Understanding, expressing, and interacting: the development of emotional functioning in young children with autism

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4

CHAPTER 4.

Towards feeling, understanding, and caring: The development of empathy in young autistic children

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ABSTRACT

Autistic children face more challenges than non-autistic children in developing empathic skills. To unravel empathy development and pinpoint the source of challenges in early childhood, this four-wave longitudinal study examined the levels and developments of four key empathy components (i.e., affective empathy, attention to others, cognitive empathy, prosocial actions) in Dutch autistic children (N = 61, M_{age} = 55 months, 89% boys), in comparison to non-autistic peers (N = 145, M_{age} = 52 months, 92% boys), using parent questionnaires and on-site observations. Compared to non-autistic children, autistic children experienced more difficulties in cognitive empathy, paid less attention to others and showed fewer prosocial actions, whereas their affective empathy was not different according to parents. Remarkably, autistic children showed great potential for developing empathic abilities. Helping them increase attention to others and improve emotion understanding can benefit their empathy development. Meanwhile, it is important for non-austistic people to enhance their understanding and interact with autistic children in a respectful and empathical way.

Introduction

Empathy is the ability to feel, understand and react prosocially towards the emotions of another person (Overgaauw et al., 2017). It is a highly valued human capacity that is crucial for maintaining social relationships and for motivating moral and compassionate behaviors (Eisenberg et al., 2010). Autism has long been associated with empathy deficits (Baron-Cohen & Wheelwright, 2004). Recent research which examined empathy as a multicomponent construct advocate that, while autistic individuals have difficulties in understanding others' emotions and thereby might be hindered from responding to others' emotions appropriately, they are not indifferent to other people's feelings (Fletcher-Watson & Bird, 2020; Smith, 2009). This multicomponent approach of empathy helps removing the negative and stereotypical view of autism (Santiesteban et al., 2020). More importantly, it facilitates identifying the unique challenges that autistic individuals face in their empathy development (Bons et al., 2013). Information in this regard obtained from early childhood can be of particular importance and benefit effective prevention and intervention (Falck-Ytter et al., 2013).

Hoping to advance our knowledge of empathy development in autistic children, this four-wave longitudinal study examined the development of four key empathy components in young autistic children aged 1 to 6 years, as compared to non-autistic peers. In addition to the commonly acknowledged affective and cognitive empathy, we also examined the extent to which autistic children knew to switch their attention from the self to the affected other, and the extent to which they displayed prosocial behaviors towards others. Furthermore, we examined how the development of empathy influenced children's psychosocial functioning.

Empathy and its development in early childhood

Empathy is a complex construct which emerges from multiple interrelated emotional and cognitive processes (Tousignant et al., 2017). Observing the emotional state of another, especially negative emotions, can induce a similar emotional state in the self ("affective empathy") (Decety & Meyer, 2008; Rieffe et al., 2020). While feeling the self being emotionally aroused, one needs to understand that the emotional state is not about the self. The attentional switch from the self to the affected other ("attention to others") marks a crucial step in the empathy process (Bird & Viding, 2014; Rieffe et al., 2010). Only when the attention is switched to interpret the information relating to another, can the individual evaluate accurately how another feels and why in that way ("cognitive empathy") (Baron-Cohen & Wheelwright, 2004; Dziobek et al., 2008). Furthermore, when one is feeling, paying attention to and understands another's feelings, they are motivated to react prosocially

(Eisenberg et al., 2010). The person is motivated to share another's pleasure or to ease another's distress ("prosocial actions").

Early childhood is the period when empathy undergoes substantial development (Davidov et al., 2013). Infants aged 6 months and above show affective concern when witnessing another in distress. Meanwhile information-seeking behaviors such as attending to another begin to emerge (Roth-Hanania et al., 2011). However, at this stage the self-other distinction is not yet fully established, therefore infants often confuse the distress of another with the distress of their own, and they can become overwhelmed by others' negative emotions (Hoffman, 2000). As children's self- and other-awareness increase with age, they become more aware that the emotional turmoil is not about themselves. The attentional switch from the self to the affected other not only facilitates better understanding of others' emotions, but also helps alleviate the distress provoked in oneself (Bird & Viding, 2014). Accordingly, longitudinal studies found that while attention to others and cognitive empathy kept growing during early childhood, affective empathy increased only slightly or remained stable (Tousignant et al., 2017; Davidov et al., 2013). With enhanced cognitive and motor abilities, children's prosocial actions increase in both quality and quantity. With age children engage more often in prosocial behaviors such as helping and comforting in response to others' distress (Flook et al., 2019; Zahn-Waxler et al., 1992).

Empathy in autistic children

While empathy seems to develop naturally and effortlessly in most typically developing children, it is more challenging for autistic children. First, decades of research provide converging evidence that autism is associated with impaired understanding of other people's minds (Baron-Cohen, 2001). Deficits in emotion understanding are observed already in the first years of life in autistic children and the problem persists into adulthood (Harms et al., 2010; Lozier et al., 2014). Correctly interpreting others' emotional states forms the core of cognitive empathy (Bons et al., 2013). Not surprisingly, lower levels of cognitive empathy are repeatedly reported in autistic children and adults as compared to non-autistic peers (e.g., Deschamps et al., 2014; Mul et al., 2018; Pouw et al., 2013).

Empathy development in autistic children can also be hindered by their diminished social attention. Reduced attention to social stimuli such as people, faces and body movements is observed in autistic individuals at different stages in life (Chita-Tegmark, 2016). Some researchers ascribed this to a diminished social motivation, positing that social interactions are less rewarding for autistic individuals, and therefore they orient less often and less spontaneously towards other people (Chevallier et al., 2012). However, this account

seems to contradict testimonies from autistic individuals, who state that they long for social interactions just as much as everyone else (Jaswal & Akhtar, 2019). Furthermore, recent behavioral and neurophysiological research found that, instead of having hypo-reactivity, autistic individuals might experience hyper-reactivity and overarousal when exposed to social stimuli such as direct gazes and emotional expressions of other people (e.g., Dalton et al., 2005; Kleinhans et al., 2010; Monk et al., 2010). It is proposed that autistic people avert their attention as a regulating strategy to avoid being overwhelmed by the intense social input (Markram & Markram, 2010; Tanaka & Sung, 2016).

