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RESEARCH ARTICLE



Attachment and inter-individual differences in empathy, compassion, and theory of mind abilities

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ABSTRACT

Social processing, namely the ability to understand others' cognitive and affective states, is crucial for successful social interaction. It encompasses socio-affective abilities such as empathy and compassion, as well as socio-cognitive abilities such as theory of mind (ToM). This study examined the link between social processing and attachment. Our study goes beyond previous research in that social processing abilities were assessed in a single, state-of-the-art behavioral paradigm using video narratives, the EmpaToM. Attachment was captured with the Adult Attachment Interview ($N = 85$; 50.60% women, $M_{\text{age}} = 25.87 \pm 4.50$ years) measuring participants' present-day capacity to think about and communicate attachment-relevant information about the past. Additionally, a self-report attachment questionnaire was employed ($N = 158$). We found that AAI-based attachment security (vs. insecurity) was associated with higher behavioral ToM abilities. Furthermore, self-reported attachment avoidance was negatively correlated with behavioral compassion abilities. Our findings provide further evidence that interview-based and self-reported attachment measures do not converge, but may rather be understood as capturing different facets of attachment that relate to different components of social processing. We conclude that individuals with secure, non-avoidant attachment show social abilities that allow them to better understand others' thoughts and generate positive, caring emotions in face of others' distress.

Highlights

- Attachment is differentially associated with distinct behavioral social processing abilities, that is, compassion and theory of mind.

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- Higher attachment security in the Adult Attachment Interview (AAI) is linked to higher behavioral theory of mind abilities.
- Increased self-reported attachment avoidance is linked to lower behavioral compassion.

1. Introduction

In today's complex and globalized society, fostering positive social relations is crucial. Consequently, strong social processing skills, including the ability to understand the cognitive and affective states of others as well as to predict their actions and motivations, are central for successful interactions. To understand how individual differences in attachment shape these social processing skills, our study examined their link with adult attachment, assessed in terms of participants' capacity to think about and communicate attachment-relevant information about the past, and using self-report questionnaires.

Social processing skills encompass socio-affective abilities like empathy and compassion, and socio-cognitive abilities like theory of mind (ToM; Schurz et al., 2021). Empathy is defined as the ability to understand how someone feels by creating a similar feeling in oneself, yet recognizing that the source of the feeling comes from the other person (de Vignemont & Singer, 2006). While empathy is feeling *with* others, compassion is feeling *for* another person. It is characterized by feelings of warmth, concern, care, and a strong motivation to improve another's wellbeing (Singer & Klimecki, 2014). ToM is the cognitive ability of inferring and reasoning about another person's perceptions, beliefs, thoughts, or emotions (Frith & Frith, 2005; Kanske, 2018). In ToM, another's affective state is not experienced, but conceptually represented. Behavioral and neural evidence indicate the independence of socio-affective social processing and ToM abilities (Kanske et al., 2016).

The quality of our social interactions is not only shaped by our social processing abilities but also by our attachment experiences, which presumably foster social processing abilities from an early age on. Accordingly, experiences of responsive and continuously available caregivers were shown to relate to social competencies later in life; yet effects are modest, hinting at additional influencing factors (Groh et al., 2017). By theory, repeated interactions with primary caregivers tend to become internalized as inner working models (IWMs) of attachment, thereby influencing our perception of future social situations including the evaluation of our own and others' emotional signals as indicators of affective states (Bretherton & Munholland, 2016).

In the early 1970s, different attachment patterns were identified in children's behavioral responses during separation and reunion with their mothers in the "strange situation" paradigm utilized in developmental psychology (Ainsworth & Bell, 1970). A few decades later, considerations of attachment were extended to adulthood assuming that with age IWMs become organized on a representational level and are best captured using narratives (Main et al., 1985). Research on adult attachment became a strong branch in social psychology. Despite distinct methodological approaches, both traditions largely agree with the presence of three main attachment patterns: secure, insecure-preoccupied, and insecure-dismissing (also referred to as anxious and avoidant, respec-

tively, in self-reports) (Hazan & Shaver, 1987; Main et al., 1985). Securely attached individuals are comfortable in their relationships and able to seek support. Insecure-preoccupied attachment is associated with fear of rejection and a strong desire for closeness. Lastly, insecure-dismissively attached individuals have a great sense of autonomy and tend to emotionally distance themselves from others (Main et al., 1985). Aim of the current study was to better understand the link between attachment and social processing abilities. Adult attachment was assessed using the semi-structured Adult Attachment Interview (AAI; George, Kaplan, et al., 1985). Indicators of empathy, compassion and ToM were collected at the same time in a behavioral computer-based task based on responses to video narratives (EmpaToM; Kanske et al., 2015).

