cognitive), "do" (second-order cognitive), "feel" (affective), and "say" (control measuring story comprehension) probe questions for each video vignette. Additionally, each vignette depicted one of four types of social exchanges, including sincere (score of 0–16), sarcastic (score of 0–20), enriched sarcastic (included extra contextual clues; score of 0–20), and lying (score of 0–16). The scores for these social exchange types reflect both cognitive and affective ToM performance. A total score (0–18 each) for first-order cognitive, second-order cognitive, and affective ToM was examined and for each social exchange type; higher scores represented better performance.

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Affective ToM was additionally measured using the Reading the Mind in the Eyes (Revised) (RME-R) (Baron-Cohen et al., 2001). While the RME-R is largely used as a measure of affective ToM, and is used as such here, broadly it is defined as measuring the ability to attribute mental states to others (Baron-Cohen et al., 2001). Participants were presented with 37 images of an actor's eyes and were required to select the best of four words that described the displayed affective state. Higher scores (0–37) represent better affective ToM.

Emotional empathy

Emotional empathy was measured using a subset of the Empathy Quotient (Baron-Cohen & Wheelwright, 2004), with 12 items identified as appropriate for measuring purely emotional empathy. Responses were measured on a four-point Likert scale ranging from "Strongly Agree" to "Strongly Disagree". Half the questions were reversed coded, with higher scores (0–24) indicating greater emotional empathy.

Non-social cognitive functioning

General cognitive functioning was measured using Addenbrooke's Cognitive Examination – III (ACE-III) (Hsieh et al., 2013). ACE-III is a brief cognitive screening tool which assesses the five cognitive abilities of attention, memory, verbal fluency, language, and visuospatial abilities. The ACE-III is widely used to screen for dementia, with clinical cut-off scores representing mild cognitive impairment (score of ≤ 88) or dementia (score of ≤ 82). Scores from each of the five subscales were summed together to create a total score ranging from 0-100, with higher scores representing better cognitive functioning. When assessed over Zoom, the remote administration guidelines for ACE-III were followed. Remote administration departed from normal administration with respect to the following: (1) visual stimuli were displayed using screen-sharing, (2) participants were asked to hold up all written and drawn materials so that screenshots could be taken, and (3) participants were asked to move their camera so that their actions to verbal prompts to interact with a pen and paper could be observed.

Social engagement

Social engagement was measured using the Lubben Social Network Scale – 6 (LSNS-6) (Lubben et al., 2006). LSNS-6 is comprised of six questions assessing the size of active and intimate networks of family and friends. Responses are measured on a six-point Likert scale ranging from 0 = "none" to 5 = "9 or more". Scores can range between 0 and 30, with higher scores reflecting greater social engagement.

Depression

Depression was measured using the Geriatric Depression Scale (Short Form) (GDS-SF) (Burke et al., 1991). The GDS-SF is comprised of 15 items with responses consisting of either "Yes" or "No". Five of the questions were reverse coded. The final score could range between 0 and 15, with higher scores reflecting greater depression severity. A score greater than five suggests depression.

Hearing

Hearing was measured using the Hearing Handicap Inventory in the Elderly Screening Version (HHIE-S) (Ventry & Weinstein, 1983). The HHIE-S contains 10 questions examining the emotional and social impacts of hearing loss in the elderly. Scores greater than 10 indicate hearing loss.

Statistical approach

Analyses were performed in R version 4.2.2. Correlations between each of the 16 outcome variables were identified using Spearman's rank correlation coefficient, and the results can be viewed in Supplementary Materials.