Diminished attention to others is also reported by empathy research on autistic children aged from 1 to 7 years (Campell et al., 2015; Corona et al., 1998; Dawson et al., 2004; Hutman et al., 2010). These studies used in vivo tasks, where children's empathic reactions to the emotional display of an adult were observed and evaluated. It is consistently reported that autistic children paid less attention to the affected adult than non-autistic children.

The above-mentioned studies also observed less intense emotional responses such as facial, vocal and gestural concerns in autistic children. This seems to indicate lower levels of affective empathy in autistic children. Worth noting, the findings of observational studies diverge from the findings of studies using parent reports (Hudry et al., 2009; Deschamps et al., 2014) and self-reports (Dziobek et al., 2008; Mul et al., 2018; Pouw et al. 2013; Santiesteban et al., 2020), which reported no group differences in affective empathy. Possibly, the presence of an adult stranger, which is usually the case in observational studies, induces a lot of stress and thus disrupts the empathy process in autistic children (Corbett et al. 2014; O'Connor et al., 2019). Intact affective empathy of autistic children and adults is further supported by evidence from neurophysiological research, which reported that when their attention to the social stimuli was maintained, autistic individuals showed comparable or even higher levels of physiological arousals and brain activations related to empathy (Dijkhuis et al., 2019; Fan et al., 2014; Hadjikhani et al., 2017; Trimmer et al., 2017).

Whereas affective empathy may stay intact in autistic children, their deficient cognitive empathy and reduced social attention can hinder them from reacting properly and prosocially towards others, leading to the impression that they are unempathetic (Fletcher-Watson & Bird, 2020). Not surprisingly, most studies reported fewer prosocial actions in autistic children than non-autistic children (e.g., Hudry et al., 2009; Russell et al., 2013). Two studies did not find group differences, which evaluated children's prosocial reactions to the emotional display of parents (McDonald & Messinger, 2012) and of a virtual player in

computerized tasks (Deschamps et al., 2014). Possibly, compared to the social demand of reacting to an adult stranger, it is less stressful for autistic children to react to parents and a virtual player.

As discussed so far, empirical evidence gathered from cross-sectional studies shows that autistic children do not lack the ability to feel for others, and yet they have difficulties in understanding, attending and reacting appropriately towards others. The challenges are present already in early childhood. Some problems seem to persist into adulthood. Albeit very informative, the cross-sectional nature of these studies precludes an evaluation of the developmental course of empathy in autistic children. To date, only a few longitudinal studies checked the development of some empathy components in young autistic children. First, regarding affective empathy, a stable trend in a short term of six months (McDonald & Messinger, 2012; Zantinge et al., 2018) and an increasing trend in a long term of three years (Hutman et al., 2010) have been reported in autistic toddlers. Besides, attention to others and prosocial actions are observed to increase in autistic children (Hutman et al., 2010; Zantinge et al., 2018; McDonald & Messinger, 2012; Russell et al., 2013). To our best knowledge, no empathy research has examined the development of cognitive empathy in autistic children. Indirect evidence comes from research on emotion understanding and Theory of Mind, both reporting age-related improvements in autistic children (e.g., Rosen & Lerner, 2016; Steel et al., 2003). It is reasonable to assume that autistic children's cognitive empathy also improves with age. However, the fact that autistic children still lag behind in emotion understanding at older ages and this gap is widening from early childhood to adolescence and adulthood suggests that the magnitude of improvement in autistic children is less than in non-autistic children (Harms et al., 2010; Lozier et al., 2014).

Present study

This study aimed to investigate the presence and developments of four empathy components (affective empathy, attention to others, cognitive empathy and prosocial actions) in autistic children aged 1 to 6 years, as compared to non-autistic peers. Furthermore, given that the associations between empathy development and positive psychosocial outcomes are well established in typical development (for reviews, see Eisenberg et al. (2010) and Jolliffe & Farrington (2004)), we wanted to examine whether the same associations existed in autistic children.

Prior research showed that autistic children were viewed as more empathic by parents than experimenters in observational tasks. While parents' insight is based on long-term and close observations, the evaluation from observational tasks provides information about how

autistic children react in real daily situations and how their reactions are perceived by non-autistic people other than parents. Considering that any single measure provides only a partial assessment of the underlying construct and can limit the explanatory power of the results (Kienbaum, 2014), we assessed empathy using both parent questionnaires and observational tasks. We asked parents to evaluate the levels of all four empathy components in their children. In the observational tasks the experimenter acted out three emotional episodes, i.e., pretending to be happy, angry and in pain, and observed the reactions of the children. Since it was difficult to incorporate a test of cognitive empathy during the acting-outs, only affective empathy, attention to others and prosocial actions were measured in the observational tasks.

Based on the former discussed literature, the following hypotheses were tested in the current study. We expected autistic children to have lower levels of cognitive empathy, pay less attention to others, display fewer prosocial actions than non-autistic peers, and the group differences would be maintained over time. Regarding affective empathy, we expected that the experimenters would evaluate autistic children as showing less affective empathy in the observational tasks whereas parents would report equivalent levels of affective empathy of autistic and non-autistic children.

Regarding the developmental trajectories of empathy components, for non-autistic children, we expected their affective empathy to either show a small increase or remain stable, and that their attention to others, cognitive empathy and prosocial actions would increase with age. Due to the limited evidence from longitudinal data of autistic children, our hypotheses regarding their developmental trajectories were explorative in nature. We expected autistic children to show similar developmental trajectories of affective empathy, attention to others and prosocial actions as their non-autistic peers. As for cognitive empathy, we expected it to increase in autistic children but the increase would be of a smaller magnitude than in non-autistic children.

