

# Initiation and response of joint attention bids in autism spectrum disorder children depend on the visibility of the target

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## Abstract

**Background and aims:** Response to joint attention (RJA) and initiation of joint attention (IJA) are impaired in pre-schoolers with autism spectrum disorder (ASD). Children's response to joint attention may depend on the presence of the target in the child's field of vision or on the type of deictic index (head and eye orientation, pointing and verbalisations) used by the adult to initiate joint attention.

**Methods:** This study deals with 50 ASD children aged from 2 years 8 months to 11 years 7 months, with a communicative level comparable to children under 31 months of age, according to the French version of the Early Social Communication Scales (ECSP, by its French acronym). We compared the aforementioned ASD children with 50 typically developing (TD) children, aged 9 to 30 months who had no communication disorders according to the ECSP. During the ECSP test, we analysed joint attention behaviours on three posters present or absent from the children's visual field.

**Results:** We did not observe any difference in the number of IJAs between groups, but ASD children were less responsive than TD children were. Our results showed a developmental progression in the responses of children with ASD if several deictic cues were used by an adult simultaneously (looking and pointing, or looking and verbalising to indicate a target), whether the referent was present or absent from the child's visual field. In addition, we observed developmental progression when the referent was behind the child and the adult only used their gaze to refer to it.

**Conclusion:** Thus, we argue that the type of cues used affects ASD children's response behaviours *during* joint attention towards a referent that may be present or absent from their visual field.

**Implications:** Regarding the social and the sensory difficulties of children with ASD, many therapeutic approaches focus their intervention methods on non-verbal communication skills and joint attention. This fundamental research makes it possible to identify the most appropriate type of deictic index for children with ASD with developmental delay, depending on the presence or absence of the referent in the child's visual field.

## Keywords

Autism spectrum disorder, joint attention, deictic behaviours

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## Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by a lack of communication and social interaction (American Psychiatric Association, 2013). In people with autism, joint attention is impaired (Mundy et al., 2009). Joint attention is the ability to coordinate one's attention with a partner in order to share a common experience related to an object or event. Joint attention involves deictic indices (referential gazing, pointing and verbalisation) (see Cilia et al., 2018 for review), which are fundamental to the initiation and response of joint attention (e.g. Falck-Ytter et al., 2012; Hurwitz & Watson, 2016; Leekam et al., 2000). Among these, particularities are noted in the use of referential gazes and the understanding of gaze monitoring (Warreyn et al., 2007; Wimpory et al., 2000), in the use of deictic gestures associated with vocalisations (Winder et al., 2013), as well as in understanding deictic gestures alone (Benjamin et al., 2014; Wimpory et al., 2000) and verbalisations addressed to the child (Chawarska et al., 2012).

The joint use of several deictic indices helps children with ASD respond to joint attention (Baron-Cohen, 1989; Benjamin et al., 2014; Franchini et al., 2017). However, the impact of the deictic indices used and the differences in response to joint attention depend on the child's age and level of autism (Rozga et al., 2011; Sigman et al., 1999) and on the presence or absence of the referent from the child's visual field (Leekam et al., 2000; Schietecatte et al., 2012).

### *Joint attention response and initiation*

It is possible to differentiate between response and initiation to joint attention (Bruinsma et al., 2004; Meindl & Cannella-Malone, 2011). Initiation and response behaviours to joint attention bids generally appear between 8 and 15 months of age (Bakeman & Adamson, 1984; Jones et al., 2006), but the response to joint attention is present before initiation (e.g. Mundy & Jarrold, 2010). Response to joint attention (RJA) refers to the children's ability to follow a partner's gaze line, pointing gestures, or vocalisations to share a common reference point (Mundy et al., 2009). These joint attention response behaviours are present in development before children can initiate this type of interaction themselves (Beuker et al., 2013; Mundy & Jarrold, 2010). Hurwitz and Watson (2016) observed RJA behaviours in children with ASD aged 3-4 years with a non-verbal mental age of 26 months and in matched children with developmental delays without autism. Even though children with ASD entered into joint attention significantly less often than matched

children with developmental delays, when they were engaged, all children used similar forms of joint attention. Leekam et al. (2000) found that 4-year-old children with ASD could focus on a referent object more quickly than children with developmental delay could. However, children with autism disengage from the object very quickly, as do 3-month-old babies. This shows a delay in the acquisition of skills needed for joint attention. These differences are even more pronounced in children with autism with lower intellectual levels.

Initiation of joint attention (IJA) occurs when the child directs the attention of another person towards a shared target, whether it is an object or an event. Mundy et al. (2009) define IJA as the "infant's ability to spontaneously create or indicate a shared point of reference by the use of gestures, or more frequently, alternating gaze between objects or events and other people" (p. 3). These same authors (Mundy et al., 1986) studied joint attention behaviours of children with ASD (aged 3 to 6) matched with children with developmental delays without autism, and typical development (TD) children by using the Early Social Communication Scales (ESCS). In the "requesting" category of the ESCS (combining eye contact and gesture), the level of competence of children with ASD was similar to that of matched groups. However, children with ASD showed delayed development of IJA behaviours, such as pointing gestures and eye-to-eye contact aimed at sharing something with the examiner when they play with a small mechanical toy).

### *Deictic index used*

Children's RJA may depend on the type of deictic index used by the adult to initiate joint attention. Some examples of deictic index are head and eye orientation, pointing, and verbalisations. In typical development, by 9 months of age, babies follow the adult's attention if they use both looking and pointing (Butterworth & Grover, 1988; Morissette et al., 1995). Nevertheless, by 12 months, children can follow an adult's head and gaze with no accompanying gestural cues (Von Hofsten et al., 2005). In autism, at all ages, the addition of pointing by an examiner acts as a facilitator for gaze following and helps to attract attention to the face and referent object for a longer period of time (Baron-Cohen, 1989; Benjamin et al., 2014).