Sixteen multiple linear regressions for each social cognitive variable were run with the following predictors: age, sex, years of education, cognition, hearing, social engagement, and depression. Sex was coded as 0=male, 1=female. The following assumptions were first checked: normality of residuals (QQ plots and Shapiro-Wilk), linearity (Residuals vs. Fitted plots), and homoscedasticity (scale-location plots and Breusch-Pagan test). Most models did not display normally distributed residuals, and many were heteroscedastic, so robust regressions were run using robust covariance matrix estimation from the R package 'sandwich' (Zeileis et al., 2020). To correct for multiple comparisons, alpha was divided by the number of social cognitive domains examined (four: emotion perception, cognitive ToM, affective ToM, and emotional empathy), resulting in an alpha of .013 for each regression. Alpha was only corrected by four as the primary aim of the current study is to examine age associations for these four social cognitive domains. Although 16 regressions will be run to explore the nuances within each domain (i.e., the influence of individual emotions and types of social inferences), these are aligned with the four overarching social cognitive domains. Correcting alpha by a factor of 16 would be an excessively conservative approach and not reflect our primary interest in the four social cognition domains and their associations with age.

Minimally adjusted regression models with only age and sex included were run for each outcome variable. These regressions did not meaningfully differ from the full models in direction, effect size, or statistical significance, so results are only reported in Supplementary Materials.

Regression models with only age and testing mode were performed to examine whether testing in-person (coded as 0) versus via Zoom (coded as 1) impacted performance. As testing mode had only a moderate, negative association with the identification of sad expressions ($B = -0.39$, $p = 0.039$) and no other outcome variables, these results are only reported in Supplementary Materials.

Results

An overview of descriptive statistics for all study measures is displayed in Table 1. Additionally, normative data for ToM performance on TASIT-S is included in Supplementary Table 1 and is consistent with performance in the current sample. For Pearson's correlation coefficients between all study variables, refer to Supplementary Table 2. Results of the multiple linear regressions that were statistically significant can be viewed in Figure 1; for detailed numerical data, refer to Supplementary Table 3. For emotion perception, age had a negative, moderate association with sad ($\beta = -0.40$, $p < 0.001$) and revolted ($\beta = -0.26$, $p = 0.002$) expressions, as well as emotion perception total ($\beta = -0.31$, $p < 0.001$). Age did not significantly predict happy ($\beta = -0.09$, $p = 0.328$), neutral ($\beta = -0.07$, $p = 0.431$), anxious ($\beta = -0.19$, $p = 0.032$), or angry expressions ($\beta = -0.10$, $p = 0.342$). For ToM, age had a negative, moderate association

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Table 1. Descriptive statistics of the 157 healthy older adults aged 50–89 years