Previous studies on relations between attachment and empathy found that attachment security activated through priming, i.e. the unconscious activation of mental representations, was linked to increased behavioral empathic abilities, which was attributed to the positive internal working models of self and others in secure attachment (Mikulincer et al., 2001). Also, both primed and self-reported attachment security were associated with decreased behavioral (Mikulincer & Shaver, 2005; Mikulincer et al., 2001) and self-reported (Ardenghi et al., 2020) personal distress, which is often considered a measure of affective empathy (Davis, 1983b). In a reverse pattern, self-reported attachment avoidance and anxiety were both linked to lower behavioral empathy (Mikulincer et al., 2001), and self-reported attachment anxiety was associated with higher behavioral (Mikulincer & Shaver, 2005; Mikulincer et al., 2001) and self-reported personal distress (Ardenghi et al., 2020; Britton & Fuendeling, 2005; Joireman et al., 2002; Trusty et al., 2005).

Regarding compassion, both primed and self-reported attachment security show a consistent link with increased behavioral (Mikulincer & Shaver, 2005; Mikulincer et al., 2005) and self-reported (Ardenghi et al., 2020; Joireman et al., 2002) compassion. Contrarily, self-reported attachment avoidance was linked to both lower behavioral (Mikulincer & Shaver, 2005; Mikulincer et al., 2005) and self-reported (Ardenghi et al., 2020; Péloquin et al., 2011) compassion, possibly due to limited interest in others' perspectives (Mikulincer et al., 2005). Research on self-reported attachment anxiety and compassion has not provided consistent results to date (see e.g. Ardenghi et al., 2020; Britton & Fuendeling, 2005; Joireman et al., 2002; Mikulincer & Shaver, 2005; Péloquin et al., 2011).

Concerning ToM, meta-analytic evidence suggests a positive association between ToM abilities and attachment security, captured with different attachment measures, in children (Szpak & Białecką-Pikul, 2020). In adults, self-reported secure attachment consistently and positively correlated with self-reported cognitive empathy or perspective-taking capacities (Joireman et al., 2002; Troyer & Greitemeyer, 2018). Showing the reverse pattern of results, self-reported attachment avoidance was also linked to lower self-reported cognitive empathy (Ardenghi et al., 2020; Péloquin et al., 2011). Studies examining self-reported anxiety and perspective taking abilities have yielded inconsistent results to date (Britton & Fuendeling, 2005; Joireman et al., 2002; Péloquin et al., 2011).

The current state of research on the link between attachment and social processing suffers from two main shortcomings. First, the variables of interest were mostly measured using self-report instruments, introducing potential bias associated with respondents' introspective abilities or social desirability effects (Paulhus & Vazire, 2007). Some studies also utilized priming techniques, instead of trait measures, adding complexity to the

interpretation of obtained results. Second, most studies focused on only one aspect of social processing – i.e. either empathy, compassion or ToM – thereby hindering direct comparisons within the same sample.

With regard to methodology, it has to be noted that there is only a trivial-to-small overlap between self-reported attachment and attachment indexed by the AAI. The two outcomes can therefore not be treated as interchangeable (Roisman et al., 2007). Instead, it is crucial to acknowledge that both measures substantially tap into different dimensions of attachment, with self-report measures mainly relying on feelings and thoughts in relationships with romantic partners. In contrast, adult attachment as assessed in the AAI reflects the capacity to provide a coherent narrative about the past, and is based on mostly unconscious internalized representations. Accordingly, coding of the AAI transcript is based on a complex system that requires extensive training, and is considered the gold-standard of assessing adult attachment (Main et al., 1985). Because the AAI also takes into account the ability to take an empathic position towards caregivers (unless a history of abuse or very harsh parenting is present), it is particularly suitable for answering the current research question. Studies linking social processing abilities to attachment using narrative measures are rare and – to our knowledge – limited to non-adult samples. In children, attachment assessed using a story stem task was associated with increased behavioral ToM abilities (Villachan-Lyra et al., 2015; but see Greig & Howe, 2001). From an attachment theory perspective, this relationship makes sense, as narrative attachment assessments are based on the ability to coherently reflect upon self and others emotions and perspectives. Self-report measures may not be able to fully capture this capacity which is thought to be rooted in early child-caregiver relationships.

Aiming to acquire a more consistent and comprehensive picture of the relationship between adult attachment patterns and social processing abilities, we used a multi-modal approach. We assessed different components of social processing in healthy male and female participants utilizing the computer-based EmpaToM (Kanske et al., 2015), which allows separation of affective (empathy, compassion) and cognitive (ToM) social processing abilities within a single task. The EmpaToM was validated on the basis of functional imaging studies, showing that the derived behavioral outcomes separately and specifically correlate with brain activation patterns previously linked to empathy, compassion and ToM (Kanske et al., 2015). In a sample of 85 participants, attachment was primarily assessed using the AAI, an interview to reliably gauge adult attachment representations via the discourse of early attachment experiences with caregivers. The utilized methodology allowed for a less biased assessment of our variables of interest. For a comparison with self-report data, attachment was additionally captured using a self-report questionnaire (Experiences in Close Relationships, ECR-R; Ehrental et al., 2009; Fraley et al., 2000) in 158 participants.

