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ORIGINAL ARTICLE

The Empathy Quotient and Systemising Quotient for Toddlers: Development and Validation

Yumnah T. Khan[1] · Alex Tsompanidis[1] · Luning Sun[2] · Carrie Allison[1] · Simon Baron-Cohen[1,3]

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Abstract

Purpose Empathy and systemising are traits that show on-average differences between autistic and non-autistic groups and have informed major theoretical frameworks of autism. While these constructs have been researched extensively in older age groups, no equivalent questionnaire-based measures exist for toddlers.

Methods Here, we developed and validated toddler (T) versions of the Empathy Quotient (EQ-T) and Systemising Quotient (SQ-T) in 1,005 toddlers (572 males, 433 females) aged 1.5 to 4 years (mean = 32.75 months). Parents completed these online along with the Quantitative Checklist for Autism in Toddlers (Q-CHAT), which measures autistic traits.

Results Results indicated that (a) the EQ-T and SQ-T show good reliability, (b) EQ-T scores negatively predicted and SQ-T scores positively predicted autistic traits, and (c) on average, EQ-T scores were higher in females ($d = 0.16$), while no significant sex differences were observed in SQ-T scores ($d = -0.09$).

Conclusion These newly validated measures open various further avenues to better understand the early profiles and developmental pathways associated with autism.

Keywords Toddlerhood · Development · Empathy · Systemising · Autism

Introduction

Autism is a set of neurodevelopmental conditions characterised by differences in social communication and interaction, alongside differences in restricted and repetitive behaviours, interests, or activities (American Psychiatric Association, 2013). Over the past decades, a considerable amount of research has been dedicated to understanding the cognitive profiles associated with autism. Two such domains – empathy and systemising – have received substantial attention to understand autism (Baron-Cohen, 2002). While these psychological constructs have been extensively researched in older age groups, the links between autism, empathy, and systemising remain poorly understood during toddlerhood, which is a critical period for the development of these traits. Instead, much of the research focuses on older children and adults, with no existing validated measures for empathy and systemising in early childhood. Given that autism is a developmental condition, it is important to understand how empathy and systemising may contribute to early autistic traits.

Empathy is defined as the ability to recognise the mental states of others and to respond to these with an appropriate

✉ Yumnah T. Khan
yk415@cam.ac.uk

Alex Tsompanidis
at768@medschl.cam.ac.uk

Luning Sun
l.sun@jbs.cam.ac.uk

Carrie Allison
cla29@cam.ac.uk

Simon Baron-Cohen
sb205@cam.ac.uk

[1] Autism Research Centre, Department of Psychiatry, University of Cambridge, Douglas House, 18B Trumpington Road, Cambridge, Cambridgeshire CB2 8AH, UK

[2] The Psychometrics Centre, Cambridge Judge Business School, University of Cambridge, Cambridge, UK

[3] Department of Psychology, University of Cambridge, Cambridge, UK

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emotion (Baron-Cohen, 2004). While empathy is a complex, multi-faceted construct, it is broken down into two distinct but interrelated components. The first component, cognitive empathy, is the ability to identify another person's thoughts and feelings (mental states). The second component, affective empathy, is the drive to respond to another person's mental state with an appropriate emotion (Baron-Cohen, 2004). These components of empathy promote prosocial behaviours (a behavioural expression of empathy), such as acts of kindness, helping, sharing, and the drive to alleviate another's distress (Ekman, 2004). Importantly, differences in empathy are a core feature of several psychiatric conditions, such as those with personality disorders (Baron-Cohen, 2011, book), as well as neurodevelopmental conditions, such as autism (American Psychiatric Association, 2013).

Empathy emerges in its most basic forms during infancy and undergoes substantial development throughout early childhood (Davidov et al., 2013; Hoffman, 1990). One behaviour, emotional contagion, emerges during the first year of life and involves infants responding to another person's emotional state with a similar affective reaction (Hatfield et al., 1993). While it is not clear if this is empathy per se, it certainly indicates a response to another person's emotional state and therefore may serve as a key developmental precursor to empathy. At around age one, infants become able to distinguish between their own emotional experiences and those of others (self-other differentiation), which subsequently supports the emergence of other-oriented empathic responses. Due to advances in the development of cognitive, motor, and social skills (Davidov et al., 2013), the second year of life is a particularly important period for the development of empathy (Davidov et al., 2013). At around 18 months of age, toddlers begin to display more complex empathic behaviours, such as concern for others even when they are not overtly displaying distress (Vaish et al., 2009). Additionally, toddlers also begin to show various prosocial behaviours, such as helping, comforting, and sharing (Roth-Hanania et al., 2011). Early instruments measuring empathy therefore focus on aspects that are observable in toddlerhood, such as emotional contagion, attention to others' feelings, and prosocial actions, which are considered as key manifestations of early empathy (Davidov et al., 2025). Individual differences in empathy are thought to also emerge early in life, shaped by factors such as temperament, emotion regulation, and parent-child interactions (McDonald & Messinger, 2010).

Systemising, by contrast, is the drive to analyse, understand, and construct systems (Baron-Cohen, 2004). This involves identifying patterns or *if-and-then* rules, and applying these processes to anaylse, predict, control and construct rule-based systems (Baron-Cohen, 2020). A system, in this context, can be anything that follows rules, ranging from a mechanical system (e.g., a machine), a mathematical system (e.g., number patterns), a natural system (e.g., weather patterns), a motoric system (e.g., a dance routine), a social system (e.g., a business), or a collectible system (e.g., classifying objects into categories).

Compared to empathy, much less is known about the early development of systemising. Systemising may be present in more basic forms during early development. This may include, for instance, a motivation and curiosity to understand how basic systems (e.g., a light switch), work through identifying simple *if-and-then* rules, or a preference for structure and organisation (e.g., sorting toys or blocks). Indeed, research has shown that the ability to group objects based on shared features is present from early infancy (Behl-Chadha, 1996). Additionally, infants show rule- learning from the first year of life (Kirkham et al., 2002; Marcus et al., 1999; Saffran et al., 1996), as well as the ability to generalise previously learnt rules to novel situations (Gomez & Gerken, 1999). In even more basic forms, there are individual differences in orienting towards systems (e.g., a swinging pendulum) measured via visual preferences even at birth (Khan et al., submitted; Connellan et al., 2000). Thus, early systemising may reflect a basic interest in predictability, order, and rule learning. Higher-order cognitive aspects of systemising, such as causal reasoning, may continue to develop throughout childhood.