	50–59			60–69			70–79			80–89		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Emotion perception												
Happy (TASIT-S)	47	0.60	0.50	53	0.51	0.50	49	0.49	0.51	8	0.63	0.52
Neutral (TASIT-S)	47	0.51	0.55	53	0.42	0.50	49	0.41	0.54	8	0.38	0.52
Sad (TASIT-S)	47	0.94	0.25	53	0.72	0.45	49	0.61	0.49	8	0.50	0.53
Angry (TASIT-S)	47	0.98	0.15	53	0.96	0.19	49	0.92	0.28	8	0.88	0.35
Anxious (TASIT-S)	47	1.68	0.47	53	1.77	0.42	49	1.76	0.43	8	2.00	0.00
Revolted (TASIT-S)	47	2.45	0.62	53	2.26	0.76	49	2.20	0.74	8	1.38	0.52
Emotion total (TASIT-S)	47	7.15	1.16	53	6.64	1.13	49	6.39	1.35	8	5.75	1.04
Cognitive ToM												
First-order cognitive (TASIT-S)	47	15.15	1.46	53	14.77	1.78	49	13.86	1.54	8	11.88	1.73
Second-order cognitive (TASIT-S)	47	15.09	1.46	53	14.79	1.75	49	13.67	1.89	8	12.13	2.64
Affective ToM												
Affective (TASIT-S)	47	14.02	1.88	53	13.19	1.92	49	12.39	1.72	8	10.88	1.96
Affective (RME-R)	47	26.26	3.63	53	26.28	3.90	49	26.22	3.89	8	22.00	5.29
Cognitive and affective ToM combined												
Sarcastic exchanges (TASIT-S)	47	17.77	2.56	53	17.26	2.73	49	16.61	3.42	8	14.75	1.98
Sincere exchanges (TASIT-S)	47	12.51	2.79	53	11.62	3.73	49	10.65	3.49	8	9.13	4.22
Lying exchanges (TASIT-S)	47	12.11	1.98	53	12.19	2.61	49	10.82	1.98	8	10.38	2.50
Enriched sarcastic exchanges (TASIT-S)	47	16.68	2.31	53	15.91	2.54	49	15.39	2.23	8	13.25	2.82
Emotional empathy (EQ)	47	14.72	5.18	53	14.17	4.21	49	12.71	4.97	8	12.13	3.14
Control variables												
Hearing (HHIE-S)	47	3.53	5.18	53	3.85	5.14	46	6.83	8.12	8	9.75	7.29
Social engagement (LSNS-6)	47	17.60	6.37	53	19.83	5.21	49	17.35	6.14	8	16.13	6.81
Depression (GDS-SF)	47	2.40	3.21	53	0.85	1.28	49	1.24	1.81	8	1.13	0.99
Non-social cognition (ACE-III)	47	94.37	4.81	51	94.20	4.92	47	93.43	3.86	8	88.50	5.56
Education	47	15.84	3.91	53	16.33	4.05	49	15.11	4.58	8	14.63	3.58
Male sex	14			10			24			2		
Female sex	33			43			25			6		
In person testing	22			21			37			7		
Zoom testing	25			32			12			1		

Note: ToM = theory of mind, TASIT-S = The Awareness of Social Inference Test Short Form, RME-R = Reading the Mind in the Eye Revised, EQ = Empathy Quotient, HHIE-S = the Hearing Handicap Inventory in the Elderly Screening Version, LSNS-6 = Lubben Social Network Scale 6, GDS-SF = Geriatric Depression Scale Short Form, ACE-III = Addenbrooke's Cognitive Examination III.

with first-order cognitive (β=−0.34, $p < 0.001$), second-order cognitive (β=−0.36, $p < 0.001$), and affective ToM measured using TASIT-S (β=−0.40, $p < 0.001$), but did not significantly predict affective ToM measured using RME-R (β=−0.03, $p = 0.779$). For social inference, there was a negative, moderate association between age and sincere (β=−0.24, $p = 0.007$), lying (β=−0.23, $p = 0.004$), and enriched sarcastic exchanges (β=−0.29, $p < 0.001$), but a lack of an association with sarcastic exchanges (β=−0.18, $p = 0.020$). Finally, age did not significantly predict emotional empathy (β=−0.12, $p = 0.126$). For Figures comparing the β values for age across non-significant social cognitive variables, refer to Supplementary Figure 1.

Discussion

In an older adult sample up to 89 years, this study identified an age-related cross-sectional decline in emotion perception, cognitive ToM, and affective ToM, with small to moderate effect sizes and no age-related change in emotional empathy. The perception of some emotions (happy, neutral, anxious, and angry) does not appear to change in older age. Affective ToM was associated with an age-related decline when examined using TASIT-S but not RME-R. All but sarcastic exchange types were impacted by age, with moderate effect sizes. This is one of the few studies using a cross-sectional design to examine whether each of the four social cognitive abilities is negatively associated with advancing age in a sample of older adults up to 89 years.

