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Exploring the nature of joint attention impairments in young children with autism spectrum disorder: associated social and cognitive skills.

Abstract

It is generally accepted that joint attention skills are impaired in children with autism spectrum disorder (ASD). In this study, social preference, attention disengagement and intention understanding, assumed to be associated with the development of joint attention, are explored in relation to joint attention skills in children with ASD at the age of 36 months. Response to joint attention was related to intention understanding, whereas the number of joint attention initiations was associated with attention disengagement, and somewhat less stronger with social preference. The level on which children initiated joint attention was related to social preference. Possible interpretations of these findings are discussed.

Key words: autism, joint attention, toddlers

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Exploring the nature of joint attention impairments in young children with autism spectrum disorder: associated social and cognitive skills.

Joint attention is impaired in children with autism spectrum disorder (ASD), regardless of their developmental or intellectual level. Not only do they show less joint attention skills, they also show it later in development (Charman et al., 1997; Naber et al., 2007; Warreyn, Roeyers, Oelbrandt, & De Groote, 2005; Wetherby, Watt, Morgan, & Shumway, 2007). Furthermore, if they show joint attention, their skills seem qualitatively different as well (Warreyn, Roeyers, Van Wetswinkel, & De Groote, 2007). Delays in both response to, and initiation of joint attention are found and although the impairments are more severe for declarative joint attention, deficits in imperative joint attention are reported as well (Clifford & Dissanayake, 2008). Joint attention skills are demonstrated to be very important in development. In typically developing children, as well as in children with ASD, joint attention skills are repeatedly demonstrated to relate to the development of language, cognition, social skills and behavioural competence problems (e.g., Charman et al., 2003; Delinicolas & Young, 2007; Kwisthout, Vogt, Haselager, & Dijkstra, 2008; Murray et al., 2008). These findings have lead interventions for children with ASD to focus more on joint attention skills, with promising outcomes (e.g., Jones, Carr, & Feeley, 2006; Kasari, Freeman, & Paparella, 2006). After ascertaining this pivotal role of joint attention, the research focus expanded to trying to understand why children with ASD are experiencing problems with joint attention.

Studies on joint attention in typical development have already attempted to reveal processes and mechanisms associated with this important social communicative skill at a very early stage. The research has built on, and has led to different models on early social-communicative development, suggesting several processes and skills to be involved (for an overview, see Mundy & Sigman, 2006; Mundy, Sullivan, & Mastergeorge, 2009). Although none of the single-factor models can explain the development of joint attention completely, understanding the contribution of single-factor processes in the development of joint attention could provide leads for early detection and intervention in children with ASD.

From a social cognitive point of view, the development of joint attention is believed to be closely related to the development of the capacity to understand mental states of others, like feelings, thoughts and intentions (e.g., Bretherton, 1991; Tomasello 1995). Especially *intention understanding* has been the focus of many studies. According to social cognitive models, children do not develop joint attention skills before they understand that other people have intentions and that their behaviour is goal-directed. The fact that children with ASD are experiencing problems with joint attention, may therefore be due to difficulties with this understanding of intentions (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Given the disturbed ability to infer mental states of others in children with ASD (e.g., Happé, 1995; Baron-Cohen, Leslie, & Frith, 1985; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998), it is plausible that they also experience problems with the easiest forms of mental states, such as intentions. However, studies that have investigated intention understanding in children with ASD, report contrasting results (e.g., Aldridge, Stone, Sweeney, & Bower, 2000; Carpenter, Pennington, & Rogers, 2001; d'Entremont & Yazbek, 2007), possibly due to different paradigms. Moreover, these studies were conducted with somewhat older children, at an age when intention understanding is typically robustly achieved. It is not precluded that an impaired ability to infer intentions at a younger age has an impact on early social-communicative behaviours.

Joint attention is also believed to be related to the *social motivation* of children (Mundy & Sigman, 2006). In typical development, children are inherently rewarded to participate in social interactions, in which they learn about social and communicative skills.

This tendency seems to be reflected in a *social preference*, which children are showing from the day they are born (e.g., Cassia, Valenza, Simion, & Leo, 2008; Farroni et al., 2005; Valenza, Simion, Cassia, & Umiltà, 1996) and that stimulates them to look at people, and to prefer social stimuli like voices and faces over nonsocial stimuli. Children and adults with ASD do not show this typical tendency to orient towards social stimuli and also tend to use different face scanning patterns (Celani, 2002; Dawson et al., 2004; Fletcher-Watson, Benson, Frank, Leekam, & Findlay, 2009; Jones, Carr, & Klin, 2008; Maestro et al., 2005; Pelphrey et al., 2002; Sasson et al., 2007). This observation is believed to be related to a deficit in social motivation, reflecting an absent rewarding value of social sharing (Vismara & Lyons, 2007), and is likely to persist throughout development (Koegel, Koegel, & Carter, 1998). It could explain why children with ASD are experiencing problems with the development of joint attention skills (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Klin, Jones, Schultz, & Volkmar, 2003; Maestro et al., 2002). Their lacking motivation not only makes it less interesting for them to engage in the sharing of experiences, but in addition, the lack of social orienting leads to less opportunities to learn about social skills. This may in turn even cause a disorganisation of social neurodevelopment (Mundy & Burnette, 2005). Only a few studies have investigated social orienting in relation to joint attention in children with ASD, with contrasting results (Dawson et al., 1998; 2004; Leekam & Ramsden, 2006; McLeod Turner, 2005).