Empathy and systemising have been widely researched in the context of autism. Autistic children show on-average differences in aspects of social cognition such as theory of mind (Baron-Cohen, 2000), emotion recognition (Uljarevic & Hamilton, 2013), social attention (Chawarska et al., 2013; Jones & Klin, 2013), and language development (Vogindroukas et al., 2022). Differences in these aspects of social cognition and social attention have also been observed early in development (Chawarska et al., 2013; Jones & Klin, 2013; Mundy & Newell, 2007). Within certain theoretical frameworks, autism has been conceptualised as a cognitive profile characterised by an increased drive to systemise and a reduced drive to empathise (Baron-Cohen, 2002). Compared to non-autistic people, autistic people, on average, score higher on measures of systemising and lower on measures of empathising (Auyeung et al., 2009, 2012; Wheelwright et al., 2006). These patterns have been observed across different age groups and measurement modalities, including self-report questionnaires and behavioural tasks. Differences are particularly pronounced on tasks assessing cognitive empathy, while performance on tasks assessing affective empathy are comparable between autistic and non-autistic people (Rueda et al., 2015). Levels of empathy and systemising also predict autistic traits within the general population (Greenberg et al., 2018). It is therefore possible

that individual differences in empathy and systemising may be predictive of autistic traits in toddlerhood, although the link between the three constructs remains under-researched in early life.

Additionally, given that autism shows a higher prevalence in males (Loomes et al., 2017), the empathising-systemising (E-S) theory has also been used to explain sex differences in autism. On-average sex differences in the general population are evident across both empathy and systemising. Across various age ranges, females on average score higher on measures of empathy, while males score higher on measures of systemising (Auyeung et al., 2009, 2012; Baron-Cohen, 2004; Goldenfeld et al., 2005; Greenberg et al., 2018). Moreover, these differences have been observed early in development, with parent-report measures showing on-average sex differences in childhood (Auyeung et al., 2009). Sex differences have also been observed in attentional measures comparing social vs. non-social stimuli as early as the first day of life (Connellan et al., 2000). It has therefore been proposed that on-average sex differences in empathy and systemising may result in males having a greater number of autistic as well as a greater likelihood of receiving an autism diagnosis (Baron-Cohen, 2002).

Empathy and systemising are typically assessed using self- or parent-report questionnaires. The Empathy Quotient (EQ) and Systemising Quotient-Revised (SQ-R) are administered using a Likert-scale format, presenting a series of statements describing real-life scenarios and interests that capture empathy and systemising. On the EQ, items include recognising others' emotions, interpreting emotional expressions, and showing appropriate emotional reactions. On the SQ, items include interests in understanding how systems work and collecting sets of objects or information in categories.

Both the EQ and SQ-R have been extensively validated, and, at present, these validated measures exist for children aged 4 to 11 (Auyeung et al., 2009), adolescents aged 12–15 (Auyeung et al., 2012), and adults aged 16 and over (Wheelwright et al., 2006). However, one key gap is that there are no equivalent measures available for toddlers and young children, limiting our understanding of how these traits emerge and develop during this early stage of life. The development of empathy is particularly rapid during toddlerhood, and, by 18 months, comforting and helping behaviours are observed in response to another's distress (Hoffman, 1990). Simultaneously, systemising traits may also become apparent during this period as toddlers explore and experiment with objects in the environment. Early systemising traits may manifest as basic interests in patterns, sorting and categorisation, and observing cause-and-effect relationships. Importantly, autistic traits can also be measured by 18 months of age (Allison et al., 2008; Baird et al., 2000), providing a critical window to investigate the early links between autistic traits, empathising and systemising.

Developing early measurement tools is critical for gaining a developmental understanding of empathy and systemising. These can provide insights into when empathy and systemising first emerge as measurable constructs, and when they begin to show associations with autistic traits. An early measurement tool could also ultimately have predictive value by linking early empathising and systemising traits to later cognitive, socioemotional, and neurodevelopmental outcomes. However, validated questionnaire-based measures for toddlers remain limited (Sesso et al., 2021). Thus, introducing such a measure has the potential to advance research in the broader field of developmental psychology.

The primary aim of the present study was to develop and conduct a preliminary validation of a toddler version of the Empathy and Systemising Quotients (EQ-T and SQ-T) for children aged 1.5 to 4 years. This may enhance understanding of the early cognitive precursors of autistic traits and, in the long term, inform future research on improving early identification tools. Objectives included: (a) to assess the reliability as well as content and construct validity of these new questionnaires, (b) to investigate the distribution of EQ-T and SQ-T scores in toddlers, (c) to examine whether EQ-T and SQ-T scores are associated with autistic traits in toddlerhood; (d) to assess sex differences in EQ-T and SQ-T scores, and (e) to understand the development of empathy and systemising across the 1.5 to 4 years age window. Based on the E-S Theory (Baron-Cohen, 2004) and on prior research on the EQ and SQ, we hypothesised that (a) the EQ-T will show negative associations with autistic traits while the SQ-T will show positive associations with autistic traits, and (b) females, on average, will score higher than males on the EQ-T, while males, on average, will score higher than females on the SQ-T.

Materials and Methods

Participants

The study received a favourable ethical opinion by the Cambridge Psychology Research Ethics Committee (ethics approval number PRE.2024.055) and informed consent was obtained from parents prior to beginning the study. Questionnaires were completed by parents of n = 1,005 toddlers (572 males, 433 females) aged 18 to 48 months (M = 32.75, SD = 9.86). This sample size was estimated via power calculations and previous validations of the EQ and SQ (Auyeung et al., 2009, 2012). In most cases (97%), the mother was the primary respondent. All questionnaires were completed online. Study advertisements were placed globally on

digital platforms (e.g., Facebook ads, parenting threads) in English-speaking countries (i.e., Australia, Canada, United Kingdom, India, Nigeria, New Zealand, Pakistan, United States, South Africa). Participants self-selected into the study following these open recruitment advertisements. Further demographic characteristics of the sample are reported in Table 1. While completing initial participation, parents were also invited to participate in an optional test-retest phase, which took place 2–4 weeks after they completed the initial questionnaires. A subset of parents indicated interest in participating in the follow-up stage, of which parents of 37 toddlers (22 males, 15 females) completed the follow-up measure (mean difference between timepoints = 20.4 days).