TD children follow the adult's gaze towards an object more frequently when the adult points and speaks about this object (Gliga & Csibra, 2009; Senju & Csibra, 2008). Adding a verbal stimulus to a pointing stimulus helps babies look at the referent object during joint attention bids (Daum et al., 2013). If they

understand and make good use of pointing gesture at 12 months of age (Behne et al., 2012), infants will be able to follow a point without additional verbal cues later on (Deák et al., 2000). However, in autism, the addition of verbalisations to joint attention bids does not seem to be a facilitating cue in guiding the infant's focus towards an object (Benjamin et al., 2014).

### *Presence or absence of the referent object from the child's visual field*

RJA is a developmental competence that differs if the object is present and visible in the child's visual field, or present but absent from the child's visual field. Depending on the perceptual index used, the child can follow the gaze from an early age. The results are different if he or she has to follow the movement of the eyes alone or the eyes with head orientation. In addition, the presence of the referent object in the child's visual field is important. Before they are 12 months old, several conditions need to be met for the child to respond to a joint attention bid (Deák et al., 2000; Morales et al., 2000). For example, an examiner pointing *and* looking at an object absent from the children visual field allows children under 12 months old to take an interest in that object, but after 12 months of age, pointing is no longer necessary (Butterworth & Grover, 1988; Morissette et al., 1995). In addition, at 12 months of age, children are more interested in objects that adults look at than those they do not (Theuring et al., 2007). It is only until 18 months of age that the child can follow another person's gaze towards an object located outside of their own visual field without additional deictic cues (Butterworth & Cochran, 1980; Carpenter et al., 1998).

In children with ASD, the difficulties of following deictic cues towards an object are even more significant if the object is not in their visual field. For example, in terms of the time it takes to fixate on an object, there is no difference whether the position of the object is in line with the examiner's gaze (Swanson & Siller, 2013). Nevertheless, children with ASD look for shorter periods of time at the target compared with TD children (Vivanti et al., 2017). If the object is absent from their visual field, only 20% of children with autism are able to follow the adult's gaze (Leekam et al., 2000). However, 52.2% of them follow the examiner's gaze to a target outside of their visual field if referential gazing (looking at the referent) is used in conjunction with other cues, such as pointing or verbalisations, towards a target outside of their visual field (Schietecatte et al., 2012). Thus, the combined use of several deictic indices seems to help children with ASD during joint attention bids.

### *This study*

The purpose of this research is to study joint attention behaviours in ASD children in their interactions with adults. Few studies have evaluated the RJA in ASD children by clearly separating the results obtained according to the presence or absence of the referent from the child's visual field. Moreover, this study focuses on a population of children with autism with significant developmental delay, a population that has not been studied in psychology for several years. Our first hypothesis (H1) is that IJA and RJA differ depending on the presence of the referent in the child's visual field. Independent variables of this study include the children's group (ASD or TD), the position of the referent (present or absent from the children's visual field), and the child's role in joint attention (RJA or IJA). The dependent variables are the number of episodes and the number of IJA and RJA within each episode. Therefore, for all groups, we hypothesize that responses will be more numerous during a joint attention episode involving an object in the child's visual field: H1-1. In addition, we hypothesize that IJA and RJA differ between groups. Thus, IJA and RJA of children with ASD will be fewer than those of TD children regardless of the position of the referent: H1-2.

Our second hypothesis (H2) is that RJA depends on the number and type of deictic indices used by the adult. Independent variables studied are the child's group (ASD or TD), the type of deictic indices used by the adult (orientation of the head and eyes = "Looking"; orientation of the head and verbalisations = "Verbalisations"; orientation of the head and pointing = "Pointing"), and the position of the referent (present or absent from the child's visual field). The dependent variable is the number instances where the child gazed at the referent during RJA. Therefore, we hypothesize that children with ASD will respond to the examiner's joint attention bids less often than TD children for both presentation (referent present or absent from the child's visual field), regardless of the deictic index used: H2-1. Finally, we hypothesize that there is an increase in RJA according to the developmental age of children (second dependent variable): H2-2.

## **Method**

### *Population*

This study involved 50 matched children with ASD, including 12 girls, aged from 2 years 8 months to 11 years 7 months. The diagnosis was made with standardized instruments, such as the Autism Diagnostic Interview-Revised (ADI-R) and the Autism

Diagnostic Observation Schedule-Generic (ADOS-G). Health professionals from Hauts-de-France and Normandie confirmed the analysis. Children with autism were recruited through the Autism Resources Centers of Picardie and Haute-Normandie, and through medical and social institutions where children are cared for (Medical-Educational Institute, Day Hospital, Pre-primary Teaching Unit). The level of autism was assessed with the French version of the Childhood Autism Rating Scale (CARS) (Rogé, 1989). Children with ASD were matched with 50 TD children based on their communicative development age. To this end, we used the Early Social Communication Scale (ECSP, by its French acronym) (Guidetti & Tourrette, 2009). The TD group was composed of 15 girls and 35 boys. If the communicative level was comparable between ASD and TD children, (from 8 months and 16 days to 31 months and 2 days for children with ASD and from 8 months and 20 days to 30 months and 23 days for TD children), the chronological age difference between children with ASD and TD children was very large (from 2 years 8 months to 11 years 7 months for children with ASD and from 8 months to 2 years 6 months for TD children). This choice of matching is related to the developmental delay of children with ASD. Characteristics of children are presented in Table 1.

Informed consent was obtained from the parents of all participants included in the study. Moreover, if they wished, parents could be present near their children in the experimental room. We were careful to respect children's different rhythms and stopped the test if they showed signs of discomfort. After reading the objectives of this study, the children's legal representatives provided informed consent in accordance with the recommendations of the Declaration of Helsinki of June 1964 (amended at the 64th General Assembly of the World Health Organization, October 2013).