Our data were part of a larger project examining attachment, empathic abilities, and stress reactivity in romantic couple dyads. Eighty-five participants (one partner per couple) completed the AAI, the number was doubled ($N = 170$) for EmpaToM testing completed by both partners of the tested couples, and reduced to $N = 158$ for self-report questionnaires due to partial drop outs. The study and hypotheses were preregistered under AsPredicted #91685. Based on the hypothesis of more positive IWMs of self and others, and more efficient emotion regulation related to secure attachment, we expected that independent of sex, affective (empathy and compassion) and cognitive empathic

abilities (ToM) would be higher in securely compared to insecurely attached individuals. Since evidence suggests that self-report measures and the AAI tap into different dimensions of attachment, we did not expect associations to be comparable across measures. Due to the lack of studies comparing the two measures in this area, we did not have a clear prediction of specific correlational patterns.

2. Methods

2.1. Participants

Eighty-five heterosexual couples participated in this study ($M_{\text{age}} = 26.03 \pm 4.42$ years, 50% women). Inclusion and exclusion criteria were chosen regarding diverse biomarkers assessed in the context of an acute stress testing session. All study candidates first underwent a telephone interview to screen eligibility. Only individuals in a romantic relationship for at least 6 months, aged 20–40 years, right-handed, and normal-weighted ($\text{BMI} < 30$ and > 18) were included. Excluded were those who had previously participated in a standardized psychosocial stress task, were pregnant, chronically ill (including current mental disorders), taking steroid-containing or blood-flow-changing medications, hormonal contraceptives, also those with regular cigarette smoking (> 5 cigarettes per week), and alcohol or recreational drug consumption. To screen for recreational drug use, participants underwent a rapid drug test upon arrival at the laboratory. Participants tested after October 2021 required vaccination and a negative COVID-19 test. The study was approved by the Research Ethics Board of Leipzig University (EthicsID: 285/19-ek). Participants provided written informed consent, could withdraw from the study anytime, and received financial compensation.

2.2. Study design

Participants attended two testing days. Due to Covid-19-specific contact restrictions, there was a considerable time gap between these two days (6.24 ± 10.20 weeks). On one day, the AAI and EmpaToM task were conducted. Only one of the partners underwent the AAI, a role that was randomly assigned as a function of dyad number: for odd-numbered dyads, the female partners and for even-numbered dyads the male partners were selected. On the second testing day, participants completed self-report questionnaires and an empathic stress paradigm. Empathic stress data will be reported elsewhere. Testing day order was randomized such that 40 couples attended AAI and EmpaToM on the first day, and 39 on the second day. Six couples only participated in AAI and EmpaToM testing.

2.3. EmpaToM

The EmpaToM task (Kanske et al., 2015) reliably differentiates three socio-affective and socio-cognitive components of social processing: empathy, compassion, and ToM (Tholen et al., 2020). During the 35-minute video-task, participants watch short sequences of actors portraying allegedly autobiographic episodes (Figure 1), either with (a) negative or neutral emotional valence and (b) ToM demands or not. Each video stimulus lasts for

