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Exploring individual trajectories of social communicative development in toddlers at risk for autism spectrum disorders

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Abstract

While impairments in joint attention, imitation, and pretend play are well documented in children with autism spectrum disorder (ASD), the developmental trajectories of these symptoms remain unknown. The main objective was to explore these trajectories in a sample of children at risk for ASD between the ages of 2 and 4 years. After screening positive for ASD, 17 children were prospectively followed with 6-monthly assessments of social communicative skills and general development. During this study, 9 children were diagnosed with ASD. Results showed that there was growth in imitation skills and in pretend play ability. Also, a slightly increased amount of initiation of joint attention was noted. However, the quality of joint attention behaviours did not significantly improve and growth rates did not significantly differ between children with ASD and non-ASD cases. There was a great intra-individual variability, especially in the performances on the imitation tasks. Also interindividual variability was apparent: Some children with ASD showed a delayed development of imitation or pretend play, whereas others had a more clearly deviant developmental profile. The importance of looking at individual trajectories and variability in the study of social communicative development in children with ASD is discussed.

Keywords: Autism Spectrum Disorder, Toddlers, Social communicative abilities, Variability, Prospective study, Individual trajectories

1. Introduction

Deficits in preverbal social communication skills, like a lack of imitation, joint attention, ~~and~~ or pretend play, are some of the early signs of autism spectrum disorder (ASD) that best discriminate between children with and without ASD in the first years of life (Baron-Cohen et al., 1996; Dereu et al., 2011; Gray & Tonge, 2001, 2005; Osterling & Dawson, 1994; Wetherby et al., 2004; Wimpory, Hobson, Williams, & Nash, 2000). Although many studies have demonstrated impairments in imitation, joint attention, and pretend play in toddlers with ASD (for reviews, see Charman, 1998; Jarrold, 2003; Vanvuchelen, Roeyers, & De Weerdt, 2011), the developmental trajectories of these skills in children with ASD remain unclear. Given the close relationship of these social communicative abilities with language development (e.g., Charman et al., 2000; Toth, Munson, Meltzoff, & Dawson, 2006) and the effects of early interventions that target these skills (e.g., Ingersoll & Schreibmann, 2006; Kasari, Paparella, Freeman, & Jahromi, 2008; Sigman & Ruskin, 1999), enhancing our understanding of the early social communicative development in children with ASD is essential for both clinical practice and theoretical accounts (see also Chawarska, Klin, Paul, Macari, & Volkmar, 2009).

Some studies suggested a delayed rather than a deviant social communicative development in children with ASD, because children with ASD displayed the same developmental sequence of behaviours as found in typically developing children or because interrelations amongst social communicative abilities were similar in children with and without ASD (e.g., Carpenter, Pennington, & Rogers, 2002; Rutherford, Young, Hepburn, & Rogers, 2007; Williams, Whiten, & Singh, 2004). However, confirmation of these findings in a longitudinal design is still pending to address the question about delayed or deviant developmental trajectories of imitation, joint attention, and pretend play skills in children with ASD. Unfortunately, longitudinal studies in young children with ASD are scarce. Pry, Petersen, and Baghdadli (2009) were the first to examine developmental trajectories of expressive language, joint attention, imitation, and play competence longitudinally

over the course of 3 years in 132 children on the autism spectrum between 5 and 8 years at the beginning of the study. They categorized the children into four distinct groups based on their linguistic activity. The two groups with a stable pattern in linguistic activity (functional phrase speech or less than five isolated words) were characterized by minor improvements in their joint attention, imitation, and play abilities. The children who changed from no linguistic activity to functional speech showed the most homogeneous developmental trajectories of social communicative skills with marked improvements in requesting, showing, and giving objects, and in their pretend play ability. Finally, the six children who regressed from functional speech to less than five isolated words showed a more heterogeneous profile with what appears to be a disturbed development of pretend play and imitation, and no mastery of joint attention at the end of the study. These results demonstrate differences in developmental trajectories of social communicative skills according to the language development of children with ASD. The children were however all above age 5 and there was no comparison group. So, this longitudinal study cannot give insight into the development of these abilities earlier in life and cannot give answers to the delay or deviant development issue.