### Tools

The ECSP scale (Guidetti & Tourrette, 2009) is the French adaptation of the ESCS of Seibert and Hogan. This scale was constructed using as a basis

Bruner's (1992) theories on the genesis of communicative behaviours. The ECSP is used "for the assessment of communication and language in children with atypical development" (Guidetti & Tourrette, 2009, p. 43). The scores allow a developmental age match ranging from 3 to 31 months. Each communicative age bracket corresponds to a developmental level. This scale allows the assessment of communication skills on both verbal and non-verbal levels in children with ASD.

In order to finely analyse the joint attention behaviours using the ECSP (Guidetti & Tourrette, 2009), we used video analysis software, The Observer XT (Noldus Information Technologies). We created a coding grid for the RJA and IJA (see online Appendix). This allowed us to conduct a microanalysis of the joint attention behaviours of the adult and child. We used two cameras to visualize the scene in a close-up shot of the child's face, in addition to a wide shot that allowed us to film the entire interaction. The ECSP was administered to all children by a psychologist. The total score allowed us to match ASD and TD children based on their respective communicative developmental age. In addition, video excerpts of the "poster sessions" using the ECSP were analysed in detail.

### Procedure

ECSP sessions lasted between 15 and 35 minutes. All ECSP items were proposed to calculate communicative developmental age. We analysed specific sequences that we called "poster sessions". A poster session was repeated 2 to 3 times per ECSP session. The experimenter made proposals for joint attention towards 3 animal posters (depicting a dog, a cat, and a horse, respectively) which were hanging on the wall in a randomised order. Two of the posters were located to the right and the left of the child, respectively, and one poster was located behind them, all of which were used as targets for joint attention. The experimenter randomly referred to the posters in a balanced way. In a standard test, the experimenter first had to refer to the poster using their gaze, later add pointing, and then verbalisations (see Figure 1 for an example of the ECSP test). We analysed data concerning referential

**Table 1.** Population characteristics.

	ASD N = 50			TD N = 50		
	M	(SD)	Range	M	(SD)	Range
Chronological age (years.month)	6.1	(2.9)	2.8–11.7	2	(0.6)	0.8–2.6
Developmental age by ECSP (month.days)	22.1	(7.8)	8.16–31.2	21.15	(6.7)	8.20–30.23
Total ESCP score	126.4	(52.7)	25–188	125.1	(44.5)	26–186
CARS score	34.1	(6.7)	30–45.5			



**Figure 1.** Photos extracted from the “poster session” of the ECSP test. Note. The child sits next to his mother. He initiates or responds to joint attention about posters placed to his left, right or behind him. The author of this article has written permission from adults as well as from the child’s parents for the publication of these photograph.

gazing, pointing gestures, and verbalisations of both partners when they were in joint attention directed towards a poster located within or outside of the children’s visual field.

### Coding

To define a joint attention episode, we used different behavioural indices as a basis: looking, pointing and verbalisations in reference to a poster present or absent from the child’s field of vision. Therefore episodes of joint attention were defined after behavioural microanalysis. We never used reciprocated eye contact as a first sign of joint attention. Joint attention does not necessarily begin with reciprocated eye contact, especially in autism. In this regard, Tomasello (1995) explains that joint attention is not simply a case of people looking at one another and then looking at an object. Joint attention requires one individual to direct their attention to an object while a partner coordinates their own attention. Thus, during a joint attention situation, we are aware of the other’s presence and of the fact that they are directing their attention to the same object, at the same time, as we are. The other person is communicating with us non-verbally (smiles or other facial gestures, gazes, gestures) or verbally (through vocalisations or verbalisations). Therefore, it is possible to start a joint attention situation with no reciprocated

gaze. In order to be coherent with this definition of joint attention, we marked every behaviour of the two interacting partners. Afterwards, we searched for the presence of shared attention behaviours (such as both adult and child looking at the same poster). We looked for the potential beginning of a joint attention episode prior to actual shared attention. We defined and analysed different behaviours: child’s gaze, adult’s gaze, child’s pointing, adult’s pointing, child’s verbalisations or vocalisations, and adult’s verbalisations. We defined the target object of each behaviour: the partner, the poster visible to the right of the child, the poster visible to the left of the child, and the poster invisible to the child, which was placed behind them.

We tallied the number of proposals for joint attention. Despite the 3 poster sessions, some children interacted only once, while others interacted at each proposal. There were from 1 to 6 observations per child depending on their possibility to initiate and respond to joint attention. Finally, to harmonize the number of proposals for the posters on the right and on the left (i.e. towards a referent present in the child’s visual field), and for the poster behind the child (i.e. outside of their visual field), data were processed as rates.

The beginning and the end of each behaviour were established very precisely in order to delimit behavioural units. Each behavioural unit coding excluded the

other units. For example, when the child's gaze was coded towards a poster, it could not be coded simultaneously as a gaze towards the other person. Each film was viewed several times and the viewing speed could be slowed down to facilitate coding work. A double rating was performed by two students (a Ph.D. student and a Master's level student of psychology) trained in the ECSP (Guidetti & Tourrette, 2009) and The Observer XT software (Noldus Information Technologies). After both of them did an initial screening together for all videos, the ECSP "poster sessions" were identified on the rating grid. A double coding of 30% of the ECSP videos (corresponding to 30 children including 15 with ASD and 15 with TD) was carried out. During this individual coding session, students coded each behavioural class for each participant. For example, they started by coding the gazes of one of the communication partners, then their pointing, and finally their verbalisations. Finally, based on the specifications of the coding grid, the two coders defined the roles of the child and the adult (RJA or IJA). The double coding showed good reliability of RJA (Kappa = .78; Rho = .85) and IJA (Kappa = .77; Rho = .84).