Our finding that emotion perception does appear to change with advancing age supports our hypothesis and the results of both Kelly et al. (2022) and Moraitou et al. (2013), who also uncovered negative associations with age. Given that both these studies and the current study examined performance using video vignettes, it is unclear whether low ecologically valid emotion perception measures (e.g., static images) would also be sensitive to age effects. Our hypothesis that disgust recognition would not be significantly associated with age, but all other emotions would be, was not supported. Therefore, these results conflict with those by Ruffman et al. (2008) and partly with those by Moraitou et al. (2013), in which the identification of only disgust versus happy expressions were not impaired with age. While it appears that recognition of some emotions do remain intact throughout later life, it is clear that further research examining the influence of individual emotions on performance in older adults is warranted in order to reach a consensus on which emotions are spared and why.

The negative association between age and first-order cognitive, second-order cognitive, and affective ToM supports our hypothesis and previous research investigating performance in adults over the age of 75 years (Baksh et al., 2018; McDonald et al., 2018). A notable strength of our study was examining affective ToM performance using both RME-R and TASIT-S, given evidence that RME-R has weak psychometric properties despite its widespread use (Higgins et al., 2023). As only TASIT-S was sensitive to age effects in the current sample, this indicates that RME-R may not be suitable for examination in older adult populations. Regarding social exchange type, we found that all but sarcastic social exchanges (i.e., sincere, enriched sarcasm, and lying) were impaired with age. This is consistent with McDonald et al.'s (2018) results in which older adults over 75 years interpreted sarcastic exchanges more easily than sincere exchanges. Similarly, the results also align with those by Martin et al. (2022), in which

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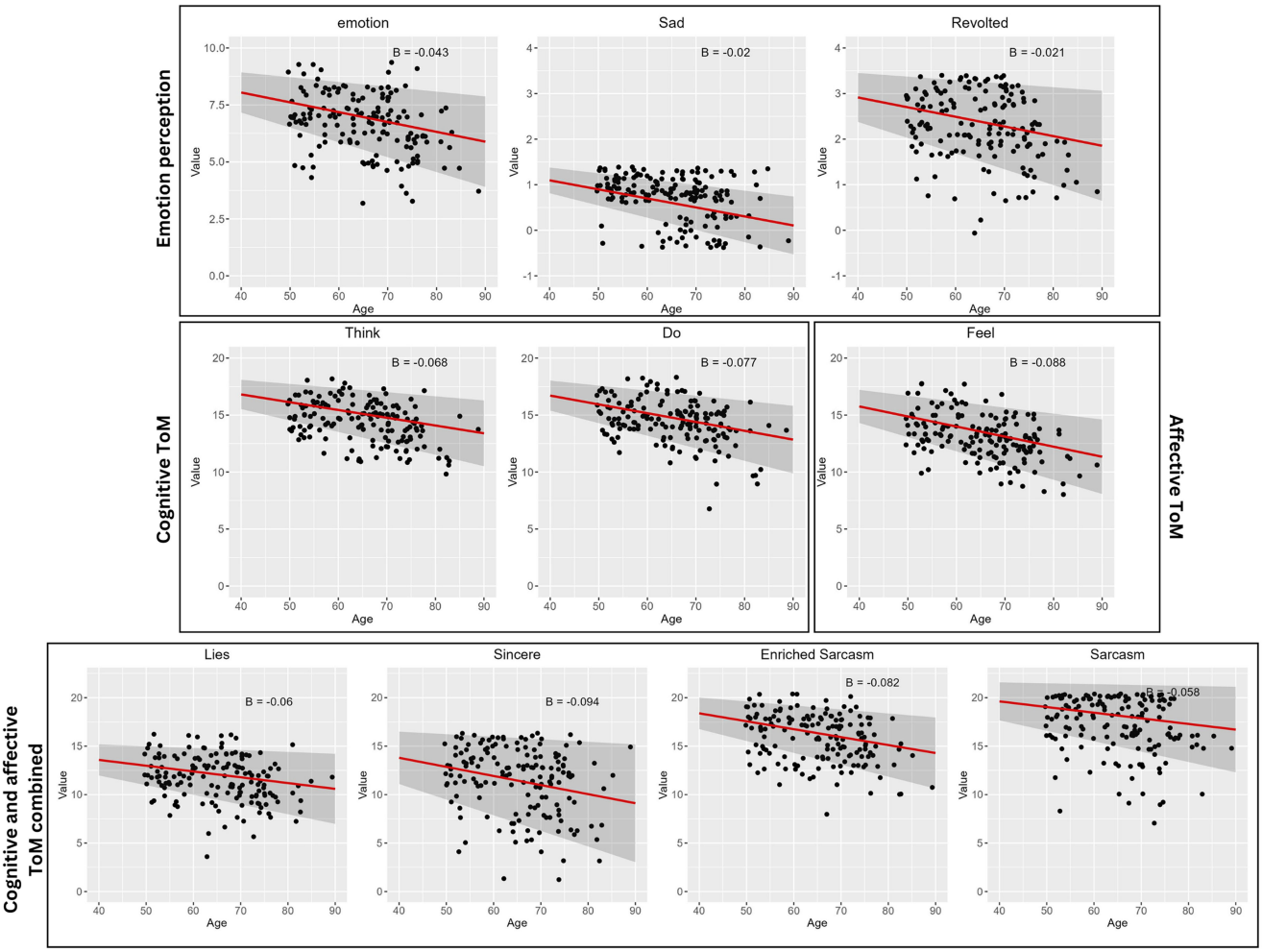