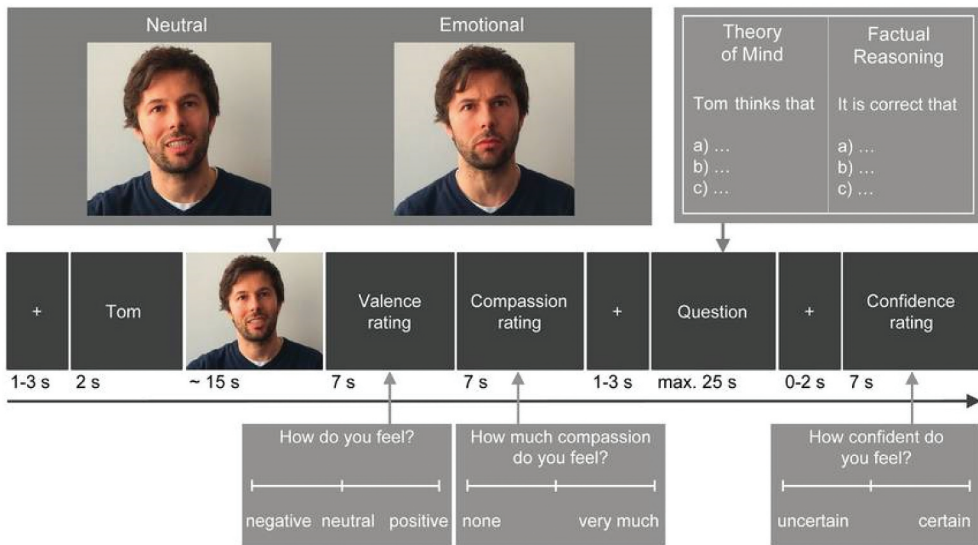


Figure 1. EmpaToM Task: exemplary sequence. In each trial, participants view emotionally negative or neutral videos of a male or female actor sharing autobiographical experiences. The videos require either theory of mind (ToM) inference or factual reasoning. Participants then rate their own affect and compassion towards the video's protagonist. Valence ratings for negative vs. neutral videos measure empathy, indicating how much participants share the protagonist's negative emotions. Afterwards, participants answer content-based multiple-choice questions requiring ToM inference or factual reasoning, rating their confidence in their answers, assessing ToM abilities. Exemplary images in the figure are illustrative and not based on the original video stimuli due to license restrictions. Figure taken from (Reiter et al., 2017).

15 seconds, with 12 trials per condition and 12 different narrators to control for possible narrator effects. After each video, participants rate their affect ("How do you feel?") and compassion ("How much compassion do you feel?"). Subsequently, they answer questions about the video content: in the ToM condition about the narrator's thoughts, goals, and intentions; in the non-ToM condition about factual reasoning concerning the narration. Additionally, participants rate their confidence in each answer to assess meta-cognitive abilities.

Empathy was operationalized as more negative emotional ratings after emotionally negative videos. It was calculated as the absolute difference in affect ratings between emotionally negative and neutral videos, thus controlling for participant's general mood. Compassion was assessed by averaging the compassion ratings across all four video conditions. ToM ability was operationalized as a composite of speed and accuracy, calculated by subtracting z-scored ToM accuracy and reaction time means, and dividing the result by two thus controlling for individual response strategies (procedure as used in Blasberg et al., 2022).

2.4. Adult attachment interview

Attachment representations were assessed with the Adult Attachment Interview (AAI; George, Kaplan, et al., 1985), a one-hour semi-structured interview in an one-on-one

setting. The AAI consists of a series of questions targeting participants' early childhood experiences and aims to "surprise" the consciousness (George, Kaplan, et al., 1985). Rather than relying on what is explicitly said, it assesses an individual's current evaluation and integration of experiences into their personal biography in terms of a coherently presented narrative. In detail, participants are asked to describe the relationship to their primary caregivers, experiences of separation, loss, and traumatizing events. The AAI is considered the gold-standard measure of adult attachment and has excellent psychometric properties (Crowell et al., 1996; Van IJzendoorn, 1995). In our study, four trained interviewers conducted the interviews, which were audio recorded and transcribed verbatim. Coding followed the AAI coding manual (Main et al., 2002), rating an individual's state of mind regarding attachment on 11 scales and classifying it as secure, insecure-dismissing or insecure-preoccupied. Coherence of discourse – reflecting a comprehensive narrative without contradictions (Main et al., 1998) – mainly distinguishes between secure and insecure attachment representations. Following a continuous approach, we used "coherence of transcript" (ranging 1–9) as an additional indicator of attachment security as it is considered to be the most important state-of mind scale (e.g. M. Bakermans-Kranenburg & van IJzendoorn, 2009; Waters et al., 2001). Further, the AAI scoring method involves rating the transcripts on additional subscales to assign individuals to attachment categories (e.g. derogation/idealization towards caregivers, loving caregivers). It assesses participants' inferred experiences with caregivers during childhood – for instance, maternal or paternal love or rejection – and the coherence of their discourse about these experiences, which entails, among others, idealization or derogation of caregivers. To provide a more refined and in-depth analysis as proposed by M. Bakermans-Kranenburg and van IJzendoorn (2009), we also included relevant AAI subscales into an exploratory analysis. Transcripts were rated by two coders with reliability certification by Mary Main and Erik Hesse who were blind to all other data. To check cross-reliability between the two independent coders, 15 transcripts were double-coded. Coders achieved good agreement ($\kappa=.61, p = .01$) for AAI classification and the coherence of transcript scale (two-way mixed ICC = .88, $p < .001$).

2.5. Questionnaires

Participants completed questionnaires via an online platform. The Experiences in Close Relationships Revised Questionnaire (ECR-R; Ehrental et al., 2009; Fraley et al., 2000) assessed attachment to romantic partners using an avoidance and an anxiety scale.

2.6. Statistical analysis

2.6.1. Data preprocessing

Non-obvious outliers beyond 3 SD from the mean were winsorized to 3 SD and included in subsequent analyses. Data was excluded for non-compliance with task instructions.