We also explored the extent to which empathy as a compound contributed to the development of autistic children's psychosocial functioning. We expected that, similar as in non-autistic children, a higher level and an improvement of empathy would contribute to the prediction of decreased externalizing problems and increased social competence in autistic children.

Methods

Participants and procedure

This study was part of a larger-scaled longitudinal research in the Netherlands on the social and emotional development of preschool children with limited access to the social world, including children with hearing loss, with developmental language disorder and with autism. The total sample of the larger-scaled research included 73 autistic children (65 boys) and 418 non-autistic children (226 boys). Autistic children met the following inclusion criteria: the child received an autism diagnosis according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM-IV-TR*, American Psychiatric Association, 2000), backed up by the *Autism Diagnostic Interview-Revised* (Lord et al., 1994) set by a qualified child psychologist or psychiatrist at Time 1; the parent confirmed three years later that the child retained the autism diagnosis; the child had IQ scores above 70 and no additional *DSM-IV-TR* diagnoses. Inclusion criteria for non-autistic children were IQ scores above 70 and no *DSM-IV-TR* diagnoses.

Autistic children were recruited via a specialized institution for diagnosis and treatment of autism (Center for Autism, Leiden, The Netherlands). Non-autistic children were recruited from day-care centers and mainstream schools in the same region. Since the IQ profiles of autistic children were either retrieved from school or collected by the institution, various intelligence tests were used, including the Snijders-Oomen Nonverbal Intelligence Tests (SON-R), Wechsler Intelligence Scale for Children, Wechsler Preschool and Primary Scale of Intelligence, and Wechsler Nonverbal Scale of Ability. Non-autistic children were tested with the SON-R.

The Ethics Committee of Leiden University and Center for Autism granted permission for the larger-scaled research project. All parents provided written informed consent. Children and their parents participated the research once a year for four consecutive years (mean duration between Time 1 and Time 2 = 13.15 months, *SD* = 3.31; between Time 2 and Time 3 = 12.13 months, *SD* = 1.58; between Time 4 and Time 3 = 12.37, *SD*=1.06). Children were visited either at school or at the specialized institution (for the autistic group only), where they finished a series of tasks under the guidance of a psychologist who had received training for administering the tasks and for coding children's behaviors. Parents filled out questionnaires to report on their children's development. The Social Responsive Scale (SRS; Constantino & Gruber, 2005) were filled out at Time 1, Time 3 and Time 4, where parents reported on the degree of their children's autistic symptomatology. It consists of 65 items with responses on a 4-point scale, where higher scores indicated greater severity

of autistic traits. First, raw total scores were calculated. Then the raw scores were converted to T-scores according to the Dutch SRS manual (Roeyers et al., 2011).

Due to time constraints, not all children were administered the full battery of tasks. Participants of the larger research project were included in this study if they had data of the examined variables on at least one time point (see Supplementary Table 1, 2 and 3 for available data at each time point). The final sample included 61 autistic children (7 girls; aged 21 to 72 months at Time 1) and 145 non-autistic children (11 girls; aged 21 to 71 months at Time 1).

Table 1 shows the descriptive characteristics of the two groups. The autistic and non-autistic group did not differ in gender distribution (χ^2 (1) = 0.81, p = .367) or age (1.21 < ts < 1.74, ps > .05). Autistic children on average had a lower IQ than non-autistic children (t(83.22) = 2.21, p = .03). Autistic children scored higher on the SRS scale than non-autistic children at Time 1(t(37.87) = 11.21, p < .001), Time 3 (t(63.63) = 9.09 , p < .001), and Time 4 (t(48.19) = 9.51, p < .001). Mothers of autistic children had lower education levels than mothers of non-autistic children (t(95.04) = 3.03, p = .003). The education levels of fathers did not differ between groups (t(89.95) = 1, p = .32). Families of autistic children had lower income than families of non-autistic children (t(130) = 3.64, p < .001).

Materials

Empathy. Two parent questionnaires were used to measure empathy. The Empathy Questionnaire (EmQue; Rieffe et al., 2010) asks parents to evaluate the extent to which their children showed affective empathy (6 items, e.g., “When another child cries, my child gets upset too”), attention to others (7 items, e.g., “When an adult gets angry with another child, my child watches attentively”), and prosocial actions (6 items, e.g., “When another child starts to cry, my child tries to comfort him/her”) over the past two months on a three-point scale: 0 = not at all applicable; 1 = a little or sometimes applicable; 2 = clearly or often applicable.

The Emotion Expression Questionnaire (EEQ; Li et al., 2020; Rieffe et al., 2010) asks parents to evaluate their children’s emotion expression and emotion acknowledgement. To measure cognitive empathy, we used the subscale “Emotion acknowledgment” (6 items), where parents reported the extent to which their children recognized and understood happiness, anger, fear, sadness and joy in their parents (e.g., “Does your child understand when you are happy?”) on a 5-point scale (ranging from “1 = (almost) never applicable” to “5 = (almost) always applicable”).

Table 1: Demographic characteristics of participants: means (standard deviations) of background variables

		Total participants at Time 1 N = 206			
		Autistic	N 61	**Non-autistic**	N 145
Age in months	Time 1	55.49 (12.64)	61	52.16 (12.50)	145
	Time 2	66.90 (13.19)	49	66.57 (13.48)	51
	Time 3	80.67 (11.80).	46	77.54 (13.29)	48
	Time 4	93.38 (11.83)	40	88.95 (13.37).	41
Male%		88.5%	54	92.4%	134
IQ*		99.08 (16.46)	50	105.14 (11.03)	59
SRS T score	Time 1**	75.13 (11.42)	40	46.92 (6.32)	13
	Time 3**	72.92 (20.40)	51	45.21 (7.33)	47
	Time 4**	78.23 (15.77)	31	47.06 (9.16)	31
Education mother[a*]		3.82 (1.13)	52	4.43 (0.87)	48
Education father[a]		3.79 (1.28)	53	4.03 (0.96)	39
Net annual income[b**]		2.96 (1.11)	43	3.74 (1.19)	89

[a] Parental education level: 1 = no/primary education; 2 = lower general secondary education; 3 = middle general secondary education; 4 = higher general secondary education; 5 = college/university.