Finally, being able to show joint attention behaviours and to participate in a triadic interaction, implies *attentional processes,* like attentional engagement, disengagement and shifting (Leekam, 2005). More research is needed in young children with ASD, but as some studies have shown, there may be attentional problems related to the disorder (Elsabbagh et al., 2009; Landry & Bryson, 2004; Renner, Klinger, & Klinger, 2006), supporting the view that these problems may be related to joint attention problems.

Some of the above described processes have been investigated in children with ASD, but rarely in direct relation to joint attention skills. In order to discover which (lacking) processes are involved in joint attention skills, in this study, social preference, attention disengagement, and intention understanding will be explored in a group of young children with ASD, in relation to their initiating as well as response to joint attention skills. It is expected that children with ASD will show no social preference and that the more children orient to social stimuli, the better their joint attention skills are. Joint attention skills are also expected to positively relate to the speed of attention disengagement. Regarding the intention understanding task, it is possible that children with ASD will perform quite well, however, the individual differences in intention understanding could still relate to joint attention. It is rather difficult to make specific predictions about the relationships with different forms of joint attention, since not many studies have investigated several social and cognitive processes in relation to early social-communicative skills.

Method

Participants

Twenty-three children (18 boys) diagnosed with autism spectrum disorder (ASD) were recruited through a Clinic for Developmental Disorders in Ghent University Hospital, Belgium. All children received a formal diagnosis of ASD made independently by a qualified professional multidisciplinary team. All children were seen as close as possible to their third birthday (mean = 36.78 months, *sd* = .81). Their mean developmental index, measured by the Mullen Scales of Early Learning (MSEL; 1995) was 68.83 (*sd* = 26.65). Parents gave their written consent for participation and the children received a small reward afterwards.

General procedure

The observation laboratory (4m x 7m) was surrounded by curtains to minimize visual distraction and contained a small carpet with some toys, a table, several chairs, a highchair, a television, a computer, and four posters on the wall. Before starting, children were given some time to get used to the new environment. The measures were gathered over the course of two sessions. During a first visit, a social preference task, a visual orientation task, an understanding of intentions task, and several joint attention tasks were conducted, as well as the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 2002), to verify the diagnosis of ASD. The original algorithm was used, because the sensitivity of the revised algorithm is yet to be demonstrated in young children (de Bildt et al., 2009; Oosterling et al., 2010). For 91 % of the children with ASD, diagnosis was confirmed. Two children did not reach the cut off score, but this is not unusual given their age (Oosterling et al., 2010). Exclusion of these cases had no effect on the results and they were therefore included in the analyses. Mean ADOS scores were 4.22 (*sd* 2.34) for the subscale Communication (cut off = 2), and 7.22 (sd 3.68) for Social behaviour (cut off = 4).

During a second visit, the MSEL was administered in order to measure cognitive development. In addition, expressive and receptive language abilities were assessed using the Dutch version of the Reynell Developmental Language Scales (RTOS; Schaerlakens, Zink, & Van Ommeslaeghe, 1993).

Tasks and measurements

Social preference task. During the social preference task, children were shown 20 trials consisting of the simultaneous presentation of two stimuli (one social and one nonsocial stimulus), at the left and right side of a 21” LCD monitor. Each trial started with a tinkling sound, followed by the two stimuli that lasted 10 seconds. In between the trials there was a central stimulus for 2 seconds, also accompanied by a sound, in order to reorient the attention of the children to the screen if necessary. The social stimuli were pictures and photographs of people (e.g., children, faces, baby, …), whereas the nonsocial stimuli were pictures and photographs of objects (e.g., blocks, tower, rope, fruit, boat, …). Twenty persons were asked to decide to what degree the stimulus could be considered social and to rate each stimulus for complexity. This allowed us to match each pair of stimuli for complexity. Examples of the stimuli can be found in Appendix A.

Video recordings were coded offline at 1/5th speed. Coding was carried out by two different observers trained by the first author, using The Observer 7.0, a program designed for observing and analyzing observational data (Noldus, 2003). It was coded whether a child was orienting to a social or a nonsocial stimulus, which resulted in a duration measure (how long children looked at social or nonsocial stimuli). Social preference was expressed by looking duration at social stimuli, relatively to total looking time at both social and nonsocial stimuli. Interrater reliability was determined by double coding of 15% of the observations and was very good (Kappa = .86).