Instrument Development

The EQ-T and SQ-T were developed by the study team, which consisted of four experts in developmental psychology (including three senior academics with PhDs in developmental psychology and one doctoral researcher in the area). A multi-method approach was used to establish content validity in line with current best practices in psychometric instrument development. First, relevant developmental frameworks were consulted to identify specific behavioural manifestations of empathy and systemising in toddlerhood. Empathising was defined as the drive to recognise the emotional states of others and respond to these with an appropriate emotion. The questionnaire aimed to integrate both affective and basic cognitive components of empathy, alongside elements of prosocial behaviour. Additionally, developmental theories of empathy were reviewed to identify age-appropriate manifestations of empathy in toddlerhood, such as emotional contagion and prosocial behaviours (e.g., comforting, helping, sharing) (Davidov et al., 2013, 2025; Hoffman, 1990; Roth-Hanania et al., 2011; Vaish et al., 2009). EQ-T items therefore assessed domains such as noticing when others are upset, appropriate emotional reactions to another person's distress, and prosocial actions (e.g., helping, sharing). Systemising was defined as the drive to analyse, predict, and construct rule-based systems (Baron-Cohen, 2004). SQ-T items focused instead on simple early manifestations of systemising, such as a basic interest in patterns and categorisation (e.g., arranging and sorting toys), a preference for predictability, exploring how simple systems work, and rule-learning.

Next, to remain consistent with previously validated versions of the EQ, a review and adaptation of items from the Child Empathy and Systemising Quotient was conducted (Auyeung et al., 2009). Each item was reviewed and adjusted based on our review of developmental theories to ensure appropriateness for the target age group while maintaining the core underlying construct being measured. Throughout development, the research team critically discussed each item's relevance, clarity, developmental appropriateness, and theoretical fit for the constructs under investigation. Finally, mothers of n = 21 toddlers were invited to complete the questionnaires in reference to their toddlers using snowball sampling. Mothers were asked to comment on the developmental appropriateness of the questionnaire items, their clarity and comprehensibility, and whether the examples provided were representative of their toddler's behaviours. A comment box was provided for each item, along with an option for open-ended general feedback at the end of the questionnaire. The questionnaire was then refined accordingly (e.g., minor alterations to the wording of some items), though no major revisions were deemed necessary.

Table 1 Participant demographic characteristics

		%
Neurodevelopmental condition diagnosed or suspected	No	87.96
	Autism	1.00
	ADHD	0.70
	Speech or Language Delay	4.08
	Other	6.27
Language ability	No words	4.16
	Single words	28.17
	2–3 word phrases	40.85
	Full sentences	20.27
Family history of neurodevelopmental conditions (sibling or parent)	Yes	12.01
	No	87.99
Preterm birth	Yes	13.46
	No	86.54

Measures

The EQ-T and SQ-T each contained 27 and 28 items respectively, presented in full in Online Resource 1. They assessed, in a four-point Likert-scale format, a child's empathising and systemising traits in everyday scenarios. EQ-T items assessed developmentally appropriate aspects of cognitive empathy (e.g., recognition of basic emotions in others), affective empathy (e.g., responsiveness to another's distress), and pro-social actions (e.g., social responsivity, helping, and sharing). The SQ-T assessed developmentally appropriate systemising traits, such as an interest in exploring and understanding simple systems, pattern identification, categorisation, and a preference for structure and predictability.

To assess the construct validity of the EQ-T and SQ-T, parents also completed the Quantitative Checklist for Autism in Toddlers (Q-CHAT), an 18-item parent-report questionnaire designed to quantitively measure autistic traits in toddlers (Allison et al., 2008, 2021). The Q-CHAT assesses various aspects of social-communication, as well as repetitive behaviour and narrow interests. It is not a

diagnostic questionnaire, but rather measures autistic traits, which exist on a continuum across the entire population. The Q-CHAT has previously been validated in large samples and shows good validity and reliability (Allison et al., 2008, 2021). Higher scores are associated with increased likelihood of later autism diagnosis, and the Q-CHAT also shows sex differences, with higher on-average scores in males compared to females. The Q-CHAT was used in the current study to assess associations between autistic traits and the EQ-T and SQ-T.

Parents were also requested to provide information on: (a) their educational attainment and age; (b) their relationship to the child (e.g., mother/father); (c) their child's sex assigned at birth; (d) neurodevelopmental conditions the child, the child's sibling, or parent has been diagnosed with (e.g., autism or ADHD); (e) whether their child was born pre-term; and (g) their child's language development. Language ability was assessed by asking parents: "Which of the following best describes your child's speech?" with the response options: "My child does not use any words", "My child uses single words (e.g., "mama," "no", "ball"), "My child uses 2–3 word phrases (e.g., "more milk", "go to bed", "big car"), and "My child uses full sentences (e.g., "Can we go to the park please?"); and (f) the toddler's current age (recorded to the precision of one month).

Scoring

Scoring of the EQ-T and SQ-T followed previous EQ and SQ scoring guidelines (Auyeung et al., 2009, 2012). Parents were asked to indicate how strongly they agree with each statement with reference to their child by selecting one of four options: "definitely agree", "slightly agree", "slightly disagree", or "definitely disagree". In positively scored items, the response "definitely agree" scored 2 points, "slightly agree" scored 1 point, and "slightly disagree" or "strongly disagree" scored 0 points. In reverse-scored items, the response "definitely disagree" scored 2 points, "slightly disagree" scored 1 point, and "slightly agree" or "definitely agree" scored 0 points. A total of 13 items were reverse-scored in the EQ-T, while 9 items were reverse-scored in the SQ-10. The maximum score was 54 for the EQ-T and 56 for the SQ-T. Any questionnaires with incomplete responses were removed from analysis. The scoring key is presented in Online Resource 2.

Results

Item-Total Correlations

First, item-total correlations were assessed using Pearson's correlations to identify the relationship between each item and the overall scale. These were computed separately for the EQ-T and SQ-T. The recommended threshold of <0.3 was used to detect items that performed poorly in relation to the overall scale (Hajjar, 2018). Correlations were <0.3 for one EQ item and four SQ items (see Online Resources 2). These items were removed, and all subsequent analyses were conducted on the remaining items.