[b] Net household income: 1 = less than €15,000; 2 = €15,000 – €30,000; 3 = €30,000 – €45,000; 4 = €45,000 – €60,000; 5 = more than €60,000.

* $p < .05$ ** $p < .001$

In addition to parent questionnaires, three Empathy Observational Tasks (EMT; Ketelaar et al., 2013; Rieffe et al., 2010) were administered to evaluate children's empathic responses to the emotional display of the experimenter. The EMT and their coding schemes were designed based on the classical empathy task developed by Zahn-Waxler and colleagues (1992) for measuring empathic responses in toddlers and preschoolers. At each time point, the experimenter acted out three emotional episodes, where he or she pretended to be happy (e.g., clicking a pen and meanwhile laughing aloud), angry (e.g., being mad at a pen which did not write), and in pain/distress (e.g., hurting a finger when closing a folder). Following

each acting-out performance, children's reactions were rated using a three-point scale (0 = not at all applicable; 1 = a little or sometimes applicable; 2 = clearly or often applicable). The coding schemes consist of three scales: (1) affective empathy (6 items; e.g., "The child shows similar emotions as the experimenter"), (2) attention to others (6 items; e.g., "The child stops playing and looks at the experimenter"), and (3) prosocial actions (4 items, not for the happy-emotion episodes; e.g., "The child tries to help").

To avoid that children remembered the tasks from the previous time, the content of the tasks varied at each time point, yet the nature of the tasks remained unchanged. Children's reactions were rated by the psychologist who administered the tasks. All the participating psychologists had received intensive training on administering and coding the behaviors. They had achieved a high inter-rater reliability during practice before they went to work independently. Besides, one author took a random selection of 10% participants (6 autistic children and 14 non-autistic children) and rated their behaviors from video recordings. The interrater agreements were good (Time 1: $.80 < k < 1.00$; Time 2: $.84 < k < 1.00$; Time 3: $.81 < k < 1.00$; Time 4: $.81 < k < 1.00$).

Psychosocial functioning. The Early Childhood Inventory-4 (ECI-4; Sprafkin et al., 2002) is a parent questionnaire designed for evaluating the psychopathological symptoms in children. The ECI-4 consists of 108 items, each item rated on a 4-point scale (from "0 = never" to "3 = very often"). The scores can be used for the screening purposes, or for indicating the symptom severity. We used the subscales "Peer conflict" (10 items), "Oppositional defiant disorder" (8 items), and "Conduct disorder" (10 items), and calculated their total mean score as the index of the severity of externalizing problems.

At the end of each testing session, experimenters completed a questionnaire that was designed for the larger-scaled research to evaluate children's performances and attitudes during the test session (Ketelaar et al., 2015). We used the subscale "Cooperation" (9 items), which evaluated the extent to which children were motivated to complete the tasks and how responsive they were to the experimenter's instructions (e.g., "The child did the task with enthusiasm and pleasure"; "The child waits for the experiment's signal to begin the task"). Items were rated on a three-point scale (0 = not, 1= sometimes, 2 = often).

Psychometric properties of the measurements. The means, standard deviations and reliabilities of the measurements were reported in Supplementary Table 1, 2 and 3. The reliabilities were examined by McDonald's ω_t. Compared to Cronbach's α, McDonald's ω-statistics are more tolerant for assumption violations and have been proven the best reliability tests for both unidimensional and multidimensional measures (Revelle & Zinbarg, 2009). The

questionnaires filled out by parents and experimenters showed satisfactory to good reliabilities across time (autistic group: $0.83<\omega_t<0.96$; non-autistic group:$0.73<\omega_t<0.95$).

The observational tasks also showed satisfactory to good reliabilities across time (autistic group: $0.71<\omega_t<0.93$; non-autistic group: $0.75<\omega_t<0.88$), except for the "Prosocial actions" scale at Time 3 (autistic: $\omega_t=0.66$; non-autistic: $\omega_t=0.55$) and at Time 4 (autistic: $\omega_t=0.64$; non-autistic: $\omega_t=0.64$). A data inspection showed that the low reliabilities were due to the little variation of the ratings of some items at Time 3 and Time 4. A decrease of reliabilities is often observed in longitudinal studies. Sample attrition can make the remaining sample more similar, and the narrowing differences of the sample can cause a decrease of the measurement reliability (Bernardi, 1998).

Statistical analyses

R (version 3.3.3; R Core Team 2019) was used to check measurement reliabilities (with the package "psych"; Revelle, 2020) and to make figures (with the package "ggplot2"; Wickham, 2009). IBM SPSS Statistics for Macintosh (version 26.0; Armonk, NY: IBM Corp.) were used to conduct Linear Mixed Model (LMM) analyses for examining the developmental trajectories of empathy and its longitudinal associations with psychosocial functioning. LMM can account for the dependency within the longitudinal data (Hox et al., 2010) and is robust in handing randomly missing data (Twisk et al., 2017). The current data had missing values at every time point. Little's MCAR tests indicated that the missing patterns could be completely at random (Time 1: $\chi^2 = 15244.44$, $df = 43995$, $p > .05$; Time 2: $\chi^2 = 4853.35$, $df = 11244$, $p > .05$; Time 3: $\chi^2 = 5184.55$, $df = 19163$, $p > .05$; Time 4: $\chi^2 = 4407.23$, $df = 15410$, $p > .05$).

We followed a formal model-fitting procedure, i.e., fitting increasingly more complex models to the data step by step. Simpler models with a better model fit were selected over the more complex model. To evaluate model fit, for nested models, the preferred model showed significant less deviance, i.e., lower values of -2 Log Likelihood (-2LL). For non-nested models, the preferred model showed lower Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values.

To examine the developmental trajectories of empathy, we started with an unconditional means model which included only a fixed and a random intercept. Then, age (centered around 21 months, the youngest age of all participants) was added to the model. We examined two models of change: linear and quadratic, respectively. Next, group (0 = non-autistic, 1 = autistic) was added to examine if the levels of empathy differed between the two groups across time. Fourth, we added the interactions between age and group to the model to examine whether the two groups differed in developmental trajectories.