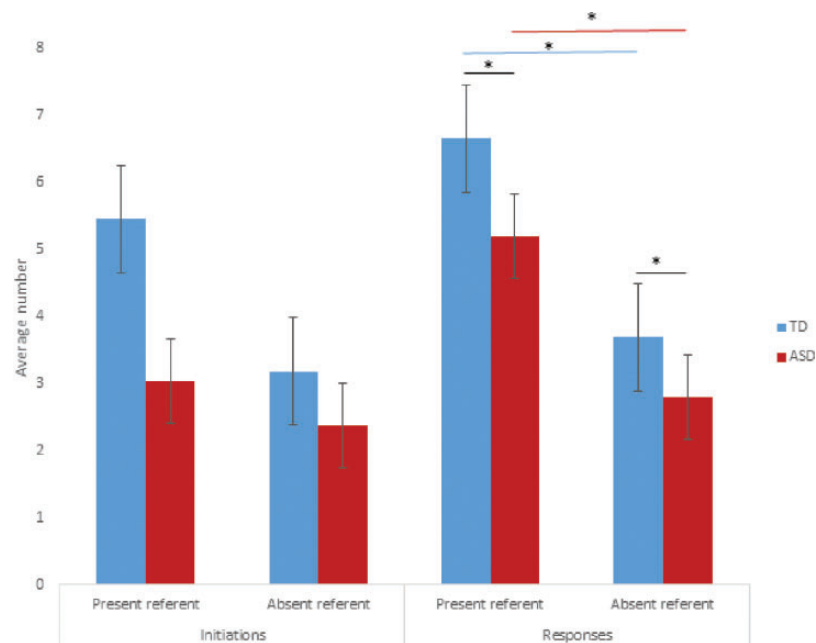
## Results

**H1:** We conducted analyses of variance (Friedman's ANOVA) for each independent variable: the child's group (ASD or TD), the position of the referent (present in or absent from the children's visual field) and

the child's role in joint attention (RJA or IJA). Then, we used the Students' t-test for a comparison of two means. The first analysis of variance showed a group effect  $F(1, 128.22) = 7.021, p = 0.009, \eta_p^2 = 0.027$ . This allowed us to demonstrate, by a test of comparisons of two means, that the number of joint attention episodes was lower for ASD children compared to TD children  $t(250) = 2.36, p = 0.019$ . We also observed an effect of the referent's presence or absence  $F(1, 334.07) = 18.293, p < 0.001, \eta_p^2 = 0.068$ . Across all groups, joint attention episodes were generally more frequent when the referent was present in the children's visual field  $t(250) = 3.53, p < 0.001$ . Finally, there was an effect of the child's role in initiating or responding to joint attention  $F(1, 87.99) = 4.818, p = 0.029, \eta_p^2 = 0.019$ . Thus, across all groups, the number of joint attention episodes was overall higher when children responded to a joint attention proposal compared to when they initiated the episodes  $t(250) = 3.85, p < 0.001$ .

**H1-1:** Regarding the dependent variable of RJA, children with ASD looked more often at the referent when it was present, compared to when it was absent from their visual field  $t(34) = 3.79, p < 0.001$ . Results are similar for TD children  $t(41) = 5.50, p < 0.001$  (see Figure 2).

**H1-2:** To compare RJA and IJA as dependent variables, we used non-parametric statistics (Mann-Whitney U test) because we did not observe any interaction effect between the groups, the poster presence, and the child's role in the joint attention episode  $F(1,$



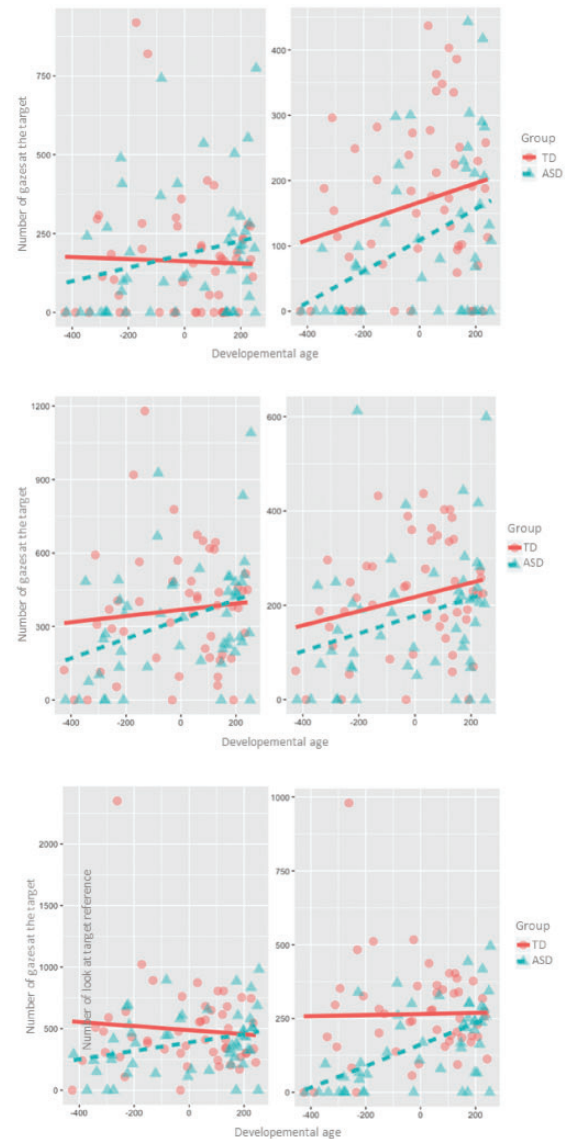
**Figure 2.** Average number of initiations and responses to joint attention on a referent present or absent in the child's visual field for the group of children with autism (ASD) and for the group of typical children (TD). Note. Error bars show standard errors. \* $p < 0.05$ .