Score Distributions

Overall, a wide range of scores were observed for both the EQ-T and SQ-T with no apparent floor or ceiling effects. Both the EQ-T and SQ-T showed normal distributions (see Figs. 1 and 2). Skewness (EQ-T = −0.03, SQ-T = 0.09) and kurtosis values (EQ-T = 2.67, SQ-T = 2.67) also fell within acceptable ranges for both questionnaires. The mean EQ-T score was 25.16 ($SD = 8.01$) while the mean SQ-T score was 25.57 ($SD = 8.30$). There was a weak yet significant, positive correlation between EQ-T and SQ-T scores (Pearson's $r = 0.134$, $p < .001$).

Internal Reliability

As determined via Cronbach's alpha and McDonald's omega, both the EQ-T ($\alpha = 0.82$, $\omega = 0.82$) and SQ-T ($\alpha = 0.80$, $\omega = 0.80$) showed good internal reliability.

Test-Retest Reliability

In the subset of participants that completed the test-retest follow-up, we computed intraclass correlations between the two timepoints to examine test-retest reliability. Both the EQ-T (ICC = 0.80, $p < .001$) and SQ-T (ICC = 0.81, $p < .001$) showed good test-retest reliability.

Associations With Autistic Traits

Construct validity of the EQ-T and SQ-T were then assessed via measuring associations with autistic traits using linear regression. Of the n = 1,005 parents who completed the EQ-T and SQ-T, 89 parents did not complete the Q-CHAT. As a result, analyses involving the Q-CHAT were conducted on a subset of n = 916 participants (516 males, 400 females, mean age = 32.40 months, $SD = 9.76$) with complete Q-CHAT data. Sensitivity analyses confirmed that all

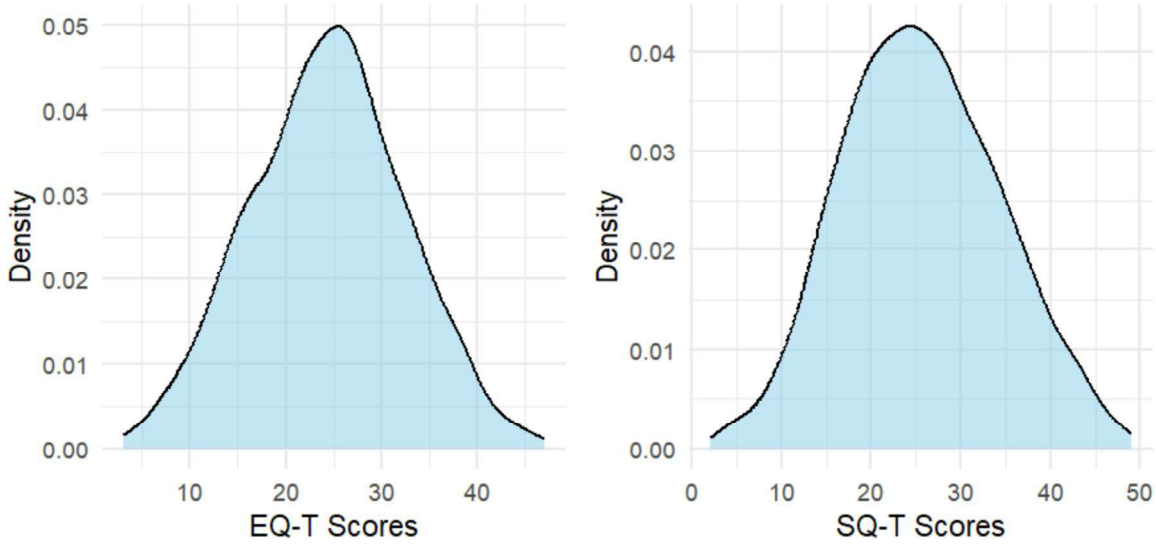

Fig. 1 Density-scaled histograms depicting EQ-T and SQ-T Score Distributions

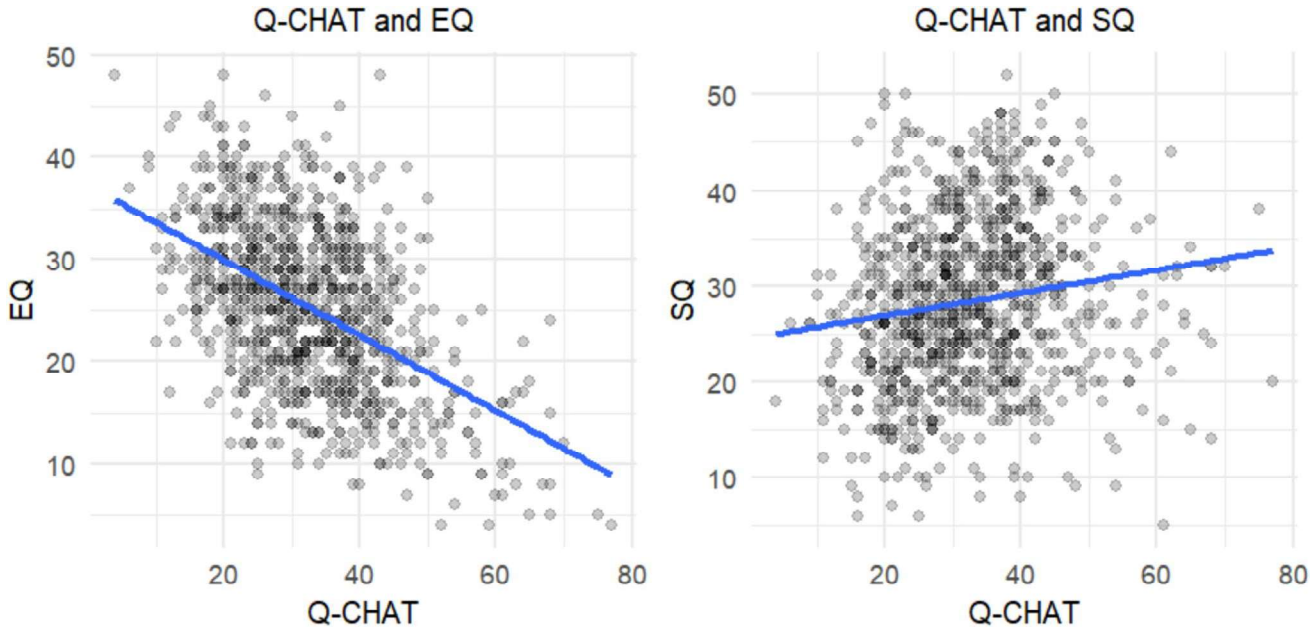

Fig. 2 Associations between the EQ-T and SQ-T with the Q-CHAT depicted in scatterplots with fitted linear regression lines

the reported findings relating to the EQ-T and SQ-T were replicated within this subset.