To investigate the contributing role of empathy to the prediction of psychosocial development, we first calculated the mean scores (mean of Time 1, Time 2, Time 3, and Time 4) and change scores (Time 1 - Time 1, Time 2 – Time 1, Time 3 – Time 1, Time 4 – Time 1) of empathy. Then we started with the model that had only age and group as the control variables. Next, we added empathy (means and change scores) to the model. Fourth, we added interactions of empathy with group to the model, to explore whether the groups differed in the relations. Non-significant interactions were removed during the procedure.

Results

Developmental trajectories of parent-reported empathy. The estimates of the best age models for parent-reported empathy were reported in Table 2 and Supplementary Table 4. The developmental trajectories of parent-reported affective empathy, attention to others, prosocial actions and cognitive empathy were depicted in Figure 1. For the development of parent-reported affective empathy, the best fitting model was with fixed effect of linear age ($t(323.04) = -0.001$, $p = .348$), indicating that affective empathy did not change over time. Adding group did not contribute to increasing the model fit, indicating that parents reported equivalent levels of affective empathy of the two groups. The best fitting model for parent-reported attention to others was with fixed effects of linear age ($t(346.26) = 0.91$, $p = .361$) and group ($t(173.30) = -7.13$, $p < .001$). This indicates that attention did not change over time, and autistic children paid less attention to others than non-autistic children. For parent-reported prosocial actions, the best fitting model was with fixed effects of linear age ($t(345.83) = 6.22$, $p < .001$) and group ($t(164.15) = -11.25$, $p < .001$), which indicates that prosocial actions increased with age in all children. Yet, autistic children displayed overall fewer prosocial actions than non-autistic children. For parent-reported cognitive empathy, the best fitting model was with fixed effects of linear age ($t(401) = 1.03$, $p = .303$), group ($t(401) = -1.56$, $p < .001$), and the interaction of age and group ($t(401) = 2.46$, $p = .014$). Overall, autistic children were evaluated as having lower levels of cognitive empathy. However, cognitive empathy increased with age in autistic children ($b = .013$, $t(167) = 3.07$, $p = .002$), whereas it did not change over time in non-autistic children ($b = .003$, $t(234) = 1.39$, $p = .167$).

Table 2. Fixed and random effects of the best age models for parent-reported empathy.

	Affective Empathy				**Attention to Others**			
Fixed effects	**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**	
Intercept	.35	.04	[.27, .43]		1.35	.05	[1.25, 1.45]	
age	-.002	.001	[-.004, .0001]		.001	.001	[-.001, .003]	
group	-	-	-		-.42	.06	[-.54, -.30]	
Random effects	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**
Residual	.05	.01	[.04, .06]	10.05	.06	.01	[.05, .07]	10.69
Intercept	.11	.02	[.08, .14]	6.81	.10	.01	[.08, .13]	7.10

	Prosocial Action				**Cognitive Empathy**			
Fixed effects	**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**	
Intercept	.80	.05	[.71, .90]		3.88	.12	[3.65, 4.11]	
age	.006	.001	[.004, .008]		.003	.003	[-.002, .008]	
group	-.64	.06	[-.75, -.53]		-1.55	.21	[-1.95, -1.14]	
*age * group*	-	-	-		.01	.004	[.002, .018]	
Random effects	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**
Residual	.06	.01	[.05, .07]	10.49	.51	.04	[.45, .59]	14.16
Intercept	.10	.01	[.07, .13]	6.79	-	-	-	-

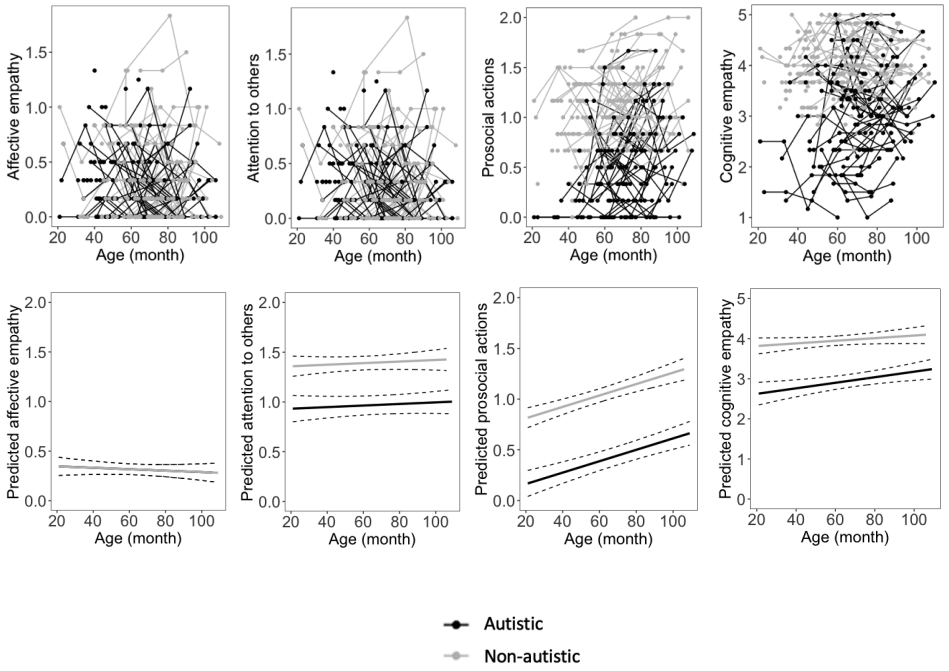

Fig 1. Developmental trajectories of parent-reported empathy. Upper from left to right: graphic representations of the levels of parent-reported affective empathy, attention to others, prosocial actions and cognitive empathy at four time points. The points were connected in lines, each line representing one participant. Participants who had data at one time point are presented by points. Lower from left to right: regression lines depicting predicted levels of parent-reported affective empathy, attention to others, prosocial actions and cognitive empathy with 95% CI's based on the best age models.