2.6.2. Main analysis

Analyses were performed with R, version 4.1.2 (R Core Team, 2020), and conducted in two samples. Sample 1 was made up of all participants attending the AAI ($N = 85$), whereas sample 2 was made up of the AAI participants and their romantic partners ($N = 158$; due to

partial drop-outs). For sample 1, three linear models were conducted with behavioral empathy (1), compassion (2), or ToM (3) (assessed with the EmpaToM) as dependent variables. AAI attachment (secure/insecure) was used as categorical predictor. Additionally, three linear models were conducted featuring again behavioral empathy (1), compassion (2), or ToM (3) as dependent variables. Here, attachment security, operationalized as the continuous coherence of transcript variable, was used as predictor. If a significant association with AAI classification was found (i.e. for ToM), we examined relevant AAI subscales in an exploratory manner. In a first step, we correlated all relevant AAI subscales with ToM abilities. Subsequently, the AAI subscales showing significant correlations with ToM were used to construct a linear model. Thus, the linear model was conducted with ToM as dependent variable and the AAI subscales “derogation” and “idealization of mother” as predictors. Within the AAI subscales, missing values were replaced using the mean of the respective attachment group as an estimator.

Sample 2 analyses used three linear models: behavioral empathy (1), compassion (2), or ToM (3) as dependent variables, and self-reported ECR-R attachment (avoidance and anxiety scales) as continuous predictors.

A Bonferroni correction was employed to control for the effects of multiple testing within conceptual clusters, setting the significance threshold at $p \leq (.05/3) = .017$ for identical analyses conducted on behavioral empathy, compassion, and theory of mind. In all analyses, we controlled for sex and age due to significant associations found between sex and AAI attachment security, and age and ECR-R avoidance (see Results). Due to the limited number of individuals classified as insecure-preoccupied ($N = 2$) and unresolved in our sample ($N = 1$), we performed additional sensitivity analyses excluding these cases. Upon exclusion, no statistically significant differences were observed within the reduced sample. Therefore, the $N = 3$ insecure-preoccupied and unresolved participants were included in the dataset.

Originally, we planned the study for 80 dyads. Due to COVID-19 restrictions, recruitment was severely delayed, and therefore the study was preregistered for 60 dyads. Eventually, with COVID-19 restrictions being dropped, it was possible to increase the sample to 85 dyads (allowing to compensate for partial drop-outs), which were all included in the analysis. Results changed in significance level with increasing sample size but not in pattern (see Supplemental Results).

3. Results

3.1. Descriptive statistics

3.1.1. Adult Attachment Interview sample

AAI data was collected for 85 participants, but coding was only possible for $N = 83$ (50.60% women, $M_{\text{age}} = 25.87 \pm 4.50$ years) due to technical problems with the recordings. Out of 30 insecure classifications, 28 were insecure-dismissing, two insecure-preoccupied, and one unresolved. Chi squared test revealed a significant sex difference between secure and insecure participants, with more women in the secure than the insecure classification. There were no significant age differences between attachment classifications (two-sample t-test; Table 1). Mean coherence of transcript ranged at 4.66 ± 1.61 . There were no significant associations between AAI attachment classifications and ECR-R anxiety scores

Table 1. Demographics and descriptive statistics including participant's AAI attachment.

	Secure	Insecure	<i>p</i>	<i>t</i> (<i>df</i>)	χ^2 (<i>df</i>)
N	53 (64%)	30 (36%)			
Women	33 (79%)	9 (21%)	<.01**		6.74 (1)
Age	25.87 ± 4.56	25.87 ± 4.47	.67	-0.43 (56)	

Age is reported in years; *** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$.

(*t*-test; $t(66.00) = 1.06$, $p = .29$). ECR-R avoidance was significantly higher in the group of secure compared to insecure participants ($t(74.93) = 3.07$, $p = .003$). Exploratory analyses (Table S6) revealed a negative correlation of ECR-R anxiety with the AAI subscale "loving mother" ($r(75) = -.22$, $p = .03$). ECR-R avoidance correlated positively with the subscales "neglecting father" ($r(75) = .34$, $p = .002$) and "angry mother" ($r(75) = .30$, $p = .008$), and negatively with the subscales "loving father" ($r(75) = -.25$, $p = .03$), "idealization mother" ($r(75) = -.24$, $p = .03$) and "idealization father" ($r(75) = -.27$, $p = .02$).

3.1.2. Experiences in Close Relationships Revised sample. ECR-R data was collected from 158 participants, but only scored for $N = 157$ participants (49.68% women, $M_{\text{age}} = 26.03 \pm 4.42$ years) because of incomplete data entry of one participant. Mean attachment avoidance ranged at 1.87 ± 0.66 , and anxiety at 2.34 ± 0.77 . Males and females did not differ in attachment anxiety ($t(152.87) = 0.49$, $p = .63$) or avoidance (*t*-tests; $t(153.8) = 0.19$, $p = .85$). *T*-tests revealed a positive association of age with attachment avoidance ($t(155) = 3.24$, $p = .001$) but not anxiety ($t(155) = 1.34$, $p = .17$).