Attentional skills. To measure attentional skills, a visual orientation task was conducted, partially based on the paradigm of Landry and Bryson (2004). Stimuli were simple coloured line drawings, presented on a 21" LCD monitor. There were two types of trials: Baseline trials and Overlap trials. At the beginning of each trial, a central stimulus was presented at the centre of the screen until the child looked at it. If the child did not look at the central stimulus, it disappeared automatically after a duration of 8 seconds. When the child looked at the central stimulus, the experimenter made a peripheral stimulus appear either at the right or at the left side on the screen, which remained there for 3 seconds. In the Baseline trials, the central stimulus simultaneously disappeared, whereas in the Overlap trials, the central stimulus remained visible on the screen. For a trial to be valid, the child had to attend to the central stimulus until the peripheral stimulus was presented and then subsequently shift gaze towards the peripheral stimulus.

Video recordings were coded offline frame by frame by two different observers trained by the first author, using The Observer 7.0 (Noldus, 2003). Both the appearance of the peripheral stimulus, as the exact moment on which the child had shifted its attention towards this stimulus were coded, allowing for exact calculation of the saccadic reaction times. In Baseline trials, the latency to attend to the peripheral stimulus was a measure of the ability to *shift* attention. In Overlap trials, the latency to attend to the peripheral stimulus was a measure of the ability to *disengage* and *shift* attention. Similar to Elsabbagh et al. (2009), a *disengagement difference score* (Overlap trials – Baseline trials) was computed to express the ability to disengage from the central stimulus. Lower *disengagement difference scores* reflected faster attention disengagement. The interrater reliability based on 15% of the observations coded by both observers was very good (Kappa = .92).

Intention understanding. To investigate the understanding of intentions, a paradigm of Behne, Carpenter, Call and Tomasello (2005) was adopted and slightly modified. The child was sitting in a high chair at the table, and was handed 30 toys by the experimenter, which it could then throw into a basket. Every fifth toy, the child was confronted with an experimenter who was either unwilling (e.g., teasing) or unable (e.g., clumsy) to give a toy. Both these conditions consisted of three trials. Each unwilling trial was matched with an unable trial for the behaviour of the experimenter in as many ways as possible (e.g., type of toy, body movements). For an overview of the different trials, see Table 1. It was assumed that if children acted differently in the two conditions, it would be because they were aware of the intentions of the experimenter and because they were able to discriminate between an experimenter who is either unwilling or unable to give something.

(INSERT TABLE 1 HERE)

In line with Behne et al. (2005), *Reaching* was observed, as a behaviour that expressed impatience. Coding was carried out using The Observer 7.0 (Noldus, 2003). Inter-rater reliability was based on double coding of 20% of the observations (Kappa = .79). In the unwilling condition, the experimenter is not giving the toy ‘on purpose’, the underlying intention is that she does not want to give the toy. The explanation for not giving the toy in the unable condition, lies more in the situational constraints. The experimenter wants to give the toy, but she can’t. Therefore, it was expected that children with a better intention understanding would be less patient / show more reaching behaviours in the first condition, compared to the second one.

Joint attention - Response to joint attention. A responding to joint attention (RJA) task was based on the response to joint attention task in the Early Social Communication Scales (ESCS; Mundy et al., 2003). Four pictures were placed on the walls to the infant’s left, right, left behind, and right behind (see Figure 1). The pictures were brightly coloured figures of Winnie the Pooh and friends®, were 50 cm long and 40 cm wide. The experimenter attempted to direct the child’s attention by calling the child’s name three times while gazing towards the poster. This was repeated for all four posters. If necessary (when the child wasn’t able to follow gaze), the experimenter gazed towards the last two posters with an additional point in the targeted direction. To receive credit, the child had to look at the target during or right after the gaze of the experimenter and for each child one score was given to express whether the child could *follow gaze* (without point) or not and another score was given to express whether a child could follow a gaze or point towards a *target outside its visual field*. Children also received a RJA level score, ranging from 0 to 4 (0 = no following, 1 = following point within visual field, 2 = following point towards target behind them, 3 = following gaze towards target within visual field, 4 = following gaze towards target behind them), according to the assumed degree of difficulty mentioned in the literature (Deák, Flom, & Pick; 2000). Inter-rater reliability was calculated on double coding of 30% of the observations (Kappa = .94).

(INSERT FIGURE 1 HERE)

Joint attention - Initiation of joint attention. Because the context in which joint attention skills are observed can have an influence on the performance of children (Roos, McDuffie, Weismer, & Gernsbacher, 2008), two different tasks were used to elicit initiations of joint attention, in order to have a more extensive picture of the IJA skills.