The fact that diagnoses of ASD are often not made prior to age 3 or 4 complicates the study of the early development of these children. In recent years, several research groups have set up prospective studies with siblings of children with ASD to overcome this problem. Siblings of children with ASD are at high risk of developing the disorder given the fact that ASD is amongst the most heritable of neurodevelopmental conditions (Yirmiya & Charman, 2010). These studies with siblings found differences in the second year between siblings who developed ASD and unaffected siblings (Landa & Garrett-Mayer, 2006; Nadig et al., 2007; Stone, McMahon, Yoder, & Walden, 2007; Yirmiya et al., 2006; Zwaigenbaum et al., 2005). Such prospective designs contribute to our knowledge about the early development of children with ASD. However, these prospective longitudinal studies have not yet published data on the developmental trajectories of joint attention, imitation, or pretend play in children with ASD. In addition, siblings of children with ASD may form a specific subgroup and results from these studies may not be generalized to all children with ASD (Rogers, 2009; Yirmiya &

Charman, 2010). Therefore, prospective longitudinal designs are warranted in which the early social communicative development of at-risk samples selected from the general population through screening for ASD is studied.

Such research has not yet been conducted, because data analysis in these designs is often complicated by wave non-response and varying ages at intake. Varying occasions across individuals (i.e., different amount of observations across participants or missing data) can be dealt with in multilevel analysis (Hox, 2002), but this statistical approach asks for a considerable large sample size. Due to the relative low prevalence of ASD, obtaining large enough samples drawn from the general population in prospective designs is very difficult. Especially when no clear hypotheses can be formulated yet, van Geert and van Dijk (2002) argued that researchers should start with the study of one case who is intensively followed throughout early development, or preferable, to study a few cases. An example of such an approach is seen in the study of Bryson and colleagues (2007) who described the early development of nine children from 6 months onwards. These cases were the first children who were diagnosed with ASD at 36 months in their prospective study of siblings of children with ASD. In the current study, we wanted to explore the social communicative development in a sample of 17 children at risk for ASD drawn from the general population. The children in the current study were selected from a population screening study of ASD in children between 3 and 39 months. Children were followed from screening positive for ASD onwards until they were about 4 years old.

Loftus (1996) stated that particularly the field of developmental psychology would benefit from such an exploratory approach to the data, which should primarily be aimed at making interesting phenomena like variability visible, both between individuals as within an individual across time. Variability has to be treated as an important source of information, rather than to disregard it as inconvenient noise and to look only at central tendencies in smoothed trajectories (van Geert & van Dijk, 2002). More commonly used methods in longitudinal studies, such as mixed designs, see variability as a by-product and even restrict variability: Variances in the dependent variable have to be equal across groups. These methods focus on comparing group means instead of focussing on the

individual level. In fact, most studies regarding social communicative impairments in ASD also focused on the group level when they compared children on the autism spectrum with typically developing children or children with an intellectual disability (e.g., Adamson, Bakeman, Deckner, & Romski, 2009; Chawarska, Klin, Paul, & Volkmar, 2007; Chawarska et al., 2009; Landa & Garrett-Mayer, 2006; Ozonoff et al., 2010). This focus on group means may mask individual differences in social communicative abilities and in their growth rates over time. So, little, if anything, is known about the individual trajectories of social communicative abilities in young children at risk for ASD and how these developmental trajectories intertwine with language or general development of these children. The current prospective exploratory research tried to fill this void.

The aim of the study was fourfold. First of all, by visualising the individual developmental trajectories of early social communicative skills, language, and general development in an at-risk sample, we wanted to explore the individual trajectories of the social communicative skills and link them to language and general development. Second, we wanted to explore interindividual variability within and between groups (ASD versus non-ASD cases) and intra-individual variability over time. Third, we wanted to address the issue of delayed versus deviant development by comparing the growth rate of the social communicative skills for each individual with that seen in a normative sample of typically developing children, if available. Finally, we wanted to investigate if the choice of method for analysing data mattered. Therefore, information about group differences derived from visual inspection of graphs of individual trajectories was compared with the information derived from more commonly used analyses to compare group means.

2. Method

2.1 Participants

The parents of the first 33 children who were seen for further assessment at the university lab between May 2006 and September 2007 as part of a large-scale ASD screening study in Flemish

day-care centres (Dereu et al., 2010), were asked to participate with their child in the current study. The parents of 10 children declined participation, two children were not able to participate because they moved abroad, two children dropped out because of time constraints and chronic illness, and two children were not included in the study because of diagnostic uncertainty[1]. This lead to a final sample size of 17 children. These 17 children did not differ from the 16 children who did not participate in the follow-up study in age, SES, or symptom severity, as measured with the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) at the initial assessment (all *F*-values < 2), nor in gender distribution ($\chi^2(1) = 0.05$). However, the children who did not take part in the follow-up study had a significantly higher developmental quotient (DQ), as measured with the Mullen Scales of Early Learning (MSEL; Mullen, 1995) Early Learning Composite score, than children who participated in the current study, $F(1,31) = 17.36$, $p < .001$, $\eta^2 = .36$. There were clear developmental delays present in children whose parents were willing to take part in the follow-up study (M_{DQ} = 68.23, *SD* = 18.56), possibly leading to more motivated participation in the study, driven by parental concerns. For the majority of children who did not take part in the current study, such obvious developmental problems were not present (M_{DQ} = 94.38, *SD* = 17.41).