As hypothesised, both EQ-T and SQ-T scores were significant predictors of Q-CHAT scores, with EQ-T scores negatively predicting autistic traits (B = −0.67, *SE* = 0.03, $p < .001$, $R^2 = 0.25$) and SQ-T scores positively predicting autistic traits (B = 0.18, *SE* = 0.04, $p < .001$, $R^2 = 0.02$). These effects remained significant after controlling for age and sex (EQ-T: B = -0.67, *SE* = 0.04, $p < .001$; SQ-T: B = 0.19, *SE* = 0.04, $p < .001$). There were no significant moderation effects by sex for the EQ-T (B = 0.13, *SE* = 0.10, $p = .210$, $R^2 = 0.12$) or the SQ-T (B = -0.09, *SE* = 0.10, $p = .386$, $R^2 = 0.02$). As expected, however, sex differences were also observed in the Q-CHAT scale ($t(914) = -2.15$, $p = .03$, Cohen's $d = -0.14$), with higher scores in males ($M = 33.18$, $SD = 10.87$) compared to females ($M = 31.61$, $SD = 10.99$).

Sex Differences

As hypothesised, independent sample t-tests indicated that the EQ-T showed significant sex differences ($t(1003) = 2.47$, $p = .014$, Cohen's $d = 0.16$), with higher scores in females ($M = 25.87$, $SD = 8$ .27) compared to males ($M = 24.62$, $SD = 7.76$) (Fig. 3). However, the SQ-T showed no

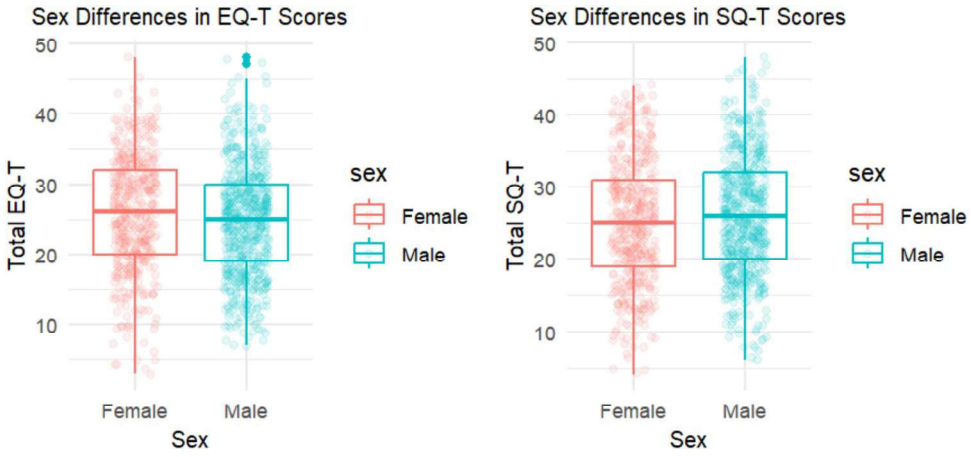

Fig. 3 Boxplots demonstrating sex differences in EQ-T and SQ-T scores. Boxes represent the interquartile range (IQR) with the median denoted by the horizontal line. Whiskers represent 1.5 × IQR

significant differences (t(1003) = -1.46, $p = .145$, Cohen's $d = -0.09$) between males ($M = 25.90$, $SD = 8.12$) and females ($M = 25.13$, $SD = 8.53$) (Fig. 3).

Associations With Age

To assess the development of empathy and systemising across the 1.5-to-4-year time window, we analysed Pearson's correlations with age. While the EQ-T showed no significant correlation with age ($r = 0.012$, $p = .705$), the SQ-T showed a small positive correlation with age ($r = 0.120$, $p < .001$).

Additional analyses computing "difference scores" and "brain types" are reported in Online Resources 3.

Discussion

In the present study, we developed and conducted a preliminary validation and test of reliability of a toddler version of the Empathy and Systemising Quotients in a large sample of n = 1,005 toddlers aged 1.5 to 4 years. Our findings indicate that both measures demonstrate good internal reliability and test-retest reliability. Additionally, both questionnaires significantly predicted autistic traits in the expected directions (Baron-Cohen, 2004), thereby demonstrating construct validity. While empathising scores were, on average, significantly higher in females, no significant sex differences were observed in systemising scores at this age.

As hypothesised, EQ-T scores negatively predicted autistic traits, while SQ-T scores positively predicted autistic traits. These results align with a large body of literature reporting that autistic traits are associated with a higher drive to systemise and a reduced drive to empathise (Auyeung et al., 2009, 2012; Greenberg et al., 2018; Wheelwright et al., 2006). Our findings extend this prior literature by demonstrating that such associations are apparent as early as toddlerhood. Moreover, EQ-T scores showed stronger correlations with, and explained more variance, in autistic traits compared to SQ-T scores, a trend that has also been observed in prior studies (Greenberg et al., 2018; Wheelwright et al., 2006). This suggests that a reduced drive to empathise may be more strongly linked to autistic traits than an increased drive to systemise, particularly in toddlerhood.

To investigate the developmental trajectories of EQ-T and SQ-T scores during toddlerhood, we examined their associations with age. While no significant correlations were observed between EQ-T scores and age, SQ-T scores showed a significant positive correlation with age. This may suggest that the aspects of empathy assessed by the EQ-T are present and consistently observable from 18 months of age, whereas systemising traits measured by the SQ-T may still be emerging during this developmental period. This is likely because systemising relies on several higher-order cognitive abilities (e.g., executive function, working memory, causal reasoning) that are still emerging during toddlerhood. On the other hand, the lack of association between EQ-T scores and age is consistent with the idea that basic empathy in toddlerhood does not necessarily require the development of higher-order processes, but relies instead on a rudimentary, implicit understanding of the emotion and situation at hand (Davidov et al., 2013; Decety et al., 2016).