Developmental trajectories of empathy observed in tasks. The estimates of the best age models for observed empathy were reported in Table 3 and supplementary Table 4. The developmental trajectories of observed affective empathy, attention to others and prosocial actions were depicted in Figure 2. The best fitting model for observed affective empathy was with the fixed effects of linear age ($t(470.18) = 1.04$, $p = .301$) and group ($t(146.88) = -4.26$, $p < .001$), indicating that affective empathy did not change over time, and that the experimenters observed lower levels of affective empathy in autistic children than non-autistic children. The best fitting model for observed attention was with fixed effects of linear age ($t(479) = -4.14$, $p < .001$), group ($t(479) = -6.75$, $p < .001$), and the interaction of age and group ($t(479) = 3.82$, $p < .001$). Autistic children paid overall less attention than non-autistic

children to the emotional display of the experimenter. Besides, attention was decreased with age in non-autistic children (b = -.006, t(284) = -4.55, p < .001), whereas it did not change in autistic children (b = .003, t(195) = 1.39, p = .167). The best fitting model for observed prosocial actions was with fixed effects of linear age (t(430.41) = 2.54, p = .012), group (t(448.01) = -2.51, p =.013), and the interaction of age and group (t(461.29) = 2.59, p = .010). Although autistic children showed overall fewer prosocial actions than non-autistic children, prosocial actions increased in autistic children with a greater magnitude (b = .008, t(191.38) = 5.88, p < .001) than in non-autistic children (b = .003, t(252.12) = 2.43, p = .016).

Empathy and the development of psychosocial functioning. To examine the integrated effects of empathy on the development of children's psychosocial functioning, three compound scores of empathy were calculated. First, we calculated the total mean of the EmQue, which included affective empathy, attention to others, and prosocial actions. Second, to incorporate cognitive empathy, we combined the EmQue and the Emotion acknowledgement scale of the EEQ. Since the former used a 3-point scale whereas the latter used a 5-point scale, to keep the more distinguished scale, we converted the 3-point-scale scores to 5-point-scale scores: 0=1 ("never applicable"), 1=3 ("sometimes or often applicable"), 2=4 ("often applicable"), and calculated the total mean of the items of the two questionnaires combined. Third, we calculated the total mean of the empathy observation tasks, which included affective empathy, attention to others, and prosocial actions.

Three separate LMM analyses were run to fit the three empathy compound scores to the models respectively and the results were similar (see Table 4 and Supplementary Table 5 for the estimates of the best predicting models). The best predicting models for externalizing problems were with the fixed effects of age (-7.67 < ts < -6.99, ps < .001), group (5.29 < ts < 6.44, ps < .001), the mean levels of empathy (-0.14 < ts < .55, ps > .05), and the change levels of empathy (-3.35 < ts < -2.36, ps < .05). This indicates that externalizing problems decreased with age in both groups, autistic children showed overall more externalizing problems than non-autistic children, and for all children increased empathy was associated with decreased externalizing problems. As for social competence, the best predicting models were with fixed effects of age (5.03 < ts < 5.19, ps < .001) and group (-9.06 < ts < -3.79, ps < .001), indicating that social competence increased with age in all children, and autistic children had lower social competence than non-autistic children. While the change level of observed empathy contributed to increased social competence in non-autistic children (b = 0.29, t(282.86) = 3.55, p < .001), the mean levels of observed and parent-reported empathy

(0.34 < *b*s < 0.78, 3.58 < *t*s < 7.55, *p*s ≤ .001) contributed to increased social competence in autistic children.

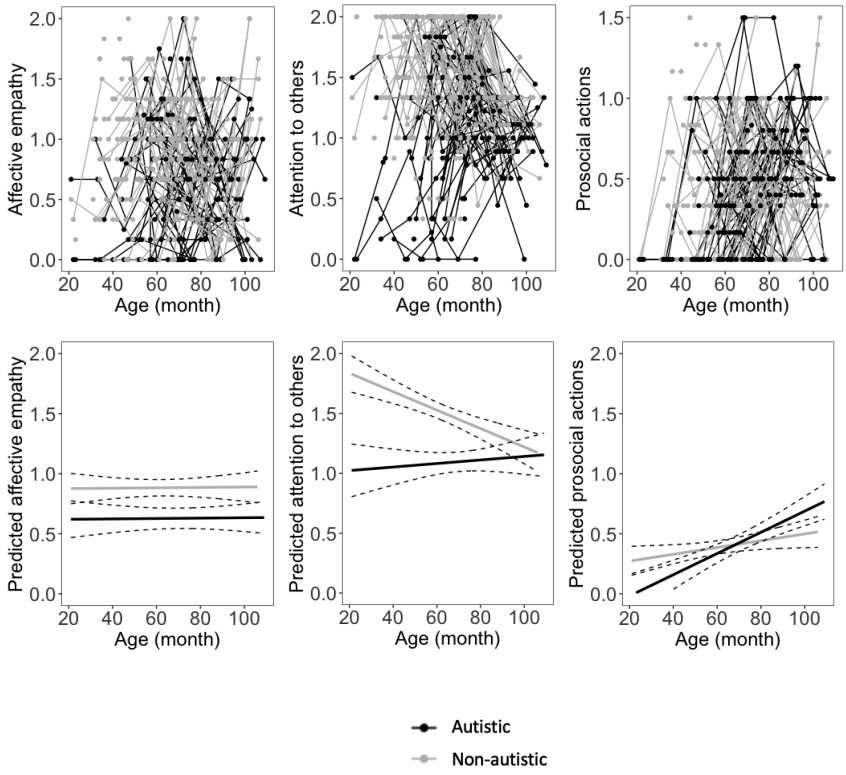

Fig 2. Developmental trajectories of empathy observed in tasks. Upper from left to right: graphic representations of the levels of observed affective empathy, attention to others and prosocial actions at four time points. The points were connected in lines, each line representing one participant. Participants who had data at one time point are presented by points. Lower from left to right: regression lines depicting predicted levels of observed affective empathy, attention to others, and prosocial actions with 95% CI's based on the best age models.