3.76) = 0.206,  $p = 0.065$ ;  $\eta_p^2 = 0.001$ . Whatever the position of the referent was, when the child initiated joint attention, the number of initiation behaviours did not differ between groups. On the other hand, when the child responded to a proposal for joint attention towards a referent present in their visual field, the number of responses was lower among children with ASD than among TD children ( $U = 833$ ,  $p = 0.019$ ). Similarly, when the child responded to a proposal for joint attention towards a referent absent from their visual field, the number of responses was lower among children with ASD than among TD children ( $U = 6855$ ,  $p = 0.013$ ) (see Figure 2).

**H2:** To assess the trajectory of the developmental age of children with ASD with reference to TD children, we compared the cross-sectional developmental trajectories of each group using an analysis of covariance (ANCOVA) as recommended by Thomas et al. (2009). We chose as a dependent variable the number of gazes at the referent of joint attention, whether it was present or absent from the child's field of view. The group corresponded to the categorical variable, and the developmental ages are analysed as covariates. The developmental ages that represent our second dependent variable were calculated based on the overall ECSP score. Later, these were scaled to the same scale and centred around zero.

**H2-1:** When the referent was present in the child's visual field, the ANCOVA did not show any difference between groups, regardless of the deictic index used (Looking:  $F(1, 12154) = 0.321$ ,  $p = 0.572$ ; Verbalizations:  $F(1, 37289) = 0.660$ ,  $p = 0.418$ ; Pointing:  $F(1, 251313) = 2.723$ ,  $p = 0.102$ ). The trajectories are shown in Figure 3. When the referent was absent from the child's visual field, a group effect was observed when the adult used only their gaze to direct the child's attention to the referent ( $F(1, 84293) = 6.231$ ,  $p = 0.014$ ) or when they used the gaze as well as pointing ( $F(1, 269489) = 13.192$ ,  $p < 0.001$ ). Regarding the Score Index, there was an interaction effect between the group and developmental age  $F(1, 117060) = 5.730$ ,  $p = 0.018$ . As a result, the ordinates of origin and the slopes of the trajectories of each group differed. In addition, we noted that the slopes on the right (representing responses to joint attention) increased steadily with the rise in developmental age in ASD and TD children in the "Looking" condition, but only in ASD in the "Pointing" condition while there was no developmental progression in TD children. On the other hand, there was no difference between groups in the "Verbalisations" index  $F(1, 39435) = 2.347$ ,  $p = 0.128$ .

**H2-2:** Linear regression analysis showed that the response to joint attention did not progress significantly with an increase in the developmental age for the ASD group when the index used involved looking at



**Figure 3.** Developmental trajectories of response to the Looking index (top), Looking and verbalizations (middle), Looking and pointing cues (bottom) to a poster present (left) or absent (right) from the visual field for the group of children with autism (ASD) and for the group of typical children (TD).

a present referent  $R^2 = 0.033$ ,  $F(1, 48) = 2.689$ ,  $p = 0.107$ ). In contrast, we observed a developmental age effect for children with ASD when the adult looked and pointed ( $R^2 = 0.071$ ,  $F(1, 48) = 4.772$ ,  $p = 0.033$ ), or looked and verbalised to present in the child's visual field ( $R^2 = 0.10$ ,  $F(1, 48) = 7.048$ ,  $p = 0.010$ ). For TD children, there was no developmental age effect on the response to joint attention towards a referent present in their visual field, whether the index used by the adult was looking only ( $R^2 = 0.19$ ,  $F(1, 48) = 0.053$ ,  $p = 0.081$ ), vocalisations with looking

( $R^2=0.011$ ,  $F(1, 48)=0.451$ ,  $p=0.054$ , or pointing and looking ( $R^2=0.13$ ,  $F(1, 48)=0.365$ ,  $p=0.548$ ).

Linear regression analysis of children with ASD shows that the response to joint attention changed significantly with developmental age when the index used involved looking ( $R^2=0.163$ ,  $F(1, 48)=3.252$ ,  $p=0.021$ ), looking and verbalising ( $R^2=0.06$ ,  $F(1, 48)=4.155$ ,  $p=0.047$ ), or looking and pointing towards a referent absent from the children's visual field ( $R^2=0.071$ ,  $F(1, 48)=4.772$ ,  $p=0.033$ ). For TD children, there was no age effect on RJA to a referent absent from their visual field, regardless of whether the index used by the adult was looking ( $R^2=0.029$ ,  $F(1, 48)=2.469$ ,  $p=0.122$ ), vocalisation and looking ( $R^2=0.034$ ,  $F(1, 48)=2.775$ ,  $p=0.102$ ), or pointing and looking ( $R^2=0.020$ ,  $F(1, 48)=0.022$ ,  $p=0.880$ ).

## Discussion

In this study, we made several developmental hypotheses regarding the number of initiations and responses for joint attention based on the deictic index used. We hypothesized that initiation and response to joint attention would be lower in children with ASD than in TD children. We also hypothesized that the presence of the referent in the child's visual field would facilitate the response to joint attention compared to a situation where the referent object was placed behind the child. In addition, we hypothesized that, regardless of the index used (head and eye orientation = "Looking" condition; head orientation and verbalisations = "Verbalisations" condition; head orientation and pointing = "Pointing" condition), children with ASD would respond less to joint attention than TD children, but that there would be developmental progression in each group.