As hypothesised, we found that females, on average, scored significantly higher on the EQ-T compared to males. This replicates prior findings in older age ranges and supports the account that observable sex differences in empathy emerge early in life (Auyeung et al., 2009; Greenberg et al., 2018). When using behavioural or observational measures, sex differences in empathy have been observed even earlier than 18 months (Rochat, 2023). These differences have been attributed to both socio-cultural as well as biological factors. For instance, early biological factors such as fetal testosterone levels - which are higher on average in male foetuses -show inverse associations with both parent-report and behavioural measures of empathy in childhood (Chapman et al., 2006; Lutchmaya et al., 2002). Additionally,

parental behaviours may also foster sex-differential socialisation from early infancy (Clearfield & Nelson, 2006; Endendijk et al., 2017; Fausto-Sterling, 2021), which likely play an important additive effect in promoting early sex differences in empathy.

On the other hand, no sex differences were observed in SQ-T scores at this age. It is worth noting that, during early development, females, on average, develop faster than males across several cognitive domains (Etchell et al., 2018; Krogh & Væver, 2019; Silverman, 2021). Given that various aspects of systemising require higher-order abilities, faster cognitive development in females may confound sex differences in earlier ages. Thus, higher scores in males may only emerge after their cognitive development 'catches up' with females, as is well-evidenced from age four onwards (Auyeung et al., 2009, 2012). More specifically, sex differences in more complex systemising may not be consistently observable in early toddlerhood but may instead emerge gradually as the cognitive capacities that support such behaviours develop. Sex differences in systemising may, nonetheless, manifest in more simpler forms in early infancy, such as when assessed via attentional preferences (Connellan et al., 2000).

We also found that the EQ-T and SQ-T showed a small but significant positive correlation with one another. This finding is contrary to what has previously been observed in older children and adults, where the EQ and SQ are typically negatively correlated (Greenberg et al., 2018). It is possible that this correlation is specific to early life and may reflect shared variance attributable to broader cognitive development. Both empathy and systemising are skills that are continuously developing at this stage and rely, in part, on broader cognitive abilities that are themselves under development. As such, increases in general cognitive abilities may be associated with parallel increases in both empathy and systemising before differentiation becomes more pronounced, potentially explaining the small correlation observed between the two. There may also be other methodological explanations for these results, such as shared method variance, since both measures were completed by the same parent. Similarly, it is possible that some parents may have shown a general tendency towards positive responding and therefore endorsed favourable statements across both questionnaires.

Overall, our findings demonstrate that both the EQ-T and SQ-T demonstrate good psychometric properties consistent with current evaluation guidelines. Both measures demonstrate good internal consistency and strong test re-test reliability. Content validity was supported through expert review, theoretical grounding within existing developmental frameworks, and community engagement, while construct validity was evidenced by the expected associations with autistic traits.

Limitations and Future Directions

There are a number of limitations to consider when interpreting the findings of this study. First, previous versions of the EQ and SQ have been validated with both autistic as well as non-autistic individuals, but this was challenging within our age range of interest as few toddlers are diagnosed with autism. Moreover, those with an early autism diagnosis might also experience co-occurring developmental and language delays and may not be representative of the whole autistic population. Although we have established validity using measures of autistic traits, it will be important for future studies to verify whether group differences in the EQ-T and SQ-T exist between autistic and non-autistic toddlers.

Second, the response to the test-retest phase of the study was low (n = 36) and it is likely that this small subsample may not be representative of the full participating sample due to self-selection bias. As such, future follow-up studies with larger re-test samples will be pertinent to confirm the test-retest reliability of the EQ-T and SQ-T. Moreover, given that participants also self-selected themselves into the study following open advertisements, the broader study is also likely susceptible to self-selection bias. Third, all measures were based on single-informant parent report, which may introduce shared method variance. It will be important for future studies to incorporate multi-method and multi-informant approaches to verify the construct validity of the questionnaires. Fourth, while the study was only advertised to a certain number of English-speaking countries, information was not collected on the exact country of origin of each participant, neither on whether the participant spoke English as a first or second language. It is possible that there may be cultural differences in empathy and systemising that can be further investigated by future research. Finally, the present study did not conduct a formal quantitative assessment of content validity, which was instead established via a multi-method qualitative approach. While such approaches are commonly used in psychometric instrument development, future work would benefit from incorporating a quantitative content validity index based on ratings from field experts.

While this research represents a first step towards developing a questionnaire-based measure for empathy and systemising in toddlers, there remain several avenues that can be explored by future research. First, further work is needed towards developing behavioural or performance-based measures of empathy and systemising in toddlerhood. This is particularly important for systemising, where such

measures are presently limited despite holding the potential to capture simpler forms of an early drive towards systemising (e.g., interest in systems assessed via eye-tracking tasks). Second, it is important for future research to provide further and more complete evidence for the validity of the EQ-T and SQ-T by testing them against behavioural or performance-based measures or other independent parent-report instruments capturing related constructs. Third, studies can examine the broader traits associated with early empathising and systemising drives to understand the factors that facilitate and are facilitated by their development. Relatedly, research may also explore the future outcomes (e.g., future autistic traits) associated with early empathising and systemising traits to assess their early predictive value. Fourth, these early measures provide an opportunity to track the developmental trajectory of empathy and systemising from early childhood to adulthood, along with their relationships with autistic traits and social, emotional, and cognitive functioning over time. Finally, studies can also explore the underlying neurobiological, genetic, or environmental correlates of early empathising and systemising.

Conclusion

In summary, our findings indicate that both the EQ-T and SQ-T demonstrate good internal reliability and test-retest reliability. Since measures of these constructs are extremely limited in toddlerhood, these questionnaires can now be used to facilitate various avenues of further research in developmental psychology. Importantly, the results demonstrate that both the EQ-T and SQ-T are associated with autistic traits as early as toddlerhood. This finding has two key implications. First, this provides an insight into the early cognitive and behavioural markers linked with autistic traits. Secondly, it supports the clinical relevance of these questionnaires, and aspects of the EQ-T and SQ-T may subsequently be considered for incorporation into early screening tools after further validation. Cross-sectional developmental trends suggest that empathy traits measured by the EQ-T are present at consistent levels throughout toddlerhood. In contrast, systemising traits measured by the SQ-T tend to be higher in older toddlers, particularly in males. While longitudinal research is required to confirm these patterns, it is possible that the measured aspects of empathy remain relatively stable from 18 months onwards, while systemising traits continue to develop across toddlerhood. Sex differences were observed in the EQ-T, supporting the notion that sex differences in empathy emerge early in life. However, no sex differences were observed in the SQ-T, potentially due to the confounding impact of faster cognitive development in females. This suggests that early sex differences in empathising are more pronounced and may precede observable sex differences in systemising.