Table 3. Fixed and random effects of the best age models for observed empathy.

	Affective empathy				**Attention to others**				**Prosocial actions**			
Fixed effects	**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**	
Intercept	.81	.06	[.69, .92]		1.73	.07	[1.60, 1.87]		.26	.06	[.16, .37]	
age	.001	.001	[-.001, .004]		-.006	.001	[-.009, -.003]		.003	.001	[.001, .005]	
group	-.23	.06	[-.34, -.13]		-.79	.11	[-1.02, -.56]		-.24	.09	[-.42, -.05]	
*age * group*	-	-	-		.009	.002	[.004, .013]		.005	.002	[.001, .008]	
Random effects	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**
Residual	.17	.01	[.15, .20]	11.94	.21	.01	[.19, .24]	15.48	.11	.01	[.09, .13]	12.08
Intercept	.05	.01	[.03, .09]	3.57	-	-	-	-	.02	.01	[.01, .05]	3.00

Table 4. Fixed and random effects of the best empathy models for predicting psychosocial functioning.

Externalizing problems												
	Parent-reported empathy (without cognitive empathy)				**Parent-reported empathy (with cognitive empathy)**				**Observed empathy**			
Fixed effects	**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**	
Intercept	.61	.10	[.42, .80]		.68	.07	[.34, 1.02]		.69	.09	[.51, .88]	
age	-.007	.001	[-.008, -.005]		-.007	.001	[-.008, -.005]		-.007	.001	[-.009, -.005]	
group	.35	.06	[.23, .46]		.33	.06	[.21, .46]		.35	.05	[.24, .46]	
Memp	.05	.09	[-.13, .24]		-.008	.06	[-.12, .10]		-.03	.09	[-.20, .14]	
Cemp	-.22	.09	[-.41, -.04]		-.21		[-.33, -.09]		-.17	.06	[-.29, -.06]	
Random effects	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald's Z**
Residual	.06	.01	[.05, .07]	9.70	.06	.01	[.05, .07]	9.79	.06	.01	[.05, .07]	9.83
Intercept	.07	.01	[.05, .09]	5.55	.07	.01	[.05, .09]	5.62	.07	.01	[.01, .05]	5.80
Social competence												
	Parent-reported empathy (without cognitive empathy)				**Parent-reported empathy (with cognitive empathy)**				**Observed empathy**			

Fixed effects	**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**		**Estimates**	**SE**	**CI [low, high]**	
Intercept	1.58	.12	[1.34, 1.82]		1.50	.24	[1.02, 1.98]		1.49	.09	[1.32, 1.66]	
age	.005	.001	[.003, .007]		.005	.001	[.003, 007]		.005	.001	[.003, .007]	
group	-.73	.14	[-1.02, -.44]		-1.10	.29	[-1.67, -.53]		-1.02	.11	[-1.24, -.80]	
Memp	.007	.12	[-.23, .25]		.03	.08	[-.13, .19]		.09	.08	[-.08, .25]	
*Memp*group*	.60	.17	[.26, .95]		.33	.11	[.12, .54]		.93	.13	[.67, .1.20]	
Cemp	-.09	.10	[-.29, .11]		-.02	.06	[-.13, .10]		.35	.09	[.18, .52]	
*Cemp*group*	-	-	-		-	-	-		-.32	.12	[-.55, -.09]	
Random effects	**Estimates**	**SE**	**CI [low, high]**	**Wald ’s Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald ’s Z**	**Estimates**	**SE**	**CI [low, high]**	**Wald ’s Z**
Residual	.08	.01	[.06, .09]	10.65	.08	.01	[.07, .09]	10.66	.08	.01	[.07, .10]	12.04
Intercept	.05	.01	[.03, .07]	4.83	.05	.01	[.03, .07]	4.68	.03	.01	[.02, .05]	3.98

NOTE. Memp=Mean levels of empathy; Cemp = Change levels of empathy.

Discussion

To our knowledge, this four-wave longitudinal study is the first simultaneously addressing the four key components of empathy and their developments in young autistic children, using parent reports and on-site observations. Consistent with the literature, autistic children were evaluated by their parents as having equivalent levels of affective empathy, whereas they were evaluated in the observational tasks as showing less affective empathy than non-autistic peers. Besides, parents reported lower levels of cognitive empathy in autistic children, and they were evaluated by both parents and experimenters as paying less attention to another's emotions and showing fewer prosocial actions than non-autistic peers. Our findings agreed with the few existing longitudinal studies that affective empathy remained stable whereas cognitive empathy and prosocial actions increased with age in autistic children. Regarding attention to others, instead of showing age-related increases as suggested by the literature, we did not find any age effect in autistic children. Furthermore, the developmental trajectories of cognitive empathy, attention to others and prosocial actions differed between autistic and non-autistic children. While cognitive empathy increased in autistic children, it remained stable in non-autistic children. Also, while autistic children maintained their attention to the experimenter in the observational tasks, non-autistic children's attention was observed to decrease with age. Remarkably, autistic children showed a greater increase of prosocial actions towards the experimenter than non-autistic children. In line with the literature, we found that higher levels and improvements of empathy were associated with better psychosocial outcomes in both groups.

First, consistent with previous findings and as we expected, parents evaluated autistic children as having more affective empathy than experimenters in the observational tasks. The social demand of interacting with an adult stranger in the observational tasks can be very taxing for autistic children and thus disrupt their empathy process (Corbett et al. 2014; O' Connor et al., 2019). On the other hand, parents' observations were based on their daily interactions with their child and the interactions of their child with other children. These situations were more relaxing and could invite more emotional responses from autistic children. It is also possible that autistic children were emotionally more involved with their parents and acquainted peers than adult strangers, and thus their emotions resonated more with these familiar agents (Pierce & Redcay, 2008; Shanok et al., 2019). It should be noted that the moderating effect of agent familiarity on empathic concerns was observed not just in autistic children but also in non-autistic children (Hudry & Slaughter, 2009). Our finding that non-autistic children still showed more affective empathy towards the experimenter indicates

that autistic children might be more vulnerable to unfamiliar situations. It should also be mentioned that in observational tasks autistic children's emotional experiences could be underestimated given their atypical emotional expressions (Brewer et al., 2016; Sheppard et al., 2016), whereas parents of autistic children might be more sensitive to detect the feelings of their children due to their long-term and close interactions with their children. It is beyond the scope of the current study to identify which factors explain the incongruence between the evaluations of parents and the observational tasks.