Basic initiation of joint attention skills (Basic IJA) were observed using tasks adapted from the ESCS (Mundy et al., 2003). Basic IJA skills were elicited within a structured interaction, with the focus of both child and experimenter already on the objects of interest. Following Mundy et al. (2007), the frequency of the following IJA behaviours was observed: 1) making eye contact with the examiner while manipulating a toy, 2) alternating eye contact between an active mechanical toy and the tester, 3) pointing to an active mechanical toy with or without eye contact, and 4) showing by raising objects toward the tester's face with eye contact. The former two were combined into a *Basic IJA low* score, the latter two were combined into a *Basic IJA high* score. The *Basic IJA* score reflected the total frequency of all four behaviours. Inter-rater reliability was determined by double coding of 25% of the observations, resulting in an intra class coefficient for the Basic IJA score of .92.

The initiation of joint attention was also elicited by confronting children with an unexpected positive event, in order to obtain a more extensive picture of the IJA skills. While children were playing on a carpet with some toys, facing the experimenter, three video clips of 30 seconds (with 60 seconds in between) appeared on a television screen behind the experimenter. The video clips were accompanied by sounds to attract attention and respectively showed a monkey jumping up and down, a car passing by several times and a mouse waving. The number of joint attention behaviours initiated by the child was measured (*Event IJA*), divided into *Event IJA low*, expressing the number of eye contact and alternates, and *Event IJA high*, expressing the number of pointing behaviours. Inter-rater reliability was determined by double coding of 30% of the observations, resulting in an intra class coefficient for the Event IJA score of .98. Where Basic IJA concerned a triadic coordination about an object already within the interaction, in this task, the object of interest was outside the interaction. In both tasks, the initiation of joint attention is considered to be socially motivated (= declarative). The duration of the tasks was taken into account, resulting in IJA scores expressed as behaviours per minute.

Results

Response to Joint Attention

Concerning the RJA skills, 65.2% of the children with ASD followed gaze and 52.2% followed attention towards a target outside their visual field. Because the RJA level score was measured on an ordinal level, Spearman correlation coefficients were used to investigate associations with other variables. There was a significantly positive correlation between the

RJA level score and the developmental index (ρ = .78; p < .001), as well as with language abilities (ρ = .69; p < .001). Both the correlation with receptive language abilities, and the correlation with expressive language abilities were significant (ρ = .66; p < .01 and ρ = .63; p < .01) (see Table 2).

(INSERT TABLE 2 HERE)

Initiation of Joint Attention

There was a significant positive correlation between Basic IJA and Event IJA (r = .51; p < .05). As the IJA behaviours in the two tasks (Basic IJA and Event IJA) were assumed to reflect the same behaviour with the same underlying social motive, elicited in a different way, composite measures for IJA were computed as the mean of Basic IJA and Event IJA, resulting in three scores reflecting the declarative IJA behaviours of the children: IJA, IJA low and IJA high.

Children on average initiated 2.31 (*sd* 1.93) joint attention behaviours per minute, with 1.39 (*sd* 1.07) low level behaviours, and .92 (*sd* 1.26) high level behaviours. No significant correlations were found between IJA, IJA low or IJA high and the developmental index or language abilities (see Table 2).

Twelve children (52.2%) showed the highest level of joint attention (= coordinated pointing). These children had a higher developmental index than children who did not show the highest level ($t(21)$ = -2.52; p < .05).

The RJA level score was positively related to IJA (ρ = .55; p < .01), IJA low (ρ = .39; p < .10), and IJA high (ρ = .58; p < .01) (see Table 2). Partial correlations revealed that, after controlling for developmental index, the RJA level score significantly related to IJA low (r = .43; p < .05), but not to IJA (r = .29; *ns*) or IJA high (r = .08; *ns*).

Social preference

Looking times at social and nonsocial stimuli were compared. A paired t-test revealed that children did not look significantly longer ($t(22) = .79$; *ns*) at social stimuli (mean = 69.70s; *sd* = 25.78) than at nonsocial stimuli (mean = 65.09s; *sd* = 24.40). As such, the mean proportion time looking at social stimuli was 51.63% (*sd* = 9.25). There were however large individual differences, with a minimal social preference of 33.33 % and a maximal social preference of 68.31 %. There was no significant correlation between social preference and the developmental index ($r = -.04$; *ns*), nor with language abilities ($r = .02$; *ns*).

Attentional skills

In the visual orientation task, children on average completed 12 of 16 possible trials. In the Baseline trials, children shifted their attention to the peripheral stimulus with a mean reaction time of 395.79ms (*sd* = 56.08). In the Overlap trials, children on average needed 458.04ms (*sd* = 126.46) to disengage their attention from the central stimulus and to shift their attention to the peripheral stimulus. A paired t-test revealed that there was a significant difference between the mean saccadic reaction time in the Baseline trials compared to that in the Overlap trials ($t(22) = -3.25$; $p < .01$).