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Data Availability Due to ethical purposes, the data that support the findings of this study are not publicly available but can be made available from the corresponding author upon reasonable request. For access to the data, a request must be, submitted to the authors detailing the intended analysis plan. A formal data sharing agreement must then be signed between institutions. The materials (questionnaire) are publicly available and provided in the supplement.

Code Availability No new analytic code was developed for the analysis.

Declarations

Competing Interests The authors declare no competing interests.

Ethical Approval The research was ethically approved by the University of Cambridge Psychology Research Ethics Committee (reference no. PRE.2024.055).

Consent to Participate Informed consent was obtained from parents prior to completing the questionnaire.

References

Allison, C., Baron-Cohen, S., Wheelwright, S., Charman, T., Richler, J., Pasco, G., & Brayne, C. (2008). The Q-CHAT (Quantitative CHecklist for Autism in Toddlers): A normally distributed quantitative measure of autistic traits at 18–24 months of age: Preliminary report. *Journal of Autism and Developmental Disorders, 38*(8), 1414–1425. https://doi.org/10.1007/s10803-007-0509-7

Allison, C., Matthews, F. E., Ruta, L., Pasco, G., Soufer, R., Brayne, C., Charman, T., & Baron-Cohen, S. (2021). Quantitative checklist for autism in toddlers (Q-CHAT). A population screening study with follow-up: The case for multiple time-point screening for autism. *BMJ Paediatrics Open, 5*(1), Article e000700. https://doi.org/10.1136/bmjpo-2020-000700

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Auyeung, B., Wheelwright, S., Allison, C., Atkinson, M., Samarawickrema, N., & Baron-Cohen, S. (2009). The children's empathy quotient and systemizing quotient: Sex differences in typical development and in autism spectrum conditions. *Journal of Autism and Developmental Disorders, 39*(11), 1509–1521. https://doi.org/10.1007/s10803-009-0772-x

Auyeung, B., Allison, C., Wheelwright, S., & Baron-Cohen, S. (2012). Brief report: Development of the adolescent empathy and systemizing quotients. *Journal of Autism and Developmental Disorders, 42*(10), 2225–2235. https://doi.org/10.1007/s10803-012-1454-7

Baird, G., Charman, T., Baron-cohen, S., Cox, A., Swettenham, J., Wheelwright, S., & Drew, A. (2000). A screening instrument for autism at 18 months of age: A 6-year follow-up study. *Journal of the American Academy of Child and Adolescent PsychiatRy, 39*(6), 694–702. https://doi.org/10.1097/00004583-200006000-00007

Baron-Cohen, S. (2000). Theory of mind and autism: A review. *International Review of Research in Mental Retardation, 23*, 169–184. https://doi.org/10.1016/S0074-7750(00)80010-5

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences, 6*(6), 248–254. https://doi.org/10.1016/S1364-6613(02)01904-6

Baron-Cohen, S. (2004). *The essential difference*. Penguin UK.

Baron-Cohen, S. (2011). Zero degrees of empathy: A new theory of human cruelty. *Allen Lane*. https://doi.org/10.1192/bjp.bp.111.098434

Behl-Chadha, G. (1996). Basic-level and superordinate-like categorical representations in early infancy. *Cognition, 60*(2), 105–141. https://doi.org/10.1016/0010-0277(96)00706-8

Chapman, E., Baron-Cohen, S., Auyeung, B., Knickmeyer, R., Taylor, K., & Hackett, G. (2006). Fetal testosterone and empathy: Evidence from the empathy quotient (EQ) and the 'reading the mind in the eyes' test. *Social Neuroscience, 1*(2), 135–148. https://doi.org/10.1080/17470910600992239

Chawarska, K., Macari, S., & Shic, F. (2013). Decreased spontaneous attention to social scenes in 6-month-old infants later diagnosed with autism spectrum disorders. *Biological Psychiatry, 74*(3), 195–203. https://doi.org/10.1016/j.biopsych.2012.11.022

Clearfield, M. W., & Nelson, N. M. (2006). Sex differences in mothers' speech and play behavior with 6-, 9-, and 14-month-old infants. *Sex Roles*, *54*, 127–137. https://doi.org/10.1007/s11199-006-8876-1

Connellan, J., Baron-Cohen, S., Wheelwright, S., Batki, A., & Ahluwalia, J. (2000). Sex differences in human neonatal social perception. *Infant Behavior & Development, 23*(1), 113–118. https://doi.org/10.1016/S0163-6383(00)00032-1

Davidov, M., Zahn-Waxler, C., Roth-Hanania, R., & Knafo, A. (2013). Concern for others in the first year of life: Theory, evidence, and avenues for research. *Child Development Perspectives, 7*(2), 126–131. https://doi.org/10.1111/cdep.12028

Davidov, M., Roth-Hanania, R., Paz, Y., Orlitsky, T., Uzefovsky, F., & Zahn-Waxler, C. (2025). Empathy development from birth to three: Advances in knowledge from 2000 to 2025. *Infant Behavior and Development, 81*, Article 102144. https://doi.org/10.1016/j.infbeh.2025.102144

Decety, J., Bartal, I.B.-A., Uzefovsky, F., & Knafo-Noam, A. (2016). Empathy as a driver of prosocial behaviour: Highly conserved neurobehavioural mechanisms across species. *Philosophical Transactions of the Royal Society B: Biological Sciences, 371*(1686), Article 20150077. https://doi.org/10.1098/rstb.2015.0077

Ekman, P. (2004). Emotions Revealed. *BMJ*. https://doi.org/10.1136/sbmj.0405184

Endendijk, J. J., Antoniucci, C., Chadwick-Brown, F., Halim, M. L. D., & Portengen, C. M. (2024). Gender-typical appearance in early childhood: Role of parental gender-typical appearance and children's gender similarity. *Sex Roles*, *90*, 923–937. https://doi.org/10.1007/s11199-024-01484-z

Etchell, A., Adhikari, A., Weinberg, L. S., Choo, A. L., Garnett, E. O., Chow, H. M., & Chang, S.-E. (2018). A systematic literature review of sex differences in childhood language and brain development. *Neuropsychologia, 114*, 19–31. https://doi.org/10.1016/j.neuropsychologia.2018.04.011

Goldenfeld, N., Baron-Cohen, S., & Wheelwright, S. (2005). Empathizing and systemizing in males, females, and autism. *Clinical Neuropsychiatry: Journal of Treatment Evaluation, 2*(6), 338–345.