Figure 1. Visual comparison of β values for age across social cognitive outcome variables that were significantly associated with age. *Note*. All variables were measured using TASIT-S. The slope of line is equal to B (the unstandardized coefficient). Intercept is equal to the intercept of robust multiple regression model. All B were significant ($p < 0.013$), indicating that age was a significant predictor of the domain''s total score. Shaded areas indicate 95%CI of B.

their sample of older adults up to 81 years showed greater impairment in sincere, but not sarcastic, exchanges, also with a moderate effect size. To date, there is still little research examining the influence of social exchange type on ToM performance in older adults, likely contributing to the conflicting results, and this should continue to be explored.

As hypothesized, emotional empathy did not significantly change with age. To the author's knowledge, this is the first study to use the Empathy Quotient to examine emotional empathy performance throughout later life. However, this use of a questionnaire measure when all other social cognitive measures used highly ecologically valid measures is a limitation of the current study. Despite this, our results align with those of Grainger et al. (2023) and Kelly et al. (2022), who both used picture stimuli to examine emotional empathy performance in adults up to 101 years and 94 years of age, respectively. Given the limited examination of emotional empathy using measures with higher ecological validity than questionnaires in older adults over 80 years, this is an avenue for further research to explore. As emotional empathy is considered an emotional rather than cognitive function, this could explain why it was the only social cognitive ability not to significantly change with age.

This study has important limitations. The sample consisted of participants who were primarily younger than 80 years, with none aged over 89 years, and were from a Western, Educated, Industrialised, Rich, and Democratic (WEIRD) background. Additionally, a cross-sectional design was used to explore age associations. Therefore, we still do not know the longitudinal age associations in non-WEIRD populations over 80 years.

This study contributes to the limited understanding of age-related associations of social cognitive performance throughout later life. Given that extensive research has determined the age-related associations of other cognitive functions, including processing speed, vocabulary, memory, and reasoning (Salthouse, 2010), the lack of research examining social cognitive abilities is a significant gap in the understanding of cognitive aging. A systematic review of 31 meta-analyses indicates that social cognitive deficits are observed in various later-life neurological disorders and could be a marker of future dementia diagnoses (Cotter et al., 2018). Therefore, we must address this gap in our understanding so that future research can explore the clinical utility of including social cognitive measures in existing neuropsychological screening and diagnostic tools for such neurological disorders.

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Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S135561772400033X

Data availability. All R code and de-identified data are available publicly on GitHub (https://github.com/ALJarvis/SocialCognitiveAgeing).

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Competing interests. The authors declare none.

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