No significant correlations were found between any of the saccadic reaction times (or the disengagement difference score) and the developmental index, or language abilities.

Intention understanding

Because not all the trials lasted equally long, percentages of time were computed instead of working with the raw data. Since the assumptions for parametric tests were not met, non-parametric analyses were performed. Wilcoxon tests were performed on the behavioural measures to analyse whether or not children discriminated between an experimenter who was unwilling or unable to give a toy. Children showed significantly more (Z = -3.04, p < .01) reaching behaviours in the unwilling condition (mean = 32.75; sd = 21.88) than in the unable condition (mean = 20.71; sd = 14.07). Also other variables, like banging, turning away, and looking up to the experimenter, were investigated, but these did not differ significantly between the two conditions, and were not included in further analyses. Analogous parametric tests led to the same results.

A difference score for reaching (reaching behaviour in unwilling condition – reaching behaviour in unable condition) was computed, which was assumed to express the degree of intention understanding. Children with a higher *Reaching difference score*, would have a better intention understanding. Assumptions for parametric tests were met for this score. No significant correlation was found between the difference score and the developmental index (r = .21; *ns*), nor with expressive or receptive language abilities (r = -.05; *ns* and r = .08; *ns*).

Intercorrelations between social preference, attention disengagement and intention understanding (reaching difference score), were not significant (see Table 3). Also the correlations between these processes and the developmental index or language abilities, were not significant.

(INSERT TABLE 3 HERE)

Association between social preference, attention disengagement and intention understanding and joint attention

Zero order correlations between social preference, attention disengagement, intention understanding, and joint attention are presented in Table 3. The RJA level score was significantly related to the reaching difference score (ρ = .49; p < .05). The better children can discriminate between an experimenter who is unwilling and one who is unable to do something, the better they are at attention following. The IJA low score was significantly related to attention disengagement (r = -.44; $p < .05$). The faster children are in disengaging their attention from a central stimulus, the more joint attention initiations they make by means of eye contact and alternates. The IJA high score was marginally significantly related to intention understanding (r = .39; $p < .10$). The better children can discriminate between an unwilling and an unable experimenter, the more joint attention initiations they make on a higher level.

Response to joint attention. A hierarchical regression analysis was done with the RJA level score as dependent variable, and the following independent variables: developmental index in Step 1, and the reaching difference score, attention disengagement, and social preference in Step 2. Results showed that the model was significant in Step 1 (R^2 = .34; $F(21)$ = 10.59; $p < .01$), and Step 2 (R^2 = .52; $F(18)$ = 4.88, $p < .01$), with the reaching difference score making the only significant and unique contribution (β = .37; $p < .05$), on top of developmental index. Attention disengagement and social preference did not make significant unique contributions to the prediction of RJA.

Initiation of joint attention. A regression analysis was conducted with the number of initiations of joint attention using eye contact or alternates (IJA low) as dependent variable, and with social preference, attention disengagement, and the reaching difference score as independent variables. The model was marginally significant (R^2 = .32; $F(19)$ = 2.94, $p < .10$), with a unique contribution of attention disengagement (β = -.42; $p < .05$), and a marginally significant contribution of social preference (β = .34; $p < .10$), but not of the reaching difference score (β = -.09; *ns*).

A second regression analysis was conducted with the number of initiations of joint attention using pointing behaviours (IJA high) as dependent variable, with the same independent variables. The model was not significant ($R^2 = .17$; $F(19) = 1.25$, *ns*).

Quality of joint attention initiations. A binary logistic regression was conducted with the highest level as dependent variable (0 = highest level not reached, 1 = highest level reached), and as independent variables: developmental index in Step 1, and social preference, attention disengagement, and intention understanding in Step 2. A null model correctly predicted the highest level for 52.2 % of the children, the model that included developmental index as independent variable predicted the highest level for 60.9 %, a marginally significant increase (Wald = 3.72; $p < .10$). The model in Step 2 predicted the highest level for 87 %. The only significant association was with social preference (Wald = 4.32; $p < .05$), and not with attention disengagement (Wald = .00; *ns*), or intention understanding (Wald = 1.31; *ns*).

Discussion

The aim of this study was to explore the relationship between several social and cognitive processes and joint attention skills in young children with ASD. Given the fact that the development of joint attention is impaired in children with ASD and that these impairments are negatively related to several developmental domains, it is crucial that we learn to understand which processes are involved in the early social-communicative development. Therefore, three processes were investigated in relation to joint attention skills: social preference, attentional skills, and intention understanding.

Response to joint attention skills

Concerning the RJA skills, 65.2% of the children with ASD followed gaze and 52.2% followed attention towards a target outside their visual field. The individual differences in RJA skills were significantly related to mental age and language abilities. However, as other studies have shown, children with ASD are more impaired in RJA skills than children with developmental delays or children matched on mental age (e.g., Dawson et al., 2004). Therefore, it could be expected that there are also other processes involved than cognitive ones.