Gomez, R. L., & Gerken, L. (1999). Artificial grammar learning by 1-year-olds leads to specific and abstract knowledge. *Cognition, 70*(2), 109–135. https://doi.org/10.1016/s0010-0277(99)00003-7

Greenberg, D. M., Warrier, V., Allison, C., & Baron-Cohen, S. (2018). Testing the empathizing-systemizing theory of sex differences and the extreme male brain theory of autism in half a million people. *Proceedings of the National Academy of Sciences of the United States of America, 115*(48), 12152–12157. https://doi.org/10.1073/pnas.1811032115

Hajjar, S. T. (2018). Statistical analysis: Internal-consistency reliability and construct validity. *International Journal of Quantitative and Qualitative Research Methods, 6*(1), 27–38.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional contagion. *Current Directions in Psychological Science, 2*(3), 96–100. https://doi.org/10.1111/1467-8721.ep10770953

Hoffman, M. L. (1990). Empathy and justice motivation. *Motivation and Emotion, 14*(2), 151–172. https://doi.org/10.1007/BF00991641

Jones, W., & Klin, A. (2013). Attention to eyes is present but in decline in 2–6-month-old infants later diagnosed with autism. *Nature, 504*(7480), 427–431. https://doi.org/10.1038/nature12715

Kirkham, N. Z., Slemmer, J. A., & Johnson, S. P. (2002). Visual statistical learning in infancy: Evidence for a domain general learning mechanism. *Cognition, 83*(2), B35-42. https://doi.org/10.1016/s0010-0277(02)00004-5

Krogh, M. T., & Væver, M. S. (2019). Does gender affect Bayley-III scores and test-taking behavior? *Infant Behavior & Development, 57*, Article 101352. https://doi.org/10.1016/j.infbeh.2019.101352

Loomes, R., Hull, L., & Mandy, W. P. L. (2017). What is the male-to-female ratio in autism spectrum disorder? A systematic review

and meta-analysis. *Journal of the American Academy of Child and Adolescent Psychiatry, 56*(6), 466–474. https://doi.org/10.1016/j.jaac.2017.03.013

Lutchmaya, S., & Baron-Cohen, S. (2002). Human sex differences in social and non-social looking preferences at 12 months of age. *Infant Behavior and Development*, *25*(3), 319–325. https://doi.org/10.1016/S0163-6383(02)00095-4

Marcus, G. F., Vijayan, S., Bandi Rao, S., & Vishton, P. M. (1999). Rule learning by seven-month-old infants. *Science, 283*(5398), 77–80. https://doi.org/10.1126/science.283.5398.77

McDonald, N., & Messinger, D. (2010). *The Development of Empathy: How , When , and Why*. https://www.semanticscholar.org/paper/The-Development-of-Empathy-%3A-How-%2C-When-%2C-and-Why-McDonald-Messinger/5c96ad3a16efb7399632f2c37cd4a768a067d332

Mundy, P., & Newell, L. (2007). Attention, joint attention, and social cognition. *Current Directions in Psychological Science, 16*(5), 269–274. https://doi.org/10.1111/j.1467-8721.2007.00518.x

Rochat, M. J. (2023). Sex and gender differences in the development of empathy. *Journal of Neuroscience Research, 101*(5), 718–729. https://doi.org/10.1002/jnr.25009

Roth-Hanania, R., Davidov, M., & Zahn-Waxler, C. (2011). Empathy development from 8 to 16 months: Early signs of concern for others. *Infant Behavior and Development, 34*(3), 447–458. https://doi.org/10.1016/j.infbeh.2011.04.007

Rueda, P., Fernández-Berrocal, P., & Baron-Cohen, S. (2014). Dissociation between cognitive and affective empathy in youth with Asperger syndrome. *European Journal of Developmental Psychology*, *12*(1), 85–98. https://doi.org/10.1080/17405629.2014.956550

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science, 274*(5294), 1926–1928. https://doi.org/10.1126/science.274.5294.1926

Sesso, G., Brancati, G. E., Fantozzi, P., Inguaggiato, E., Milone, A., & Masi, G. (2021). Measures of empathy in children and adolescents: A systematic review of questionnaires. *World Journal of Psychiatry, 11*(10), 876–896. https://doi.org/10.5498/wjp.v11.i10.876

Silverman, I. W. (2021). Gender differences in inhibitory control as assessed on simple delay tasks in early childhood: A meta-analysis. *International Journal of Behavioral Development, 45*(6), 533–544. https://doi.org/10.1177/01650254211020385

Uljarevic, M., & Hamilton, A. (2013). Recognition of emotions in autism: A formal meta-analysis. *Journal of Autism and Developmental Disorders, 43*(7), 1517–1526. https://doi.org/10.1007/s10803-012-1695-5

Vaish, A., Carpenter, M., & Tomasello, M. (2009). Sympathy through affective perspective taking and its relation to prosocial behavior in toddlers. *Developmental Psychology, 45*(2), 534–543. https://doi.org/10.1037/a0014322

Vogindroukas, I., Stankova, M., Chelas, E.-N., & Proedrou, A. (2022). Language and speech characteristics in autism. *Neuropsychiatric Disease and Treatment, 18*, 2367–2377. https://doi.org/10.2147/NDT.S331987

Wheelwright, S., Baron-Cohen, S., Goldenfeld, N., Delaney, J., Fine, D., Smith, R., Weil, L., & Wakabayashi, A. (2006). Predicting autism spectrum quotient (AQ) from the systemizing quotient-revised (SQ-R) and empathy quotient (EQ). *Brain Research, 1079*(1), 47–56. https://doi.org/10.1016/j.brainres.2006.01.012