First, we found that, during ECSP assessment, joint attention episodes between an adult and a child with ASD were fewer compared to the interaction between an adult and a TD child. These findings partially corroborate those of Hurwitz and Watson's (2016) study, which compared children with ASD (aged between 3 and 4 with a non-verbal mental age of 26 months) with children with a developmental delay. More precisely, in their study, the groups differ on IJA but not on RJA: children with ASD entered into joint attention significantly less often than children with developmental delay but, once engaged, they used the forms of joint attention similarly. In contrast, in our research, there was no difference between groups in engagement in a joint attention episode. However, as found in other studies (Congiu et al., 2016; Corkum & Moore, 1998; Leekam et al., 2000), children with ASD responded less to joint attention bids than TD children. When the joint attention referent was present or absent from

the children's visual field, our results showed a lower frequency of RJA among ASD compared to TD children. However, children generally respond more to joint attention bids with a present referent than to a situation where the adult refers to a referent absent from the child's visual field (Leekam et al., 2000).

In a second step, the analysis of cross-sectional developmental trajectories and response profiles for the joint attention of our participants provided interesting elements. These differences in trajectories depend on the presence of the referent in the child's visual field and the cue used by the adult to initiate joint attention. Thus, when the referent was present in the child's visual field, there was no difference between the two groups. However, the index used had an impact since there was developmental progression in children with ASD when they responded to a joint attention bid from the adult who used pointing or verbalisations regarding a present object. The chronological age of children with ASD influenced these response behaviours.

Thus, the diversity of a child's vocabulary can influence the way they engage in joint attention and can help them share more experiences (Vallotton & Ayoub, 2010). In addition, episodes of joint attention evolve with developmental age and are therefore a source of learning symbolic function (Adamson et al., 2004). Regarding results of TD children in our research, our group had a chronological and developmental age greater than 15 months. Because of the ceiling effect, there was no developmental progression in their response behaviours to joint attention, regardless of the deictic index used by the adult to refer to a referent present in the child's visual field.

Furthermore, when the adult referred to an object absent from the child's visual field, by looking or by looking and pointing, the slope of the developmental trajectory of children with ASD was steeper than that of TD children. However, Leekam et al. (2000) show that at 4 years of age, only 20% of children with ASD follow the gaze towards a target absent from their visual field, while 65% of children with developmental delay are able to do so. In our study, the chronological ages of children with ASD and, as a result, their life experience, help explain this difference. For all indices involving the gaze (looking, looking and verbalising, or looking and pointing), our results show an increase in responses to the joint attention of children with ASD according to their communicative development age. Thus, children with ASD with a higher communication age pay more regard to the indices of looking (Congiu et al., 2016; Vivanti et al., 2017), looking and verbalising (Benjamin et al., 2014; Schietecatte et al., 2012), or looking and pointing (Benjamin et al., 2014; Schietecatte et al., 2012; Sullivan et al., 2007) used by adults to initiate joint attention. Our study shows that



the developmental age of TD children is too high to observe an effect of the index used during joint attention to a referent placed behind them. Indeed, at 15 months of age, regardless of the deictic index used by the adult, children can acknowledge there is an object even if it is absent from their visual field (Morissette et al., 1995).

In our study, cross-sectional developmental trajectories showed a developmental progression when the adult referred to a poster by looking, looking and pointing, or looking paired with verbalisations, whether it was present in or absent from the child's visual field. Depending on the developmental level of the child with ASD, it is important to combine different deictic indices. This allows different sensory channels to be engaged without overloading one relative to the other. For example, in the Early Start Denver Model (Rogers & Dawson, 2010) it is recommended to use the 'one-up' rule (i.e. "use the same number of words as in the child's spontaneous production plus one") (p. 177). It is suggested to wait until the child has at least 60 to 80 spontaneous words in their repertoire and then to use joint activity routines to help them go from single-word speech to two-word phrases. Joint attention is a key feature of this intervention. This is why it is important to clearly identify IJA and RJA skills and help the child develop them.

### Limits

Several limitations of our research concern the characteristics of the participants. We did not control the type of care for all children and we did not have access to all their medical records containing exact scores of various psychometric assessments. In addition, some experimental biases and others related to software and coding may have limited the interpretation of the results. The position of the posters in the room was controlled, but the layout of the rooms was not always identical between the different institutions, a fact that could have introduced certain biases in the interpretation of referential gazing. Moreover, the ECSP disposal recommendations were fully respected, but this limited the impact of our findings on joint attention bids where the poster was placed behind the child. Indeed, if pointing and verbalising did not really differ between the different posters located on the right, left, or behind the child, the adult's gaze appeared less clear in initiating joint attention towards the object placed behind the child (Deák et al., 2000). Indeed, despite the fact that we used two cameras to record the experiment, if the adult did not move their head sufficiently, it was not easy for the viewer to differentiate if the adult's gaze was aimed towards the poster or towards the child. Therefore, two posters should have

been placed behind the child, one behind them to their right and the other behind them to their left. Finally, it would have been interesting to place a poster behind the adult to see which cue the child used to initiate joint attention towards this poster.

### Conclusion

The purpose of this study was to compare joint attention behaviours concerning a referent present or absent in the visual field of matched ASD and TD children according to their communicative developmental age measured on the ECSP. While there was no difference in terms of initiation of joint attention, we noted that children with ASD responded less to a proposal for joint attention than TDs. Children with advanced communication skills were more responsive to adult's joint attention bids, regardless of the deictic cue used (looking, pointing and verbalisations). Obviously, the level of communication (the developmental progression) had an impact. Thus, the use of pointing and verbalisations when initiating joint attention are elements to be considered in the specific management of autism. Indeed, for non-verbal children, it is necessary for practitioners to teach different behaviours involving joint attention, as this is a precursor to language development and is essential in the use of certain augmentative and alternative communication tools (e.g. Communication System by Image Exchange).

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### Supplemental material

Supplemental material for this article is available online.