In typical development, early RJA skills are assumed to be rather involuntary, involving mainly basic attentional skills. There is however some evidence for the importance of intention understanding as well, mostly considered as a motivation/reason to follow gaze, but not sufficient in itself (Nation & Penny, 2008). Results showed that only intention understanding had a significant and unique contribution in explaining RJA skills, on top of developmental index. This finding suggests that, in children with ASD, intention understanding is involved in gaze following skills. A possible interpretation of these results is that basic attentional skills are in themselves insufficient to learn to follow gaze, and intention understanding is necessary in order to learn this skill (Tomasello & Racoczy, 2003). This could be the case in typical development as well. Although the direction of this interpretation is considered plausible, it should be noted that the correlational nature of the study does not allow us to draw linear conclusions and that other interpretations are equally likely. It is for instance possible that experience with RJA skills provides an early onset form of information processing that contributes to the development of understanding intentions of others. Support for this interpretation is for example found in a study suggesting that 9-month-old infants engage in joint attention before they fully develop aspects of social cognitive awareness (Brooks & Meltzoff, 2005). Another possibility is that the development of social cognition and the development of RJA skills are strongly intertwined and that we need to abandon a linear interpretation. Social cognition as well as joint attention could both be regarded as the integration of two neural networks processing information from self-attention and attention of others (Mundy et al., 2009). Longitudinal research with younger typically developing infants and infants at risk for ASD is needed in order to gain more insight into this matter.

Initiation of joint attention skills

The individual differences in the IJA skills were not explained by the developmental level of children and were not related to language abilities. Since the amount of joint attention initiations is assumed to be related to the social motivation of children, a relationship was expected with social preference. Indeed, social preference contributed marginally to the number of joint attention initiations on a lower level. Several researchers have put forward the hypothesis that joint attention involves a motivational aspect and that joint attention disturbances in children with ASD are at least partially due to a lacking social motivation to share attention with others (Dawson et al., 1998; Klin et al., 2003; Mundy, 1995). Although a social preference task may not be the most powerful measure of social motivation, the findings offer some support the social motivation hypothesis and are in line with foregoing literature. Recently, neurological evidence was found for IJA skills being more related to social motivational processes than RJA skills (Schilbach et al., 2009). This was also supported by our data, as social preference was related to IJA skills, but not to RJA skills.

Next to social preference, also attention disengagement was related to IJA low behaviours. When sharing attention about an interesting object or event, children need to disengage their attention from it, in order to initiate joint attention. Therefore, the better children can disengage their attention, the more eye contact and alternates they can show to share attention. This finding may indicate that the limited frequency to which children with ASD tend to initiate joint attention is not merely due to a motivational deficit, as expressed by (lacking) social preference. Also attentional processes seem to be involved, making it more difficult for children with ASD to share their attention with another person.

Next to the number of joint attention initiations on a low or high level, it was also observed whether or not children showed the highest level of joint attention, namely pointing with coordinated eye contact. This variable could give us insight into the ability or expertise of children to initiate joint attention. About half of the group of children with ASD was showing the highest level of joint attention. On top of developmental index, only social preference was associated with this ability. Thus, children who direct the attention of the experimenter in a very adequate manner, seem stronger socially motivated. It is possible that children who are orienting more to other people, are learning more about social-communicative skills, through observation of or participation in social interactions, leading to joint attention skills on a high level.

In typical development, recent evidence suggests that IJA and RJA are mostly independently developing skills (Mundy et al., 2009; Slaughter & McConnell, 2003; Striano, Stahl, & Cleveland, 2009; Vaughan Van Hecke et al., 2007). However, in this study, a significant correlation was found between the IJA and RJA skills of children with ASD, which is in line with the results of some other studies in young children with ASD (e.g., Bono, Daley, and Sigman, 2004; Dawson et al., 2004; Siller and Sigman, 2008, Toth, Munson, Meltzoff, Dawson, 2006). Even after controlling for mental age, a significant correlation was found between RJA and IJA skills (on a lower level). However, there are also studies with children with ASD which report nonsignificant correlations between RJA and IJA skills (e.g., Kasari, Paparella, & Freeman, 2008; Murray et al., 2008). The children with ASD in these studies were somewhat older than the children in our study, but the contradictory findings may rather be due to differences in the methods used. Perhaps the RJA level score is a more powerful measure of the ability to follow the attention of others than the number of targets located correctly. Moreover, in this study, IJA skills were measured in different contexts, in order to obtain a more extensive picture of this ability.