We confirmed the literature on the challenges in cognitive empathy and other-oriented attention in autistic children. Cognitive empathy constitutes a crucial part of empathy, as understanding how the other feels is the prerequisite for reacting empathetically and appropriately (Baron-Cohen & Wheelwright, 2004; Dziobek et al., 2008). For autistic children, not understanding the emotions of another while being exposed to that person's emotional display can be very stressful. To cope with the stress, autistic children may switch their attention away, i.e., "out of sight, out of mind" (Markram & Markram, 2010; Tanaka & Sung, 2016). Although not looking at the emotional stimuli might be relieving at the moment, in the long run it is detrimental to children's social and emotional development. A vicious circle can be formed, where impaired emotion understanding propels autistic children to avoid attending to others' emotions; this hinders them from learning about emotions, which in turn leads to future and further avoidance of the emotional stimuli.

Also, in line with the literature, autistic children displayed fewer prosocial actions in response to others' emotional display. In order to take prosocial actions, one needs to correctly interpret the emotional state of another and infer what the other person needs in such a situation. This can be very challenging for autistic children considering their struggles in perspective-taking and in cognitive empathy (Dunfield et al., 2019). The situation can be even worsened if they do not attend to the emotional stimuli. After all, if an autistic child does not pay attention to the situation and does not understand what is needed from them, how can we expect the child to react prosocially and appropriately?

Despite the difficulties and challenges, autistic children showed great improvements in cognitive empathy and prosocial actions, both increasing with age. What is unexpected, cognitive empathy did not increase in non-autistic children. Considering that we only asked parents to report on their children's understanding of basic emotions, the lack of age effect in non-autistic children could be due to the fact that they already had a good knowledge of basic emotions at such young ages (Widen & Russell, 2008), and hence there was little space for improvement. On the other hand, autistic children were still developing their understanding of

basic emotions. As for prosocial actions, like non-autistic children, autistic children showed age-related increase. Remarkably, their prosocial actions towards the experimenter in the observational tasks increased more sharply than non-autistic children. This again supports our assumption that autistic children did have the motivation to help others, otherwise we would not expect to observe any increase here.

As we expected, affective empathy remained stable in both groups. Whereas appropriate levels of affective empathy and emotional concern are crucial for motivating prosocial and compassionate actions towards others, excessive personal distress can disrupt the empathy process and make the person absorbed in self-concern. The finding that children's affective empathy did not increase with age may reflect their enhanced ability to distinguish between self-distress and the distress of others (Hoffman, 2000). It may also have to do with their improved ability to regulate emotional arousals (Tousignant et al., 2017). It is remarkable to find that, like non-autistic peers, autistic children were able to keep their emotional arousals in control, and meanwhile showing improved cognitive empathy and increased prosocial actions. Contrary to our expectation that children's attention to others would increase with age, we found no age effect on parent-reported attention to others, and non-autistic children's attention in the observational tasks actually dropped from Time 1 to Time 4. Possibly, with age children became more proficient in evaluating others' emotions, and thus there was no need to spend more time looking at the emotional display. Their attention may even decrease if the situation becomes increasingly easier for them to process, which might be the case for non-autistic children in the observational tasks. However, it probably still required many efforts from autistic children to process the emotional information, and thus their attention was maintained over time.

In our study, we also examined the integrated effects of empathy on the development of children's externalizing problems and social competence. In line with the literature (e.g., Li et al., 2020), we found that autistic children had more externalizing problems and lower social competence than non-autistic children. Yet, they showed age-related improvements as their externalizing problems decreased and social competence increased over time. Importantly, our findings added to the extent literature that not only for non-autistic children, but also for autistic children, empathy is a protective factor against the development of externalizing problems and facilitates the development of social competence.

This study has the advantages of examining an autistic sample at a young age and using a multicomponent and multimethod approach to investigate the early development of empathy. Nonetheless, there are also limitations. First, cognitive empathy was measured only

by a parent questionnaire, which evaluated the extent to which children understood their parents' experiences of basic emotions. In daily life, social interactions involve multiple and complex emotional exchanges with not only parents but also peers and other adults. To capture the full picture of children's development of cognitive empathy, future research should use multiple informants and examine not only basic emotion understanding but also the understanding of complex emotions and mental states. Another limitation is that affective empathy was measured only by the subjective evaluations of parents and experimenters. To increase the reliability, future research could add physiological measurements such as heart rates and skin conductance to the experimental paradigm. Third, the autistic sample included in this study did not have intellectual impairments, and these children and their parents participated in rehabilitation programs for autism. Caution is warranted when generalizing our findings to other autistic groups.

Despite the limitations, the current study advanced our knowledge of empathy development in young autistic children. Empathy is a multicomponent construct. To make this complex machine run, all the components must function well and work closely. Any problem in any link will affect children's ability to empathize. Our study identified autistic children's struggles in cognitive empathy, other-oriented attention and prosocial actions. These difficulties were present already at young ages and persisted over time. Nonetheless, autistic children did not lack the capacity to feel for others and they showed great potential for developing empathic abilities. We suggest that future supporting programs can focus more on helping autistic children increase their attention to emotional stimuli and help them improve emotion understanding. Meanwhile, it is vital to inform non-autistic people about the differences, enhance their awareness of autism and encourage them to interact with autistic children in a respectful and empathic way. This will not only benefit empathy development but will also contribute to more positive psychosocial outcomes in autistic children.

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