3.2. Main analysis

3.2.1. Adult attachment interview

There was a significant association between AAI-derived attachment representations and cognitive social processing in the EmpaToM, such that ToM abilities were higher in individuals with secure (vs insecure) attachment. This was true both for attachment measured as a categorical variable (Figure 2) and the dimensional/continuous coherence of transcript variable. There were no significant associations between attachment representations and EmpaToM-derived affective social processing abilities, that is, empathy or compassion (Table 2 and S5).

Exploratory subscales analysis showed that ToM abilities were significantly negatively correlated with "idealization mother" ($r(81) = -.33$, $p = .002$) and "derogation mother" ($r(81) = -.28$, $p = .01$) (Table S6). A linear model with "idealization mother" and "derogation mother" as predictors also revealed a significant negative association between both scales and ToM abilities (Table 3).

3.2.2. Self-reported attachment (ECR-R)

Using the ECR-R, we found a significant negative correlation between attachment avoidance and EmpaToM-derived compassion (Figure 3). There were no significant associations between EmpaToM-derived empathy and ToM abilities with ECR-R-derived attachment (Table 4).

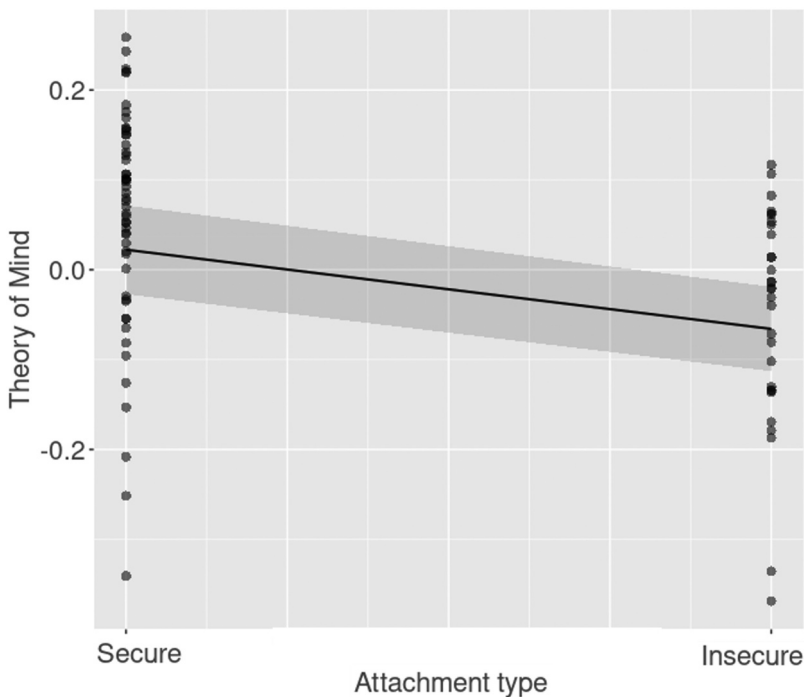


Figure 2. Association of theory of mind abilities with attachment security. Linear models revealed that secure attachment correlated positively with theory of mind abilities ($p=.01$). Attachment security was assessed with the adult attachment interview (AAI; George, Kaplan, et al., 1985), theory of mind abilities with the EmpaToM, a behavioral computer-based paradigm (Kanske et al., 2015).

Table 2. Three linear models predicting categorial (secure vs insecure) AAI attachment.

	Empathy				Compassion				Theory of Mind			
	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>
Intercept	51.32	11.69	4.39	<.001***	54.42	9.02	6.03	<.001***	0.87	0.09	9.89	<.001***
Attachment (categorical)	-3.73	3.94	-0.95	.35	0.88	3.04	0.29	.77	-0.08	0.03	-2.63	.01*
Age	-0.59	0.41	-1.43	.16	0.22	0.32	0.69	.49	<0.01	<0.01	1.40	.17
Sex	-5.56	3.99	-1.43	.16	-2.25	3.01	-0.75	.46	0.05	0.03	1.62	.11

*** $p \leq .0003$, ** $p \leq .0033$, * $p \leq .0167$ after Bonferroni correction.

4. Discussion

The current study investigated the link between adult attachment and social processing. Going beyond prior studies, both variables were assessed with methods aiming for unbiased accounts of experience: social processing, namely empathy, compassion, and ToM were probed in a single task using the behavioral EmpaToM paradigm, capturing responses to video narratives. Attachment representations were assessed with the AAI, the current gold-standard interview-based attachment measure. Additionally, we employed a standardized self-report questionnaire for romantic attachment to compare

Table 3. Linear model associating theory of mind abilities with AAI subscales idealization mother and derogation mother.