Considering the relationship between joint attention skills and language skills, the findings were in line with previous reports, in that language abilities were related to RJA skills, but not to IJA skills (Murray et al., 2008). Although a significant correlation was found between RJA and IJA skills, this finding suggests that both joint attention skills also rely on distinct processes. Also the finding that the three investigated processes related differently to RJA and IJA skills, supports recent formulations of joint attention theory suggesting that IJA and RJA reflect different constellations of processes (e.g., Mundy et al., 2009). These dissociative features may increase our understanding of the difficulties children with autism are experiencing and may help to explain the observation that with maturation, children with autism continue to display IJA deficits while the RJA deficits remit to a significant extent (e.g., Leekam, Hunnisett, & Moore, 1998).

Social preference

In typical development, children are showing a preference for social stimuli over nonsocial stimuli as from the day they are born (e.g., Farroni et al., 2005). This preference remains present during development (e.g., Fletcher-Watson, Findlay, Leekam, & Benson, 2008), and is assumed to have an important influence on social communicative skills. In this study, the group of children with ASD on average did not show a preference for the social stimuli, that is, they did not look significantly longer at social than at nonsocial stimuli. This finding is in line with previous studies (e.g., Dawson et al., 2004). There were however large individual differences, unrelated to developmental index. This makes it a very interesting social process that could relate to several social communicative skills in children with ASD, who are often showing very heterogeneous symptomatology. However, if regarded as a process involved in the development of joint attention, in the search for very early primary deficits in ASD, the large variability also means that a (lacking) social preference should be interpreted cautiously in early screening. The finding that the social preference of children was related to the level of joint attention and to the amount of attention sharing, supports the assumption that this variable not only reflects an underlying motivation, but also a tendency through which children learn about joint attention skills in social interactions.

Attention disengagement

Children with ASD demonstrated the typical gap effect, in that they were faster in trials where no disengagement of attention was needed, compared to trials where this was necessary. As triadic engagement requires disengaging attention from an interesting stimulus, a relation was expected and confirmed with the number of low joint attention skills. This could mean that the joint attention impairments of children with ASD may be partially explained by the attentional problems they experience (Elsabbagh et. al., 2009; Leekam, 2005), However, attention disengagement did not have a significant unique contribution to RJA skills and it was not related to the ability to show the highest level of IJA (coordinated pointing). Maybe attention disengagement is necessary for sharing attention on a more basic level, but once children use pointing behaviours, it may lose its importance. Important to note here is that joint attention on a lower level (alternates) rather than on a higher level (pointing) has been shown to be the more powerful discriminant marker of autism (e.g., Dawson et al., 2004) and that literature suggests that joint attention alternates may be sensitive to frontal lobe functional disturbance which may be central to fundamental features of autism (Landry & Bryson, 2004; Mundy, 2003; Schilbach et al., 2009).

Intention understanding

The children with ASD were able to differentiate between an experimenter who was unwilling to give something and an experimenter who was unable to give something. They showed more reaching behaviours in the unwilling condition than in the unable condition. Since this task was a quite easy intention understanding task, it is not surprising that children with ASD performed well. Also other studies report few difficulties with intention understanding in children with ASD (e.g., Aldridge et al., 2000; Carpenter et al., 2001). However, research with infants at risk for ASD is needed to determine whether this intention understanding is not impaired at a younger age. After all, recent evidence demonstrated intention understanding in typically developing infants as young as six months of age (Legerstee, Markova, & Marsh, 2006; Marsh, Stavropoulos, Nienhuis, & Legerstee, 2010).

The main goal of interest in this study was to investigate whether there was an association between this understanding of intentions and joint attention skills. Perhaps most interesting was the finding that intention understanding was related to RJA skills. The evidence of intention understanding very early in development would suggest that understanding intentions influences joint attention development. On the other hand, behavioral and brain activity data suggest that RJA skills are already underway by 3-5 months (Grossman & Johnson, 2007; Striano & Stahl, 2005), perhaps contributing to the development of intention understanding. This study provides empirical support for a relationship between joint attention and intention understanding, but it cannot contribute to a linear interpretation. Longitudinal research with younger typically developing infants and infants at risk for ASD is needed in order to gain more insight into the nature of this relationship.

Limitations

Because the main goal of interest was to look at associations between different skills, it was interesting to investigate a group of children with ASD, without comparing them with a control group. However, in order to make more confident interpretations, it would be very interesting to investigate the same processes and skills in a chronological age matched and/or mental age matched control group.

Given the relatively late age of diagnosis, it is difficult to study the processes and IJA skills consecutively at a very early stage. Therefore, longitudinal assessment of the variables would give us very valuable information, not only in prospective studies with children at risk for ASD, but also in typical development. In children with ASD, joint attention skills are still developing at the age of three years, making it still worthwhile to investigate these skills at this age, but some of the processes may have a larger influence at a younger age. Especially intention understanding must be studied earlier, in order to determine if children with ASD are having trouble with these mental states or not.