## References

- Adamson, L. B., Bakeman, R., & Deckner, D. F. (2004). The development of symbol-infused joint engagement. *Child Development, 75*, 1171–1187. <https://doi.org/10.1111/j.1467-8624.2004.00732.x>
- American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders DSM-5*. American Psychiatric Publishing.
- Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother-infant and peer-infant coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development, 55*, 1278–1289. <https://doi.org/10.2307/1129997>
- Baron-Cohen, S. (1989). Joint-attention deficits in autism: Toward a cognitive analysis. *Development and Psychopathology, 1*, 185–189.
- Behne, T., Liszkowski, U., Carpenter, M., & Tomasello, M. (2012). Twelve-month-olds' comprehension and production of pointing. *The British Journal of Developmental Psychology, 30*, 359–375. <https://doi.org/10.1111/j.2044-835X.2011.02043.x>
- Benjamin, D. P., Mastergeorge, A. M., McDuffie, A. S., Kover, S. T., Hagerman, R. J., & Abbeduto, L. (2014). Effects of labeling and pointing on object gaze in boys with fragile X syndrome: An eye-tracking study. *Research in Developmental Disabilities, 35*, 2658–2672. <https://doi.org/10.1016/j.ridd.2014.06.021>
- Beuker, K. T., Rommelse, N. N. J., Donders, R., & Buitelaar, J. K. (2013). Infant behavior and development of early communication skills in the first two years of life. *Infant Behavior & Development, 36*, 71–83. <https://doi.org/10.1016/j.infbeh.2012.11.001>
- Bruinsma, Y., Koegel, R. L., & Koegel, L. K. (2004). Joint attention and children with autism: A review of literature. *Mental Retardation and Developmental Disabilities Research Reviews, 10*, 169–175. <https://doi.org/10.1002/mrdd.20036>
- Butterworth, G., & Cochran, E. (1980). Towards a mechanism of joint visual attention in human infancy. *International Journal of Behavioral Development, 3*, 253–272.
- Butterworth, G., & Grover, L. (1988). The origins of referential communication in human infancy. In L. Weiskrantz (Ed.), *A Fyssen foundation symposium. Thought without language* (pp. 5–24). New York: Clarendon Press/Oxford University Press. [Mismatch]
- Carpenter, M., Nagell, K., Tomasello, M., Butterworth, G., & Moore, C. (1998). Social cognition, joint attention and communicative competence from 9 to 15 month of age. *Monographs of the Society for Research in Child Development, 63*, i. <https://doi.org/10.2307/1166214>
- Chawarska, K., Macari, S., & Shic, F. (2012). Context modulates attention to social scenes in toddlers with autism. *Journal of Child Psychology and Psychiatry, 53*(8), 903–913. <https://doi.org/10.1111/j.1469-7610.2012.02538.x>
- Cilia, F., Garry, C., Brisson, J., & Vandromme, L. (2018). Joint attention and visual exploration of children with typical development and with ASD: review of eye-tracking studies. *Neuropsychiatrie de L'enfance et de L'adolescence, 66*, 304–314. <https://doi.org/10.1016/j.neurenf.2018.06.002>
- Congiu, S., Fadda, R., Doneddu, G., & Striano, T. (2016). Impaired representational gaze following in children with autism spectrum disorder. *Research in Developmental Disabilities, 57*, 11–17. <https://doi.org/10.1016/j.ridd.2016.06.008>
- Corkum, V., & Moore, C. (1998). The origins of joint visual attention in infants. *Developmental Psychology, 34*, 28–38. <https://doi.org/10.1037/0012-1649.34.1.28>
- Daum, M. M., Ulber, J., & Gredebäck, G. (2013). The development of pointing perception in infancy: Effects of communicative signals on covert shifts of attention. *Developmental Psychology, 49*, 1898–1908. <https://doi.org/10.1037/a0031111>
- Deák, G. O., Flom, R. A., & Pick, A. D. (2000). Effects of gesture and target on 12- and 18-month-olds' joint visual attention to objects in front of or behind them. *Developmental Psychology, 36*, 511–523. <https://doi.org/10.1037/0012-1649.36.4.511>
- Falck-Ytter, T., Fernell, E., Hedvall, A. L., von Hofsten, C., & Gillberg, C. (2012). Gaze performance in children with autism spectrum disorder when observing communicative actions. *Journal of Autism and Developmental Disorders, 42*, 2236–2245. <https://doi.org/10.1007/s10803-012-1471-6>
- Franchini, M., Glaser, B., Gentaz, E., Wood, H., Eliez, S., & Schaer, M. (2017). The effect of emotional intensity on responses to joint attention in preschoolers with an autism spectrum disorder. *Research in Autism Spectrum Disorders, 35*, 13–24. <https://doi.org/10.1016/j.rasd.2016.11.010>
- Gliga, T., & Csibra, G. (2009). One-year-old infants appreciate the referential nature of deictic gestures and words. *Psychological Science, 20*, 347–353. <https://doi.org/10.1111/j.1467-9280.2009.02295.x>
- Guidetti, M., & Tournette, C. (2009). *Evaluation de la communication sociale précoce (ECSP)* (Eurotests) [Early Social Communication Scale French Edition]. Eurotests Editions.
- Hurwitz, S., & Watson, L. R. (2016). Joint attention revisited: Finding strengths among children with autism. *Autism: The International Journal of Research and Practice, 20*, 538–550. <https://doi.org/10.1177/1362361315593536>
- Jones, E. A., Carr, E. G., & Feeley, K. M. (2006). Multiple effects of joint attention intervention for children with autism. *Behavior Modification, 30*, 782–834. <https://doi.org/10.1177/0145445506289392>
- Leekam, S. R., Lopez, B., & Moore, C. (2000). Attention and joint attention in preschool children with autism. *Developmental Psychology, 36*, 261–273. <https://doi.org/10.1037/0012-1649.36>
- Meindl, J. N., & Cannella-Malone, H. I. (2011). Initiating and responding to joint attention bids in children with autism: A review of the literature. *Research in Developmental Disabilities, 32*, 1441–1454. <https://doi.org/10.1016/j.ridd.2011.02.013>
- Morales, M., Mundy, P., Delgado, C. E. F., Yale, M., Messinger, D., Neal, R., & Schwartz, H. K. (2000). Responding to joint attention across the 6-through 24-