	Theory of Mind			
	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>
Intercept	0.03	0.10	0.31	.76
Idealization Mother	-0.02	<0.01	-2.16	.03*
Derogation Mother	-0.07	0.03	-2.12	.04*
Age	<0.01	<0.01	1.12	.27
Sex	0.04	0.03	1.48	.14

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$.

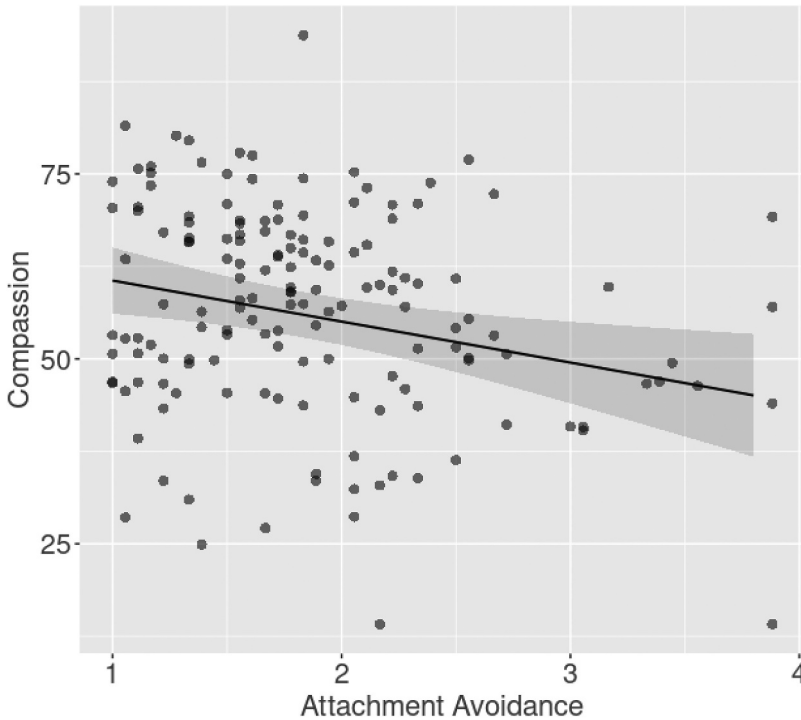


Figure 3. Association of compassion with subjective attachment avoidance. Linear models revealed that subjective attachment avoidance correlated negatively with compassion ($p = .006$). Attachment avoidance was assessed with the experience in close relationship questionnaire (ECR-R; Ehrental et al., 2009; Fraley et al., 2000), compassion with the EmpaToM, a behavioral computer-based paradigm (Kanske et al., 2015).

behavioral and subjective representations. Using self-reports of attachment allowed the direct comparison of attachment measures derived from developmental and social psychological research traditions. We primarily hypothesized secure (vs insecure) AAI-derived attachment to be associated with higher behavioral social processing abilities.

As hypothesized, AAI-derived attachment security (vs insecurity) was linked to higher EmpaToM-derived ToM abilities. This was true for attachment operationalized in terms of distinct attachment types or as the continuous coherence of transcript variable. Furthermore, as investigated in a set of exploratory analyses,

Table 4. Three linear models predicting subjective attachment anxiety and avoidance.

	Empathy				Compassion				Theory of Mind			
	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>Std. Error</i>	<i>t</i>	<i>p</i>
Intercept	35.83	8.19	4.38	<.001***	61.9	7.53	8.22	<.001***	<0.01	0.07	0.01	.99
Attachment Anxiety	3.08	1.80	1.71	.09	0.9	1.65	0.55	.59	0.01	0.02	0.48	.63
Attachment Avoidance	-2.44	2.18	-1.12	.26	-5.54	2.00	-2.78	.01*	<0.01	0.02	-0.17	.87
Age	-0.29	0.29	-1.01	.31	0.08	0.26	0.31	.76	<0.01	<0.01	-0.44	.66
Sex	0.51	2.44	0.21	.83	1.7	2.24	0.76	.45	0.06	0.02	2.86	<.01*

*** $p \leq .0003$, ** $p \leq .0033$, * $p \leq .0167$ after Bonferroni correction.

ECR-R self-reported attachment avoidance was negatively associated with EmpaToM-derived compassion. While these results confirm our primary theory-based hypotheses, self-reported and behavioral assessments yielded differential results.

Our AAI-based results suggest that adults with a secure state of mind and coherent discourse about past relationships with their caregivers may be able to more easily tune in to someone else's thoughts. This is consistent with previous studies reporting a positive correlation between self-reported attachment security and cognitive empathy (Joireman et al., 2002; Troyer & Greitemeyer, 2018), as well as a finding in children using a narrative attachment measure and a behavioral ToM paradigm (Villachan-Lyra et al., 2015). Also, since our insecurely attached group consisted mainly of insecure-dismissively attached individuals, these data complement prior findings of a negative association between self-reported avoidant attachment and self-reported perspective taking (Kungl, Gabler et al., 2024; Ardenghi et al., 2020; Péloquin et al., 2011).