Conclusion

In this study, three unrelated social and cognitive processes were explored in relation to joint attention skills in young children with ASD. Both response to joint attention (RJA) and initiation of joint attention (IJA) skills were investigated and a significant correlation was found between both joint attention skills. The results however also support a partial dissociation between RJA and IJA skills, as only RJA skills related to language abilities and the three investigated processes related differently to RJA and IJA skills. The ability of children with ASD to respond to joint attention was related to their developmental index and to social cognitive skills. Concerning IJA skills, empirical support was found for the attention disengagement hypothesis and partially for the social motivation hypothesis. The limited frequency to which children with ASD tend to initiate joint attention seems to rely on an incapability aspect next to a motivational deficit.

More research is needed to further explore these complex skills, as knowledge about the early development of joint attention can help us to understand the joint attention impairments of children with ASD. If it turns out that social preference, attention disengagement and intention understanding are crucial in the development of joint attention, it becomes possible and useful to monitor these skills in very young children at risk for ASD, and to target these skills in early interventions.

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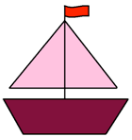
Appendix

(a)

(b)



Examples of social (a) and nonsocial stimuli (b) used in the social preference task

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Table 1

Description of 'unwilling' and 'unable' condition

Group	Condition	Description
Tease	Unwilling	E gives a ball to the child and pulls it back when the child tries to reach for it, saying 'Oh' in a teasing way, while looking at the child
	Unable	E gives a ball to the child and accidently drops it (the ball rolls back because the table is slightly inclined), saying 'Oh' in a disappointed way, while looking at the child
Refuse	Unwilling	E puts a toy in front of herself and alternates her gaze between the toy and the child, saying 'mmm' in a teasing way and alternating her gaze between the toy and the child
	Unable	E tries in vain to reach for a toy in a box, while alternating her gaze between the toy and the child, saying 'mmm' in a frustrated way and alternating her gaze between the toy and the child
Play	Unwilling	E plays with a toy car, moving it from the right to the left and back in front of her, while focusing on the toy and saying nothing
	Unable	E tries to open a transparent box with a toy inside of it, moving it from the right to the left and back , while focusing on the toy and saying nothing

Table 2

Pearson correlations between different joint attention tasks, developmental index and language abilities (receptive and expressive)

	IJA low	IJA high	RJA	Developmental index	Receptive language	Expressive language
IJA	.80***	.86***	.55**	.18	.13	.01
IJA low		.38^	.39^	-.02	.03	-.04
IJA high			.58**	.30	.18	.05
RJA[a]				.78***	.66**	.63**
Developmental index					.89***	.61***
Receptive language						.74***

Note. RJA = response to joint attention, IJA = initiation of joint attention, ^*p* < .10, **p* < .05, ***p* < .01, ****p* < .001, [a]Spearman correlation coefficients

Table 3

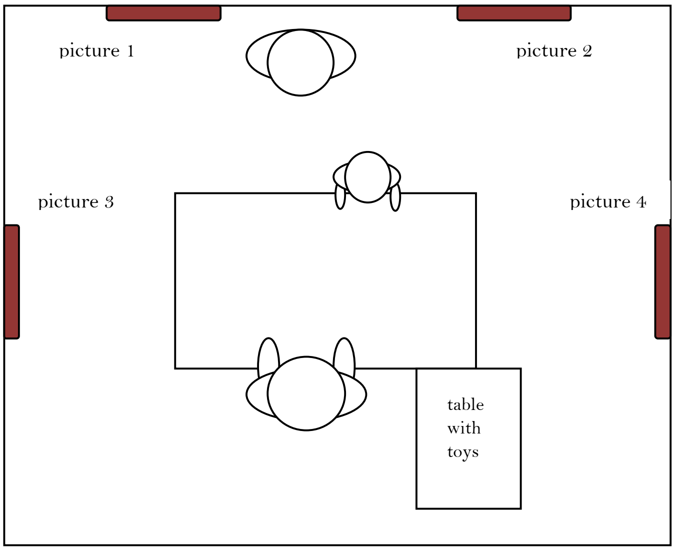
Pearson correlations between social and cognitive skills, developmental index, language abilities, and joint attention variables

	Social preference	Attention disengagement	Intention understanding
Attention disengagement	.03		
Intention understanding	.01	-.30	
Developmental index	-.04	-.27	.21
Receptive language	.07	-.08	.08
Expressive language	-.04	.07	-.05
RJA[a]	.12	-.34	.49*
IJA	.26	-.34	.37^
IJA low	.33	-.44*	.22
IJA high	.12	-.16	.39^

Note. ^$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$; [a]Spearman correlation coefficients

Figure Captions

Figure 1. Position of the Four Posters in the Response to Joint Attention Task


picture 1
picture 2
picture 3
picture 4
table
with
toys