- month age period and early language acquisition. *Journal of Applied Developmental Psychology*, 21, 283–298.
- Morissette, P., Ricard, M., & Décarie, T. G. (1995). Joint visual attention and pointing in infancy: A longitudinal study of comprehension. *British Journal of Developmental Psychology*, 13, 163–175. <https://doi.org/10.1111/j.2044-835X.1995.tb00671.x>
- Mundy, P., & Jarrold, W. (2010). Infant joint attention, neural networks and social cognition. *Neural Networks: The Official Journal of the International Neural Network Society*, 23, 985–997. <https://doi.org/10.1016/j.neunet.2010.08.009>. Infant
- Mundy, P., Sigman, M., Ungerer, J., & Sherman, T. (1986). Defining the social deficits of autism: The contribution of non-verbal communication measures. *Journal of Child Psychology and Psychiatry*, 27, 657–669.
- Mundy, P., Sullivan, L., & Mastergeorge, A. M. (2009). A parallel and distributed-processing model of joint attention, social cognition and autism. *Autism Research: Official Journal of the International Society for Autism Research*, 2, 2–21. <https://doi.org/10.1002/aur.61>
- Rogé, B. (1989). *Childhood Autistic Rating Scale French Edition* Editions d'Applications psychotechniques.
- Rogers, S. J., & Dawson, G. (2010). *Early start Denver model for young children with autism: Promoting language, learning, and engagement*. Guilford Press.
- Rozga, A., Hutman, T., Young, G. S., Rogers, S. J., Ozonoff, S., Dapretto, M., & Sigman, M. (2011). Behavioral profiles of affected and unaffected siblings of children with autism: Contribution of measures of mother-infant interaction and nonverbal communication. *Journal of Autism and Developmental Disorders*, 41, 287–301. <https://doi.org/10.1007/s10803-010-1051-6>
- Schietecatte, I., Roeyers, H., & Warreyn, P. (2012). Exploring the nature of joint attention impairments in young children with autism spectrum disorder: Associated social and cognitive skills. *Journal of Autism and Developmental Disorders*, 42, 1–12. <https://doi.org/10.1007/s10803-011-1209-x>
- Senju, A., & Csibra, G. (2008). Gaze following in human infants depends on communicative signals. *Current Biology*, 18, 668–671. <https://doi.org/10.1016/j.cub.2008.03.059>
- Sigman, M., Ruskin, E., Arbelle, S., Corona, R., Dissanayake, C., Espinosa, M., ... Robinson, B. E. (1999). Continuity and change in the social competence of children with autism, down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development*, 64, 11–139. <http://www.jstor.org/stable/3181510%5Cnhttp://about.jstor.org/terms>
- Sullivan, M., Finelli, J., Marvin, A., Garrett-Mayer, E., Bauman, M., & Landa, R. (2007). Response to joint attention in toddlers at risk for autism spectrum disorder: A prospective study. *Journal of Autism and Developmental Disorders*, 37(1), 37–48. <https://doi.org/10.1007/s10803-006-0335-3>
- Swanson, M. R., & Siller, M. (2013). Patterns of gaze behavior during an eye-tracking measure of joint attention in typically developing children and children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, 7, 1087–1096. <https://doi.org/10.1016/j.rasd.2013.05.007>
- Theuring, C., Gredebäck, G., & Hauf, P. (2007). Object processing during a joint gaze following task. *European Journal of Developmental Psychology*, 4, 65–79. <https://doi.org/10.1080/17405620601051246>
- Thomas, M. S. C., Annaz, D., Ansari, D., Scerif, G., Jarrold, C., & Karmiloff-Smith, A. (2009). Understand developmental disorders. *Journal of Speech, Language, and Hearing Research*, 52, 336–359. [https://doi.org/10.1044/1092-4388\(2009/07-0144\)](https://doi.org/10.1044/1092-4388(2009/07-0144))
- Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. J. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103–130). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Vallotton, C. D., & Ayoub, C. C. (2010). Symbols build communication and thought: The role of gestures and words in the development of engagement skills and social-emotional concepts during toddlerhood. *Social Development (Oxford, England)*, 19, 601–626. <https://doi.org/10.1111/j.1467-9507.2009.00549.x>
- Vivanti, G., Fanning, P. A. J., Hocking, D. R., Sievers, S., & Dissanayake, C. (2017). Social attention, joint attention and sustained attention in autism spectrum disorder and Williams syndrome: Convergences and divergences. *Journal of Autism and Developmental Disorders*, 47, 1866–1877. <https://doi.org/10.1007/s10803-017-3106-4>
- Von Hofsten, C., Dahlström, E., & Fredriksson, Y. (2005). 12-Month-old infants' perception of attention direction in static video images. *Infancy*, 8, 217–231.
- Warreyn, P., Roeyers, H., Van Wetswinkel, U., & De Groote, I. (2007). Temporal coordination of joint attention behavior in preschoolers with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 37, 501–512. <https://doi.org/10.1007/s10803-006-0184-0>
- Wimpory, D. C., Hobson, R. P., Williams, J. M. G., & Nash, S. (2000). Are infants with autism socially engaged? A study of recent retrospective parental reports. *Journal of Autism and Developmental Disorders*, 30, 525–536. <https://doi.org/10.1023/A:1005683209438>
- Winder, B. M., Wozniak, R. H., Parladé, M. V., & Iverson, J. M. (2013). Spontaneous initiation of communication in infants at low and heightened risk for autism spectrum disorders. *Developmental Psychology*, 49, 1931–1942. <https://doi.org/10.1037/a0031061>