Our exploratory analysis revealed that it was specifically two parent-specific AAI state of mind subscales, i.e. idealization mother and derogation mother, that were associated with lower EmpaToM-derived ToM abilities. This result is in line with a study reporting an association of the AAI subscales derogation and idealization with impairments in reflective functioning, i.e. cognitive empathy (Rosso et al., 2015). It also aligns with the theoretical concept of insecure-dismissive defense: both strategies, i.e. idealization and derogation, may lead to little effort being made to understand others, driven by an underlying aim to avoid engagement with others overall. Our mother-specific results could potentially be attributed to the prevailing cultural norm within our sample's age group, where mothers spent the most time with their children. Such increased interaction may have resulted in a slightly stronger influence of the mother.

Within the larger ECR-R sample, we found that self-reported attachment avoidance was negatively correlated with EmpaToM-derived compassion, consistent with previous self-report studies (Ardenghi et al., 2020; Péloquin et al., 2011) as well as studies using behavioral compassion and attachment priming (Mikulincer & Shaver, 2005; Mikulincer et al., 2005). Our results also correspond to findings showing that self-reported or primed attachment security was associated with higher levels of self-reported or behavioral compassion (Ardenghi et al., 2020; Joireman et al., 2002; Mikulincer & Shaver, 2005; Mikulincer et al., 2005). Together, these results suggest that individuals who describe

themselves as being less emotionally available or responsive to others' needs, may also exhibit less care and concern for others.

The delineated findings align with our hypotheses and attachment theory: from a foundation of secure attachment, positive models of others arise and support social processing abilities (Stern & Cassidy, 2018). Insecure-dismissing or avoidant attachment, on the other hand, goes along with a more negative view of others, which may promote cognitive and emotional distancing, particularly from distress-related cues. Lower EmpaToM-derived ToM abilities and compassion match the emotional deactivation of insecure-dismissing attachment, comprising less emotional closeness and interest in others' perspectives (Mikulincer et al., 2005). Moreover, considering stress, lower ToM abilities and compassion might serve as a coping strategy, buffering emotional responses when witnessing others' distress.

The current analyses reflect the previously described discrepancy between AAI-derived and self-reported attachment (Roisman et al., 2007). Yet, both our findings yielded results aligning with attachment theory, suggesting that they capture different facets of the same construct. Roisman et al. (2007) propose AAI security as a general interpersonal asset, whereas self-reported avoidance and anxiety may underlie diatheses in romantic relationships, particularly under attachment-related threat. Our results align with this proposition. We found that AAI-derived attachment security was significantly correlated with EmpaToM-derived ToM, indicating a general heightened ability to understand others' mental states and emotions. In contrast, our ECR-R attachment self-report findings were related to responses to distress. ECR-R avoidance was associated negatively with EmpaToM-derived compassion, which is a pro-social response to distress reflecting a willingness to help others in need.

There are several limitations to our study. First, the EmpaToM is a computer-based task and not a real-life behavioral assessment. There is, however, indication that ToM-related brain activity during the EmpaToM relates to everyday ToM ability (Hildebrandt et al., 2021). Second, the sample size for AAI and ECR-R data differed due to financial considerations (i.e. with the AAI being time- and cost-intensive). Third, both AAI- and ECR-R-based samples exhibited limited variance in attachment measures, especially the AAI sample with fewer than average insecure-preoccupied and unresolved individuals. This could be due to our strict inclusion/exclusion criteria, focusing on very healthy individuals.

Overall, we found that AAI-derived attachment security was associated with higher EmpaToM-derived ToM abilities, and self-reported attachment avoidance with lower EmpaToM-derived compassion abilities. By providing further empirical evidence that both interview-based and self-report measures of adult attachment should not be treated as interchangeable, these findings inform ongoing debates in attachment research. Taken together, our results suggests that individuals with secure, non-avoidant attachment show social abilities that allow them to better understand the thoughts and emotions of others, and generate positive, caring emotions in face of others' distress. These findings highlight the importance of adult attachment representations in shaping our capacities for successful social interaction.

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Author contributions

M.G. conducted the bulk of Adult Attachment Interviews (AAI), managed data collection, processed and analysed the data, and drafted the manuscript. M.K. and S.G. provided the training for AAI conduction, and supervised the interviews and their transcriptions. P.K. provided training on how to use and analyse the EmpaToM task. V.E. and P.V. initiated and developed the ARC project. V. E. supervised data collection, and supported the drafting of the manuscript. All authors critically revised the manuscript.

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