The children ranged in age from 17.23 to 38.60 months (M_{age} = 25.78 months, *SD* = 5.84) at the beginning of the study. They all had an elevated risk for ASD based on a positive screen on at least one of the screening instruments used: the Checklist for Early Signs of Developmental Disorders (CESDD; Dereu et al., 2010), the Early Screening of Autistic Traits questionnaire (ESAT; Dietz, Swinkels, van Daalen, van Engeland, & Buitelaar, 2006; Swinkels et al., 2006), the First Year Inventory (FYI; Reznick, Baranek, Reavis, Watson, & Crais, 2007), the Modified Checklist for Autism in Toddlers (M-CHAT; Robins, Fein, Barton, & Green, 2001), and/or the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) (for more details, see Dereu et al., 2011). These children were

[1] One child received a working diagnosis of ASD at age 2 that could not be confirmed at age 4 with the Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003). The other child was highly suspected of ASD based on an autism classification on the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) at age 2 and meeting ADI-R criteria for autism at age 4, but for this child parents declined further evaluation at an independent autism clinic, so no formal diagnosis could be made

prospectively followed by 6-monthly assessments until they were 4 years old (M_{age} = 49.14 months, *SD* = 1.47).

During their participation in this follow-up study, nine children received a diagnosis of ASD after referral to a university based autism clinic in Flanders. At about 48 months, this diagnosis was confirmed with the ADOS (Lord et al., 1999) and the Autism Diagnostic Interview – Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003). Both ADI-R and ADOS were administered and scored by the first author, a clinical psychologist, trained and certified to use these instruments. All children in the ASD group scored above the cut-offs for ASD on the new ADOS scoring algorithms (Gotham, Risi, Pickles, & Lord, 2007) and came within one point on ADI-R social and communication domains, or met the ADI-R autism cut-off on one domain and came within two points on the other (see Risi et al., 2006). Four children within the ASD group were also diagnosed with an intellectual disability. In addition, two children with ASD showed a delayed general development at the initial assessment, which was not longer apparent at age 4.

The remaining eight children received no diagnosis of ASD, but all showed a delay in their general development at initial assessment (Early Learning Composite scores > 1 *SD* below average; Mullen, 1995). Two of them were diagnosed with an intellectual disability and another four children were diagnosed with general developmental delay in a university based clinic for developmental disorders during their participation in the current study. The remaining two children without ASD received no diagnosis.

There were more boys than girls in the ASD group (six boys and three girls), whereas there were as many boys as girls in the non-ASD group (four boys and four girls), although this difference was not significant, $\chi^2(1) = 0.49$, $p = .637$. All children came from families with middle to high socio-economic status (Hollingshead, 1975), M_{ASD} = 43.00, SD_{ASD} = 4.58 and $M_{non\text{-}ASD}$ = 43.50, $SD_{non\text{-}ASD}$ = 5.95), $F(1,15) = 0.01$, $p = .947$.

2.2 Measures

2.2.1 Mullen Scales of Early Learning (MSEL; Mullen, 1995)

This instrument assesses the cognitive functioning of children between 0 and 68 months. Normative scores are provided for the five subscales of the instrument: Gross Motor, Visual Reception, Fine Motor, Receptive Language, and Expressive Language. For this study, only age equivalents (AEs) for the language subscales were used. AEs were chosen because of the easy comparison of the current sample with the mean of the normative sample of the MSEL (N = 1849) for every age group. The MSEL also yields a standard score representing general development that was used in this study as a developmental quotient (DQ): the Early Learning Composite score (ELC; M = 100, SD = 15).

2.2.2 Early Social Communication Scales (ESCS; Mundy et al., 2003)

This structured observation procedure of about 20 minutes was developed to assess individual differences in nonverbal communication skills that typically emerge in children between 8 and 30 months of age. For the current study, the entire ESCS was administered by the first author, but only tasks that measure joint attention behaviours were coded from the videotapes by raters blind to the diagnoses. A complete description of the test procedure is available elsewhere (see Mundy et al., 2003).

In this study, data from the ESCS measures of initiating joint attention (IJA) and responding to joint attention (RJA) were examined. IJA was measured by the relative frequency (rate per minute) of four behaviours: (1) making eye contact with the examiner while manipulating a toy, (2) alternating gaze between an active mechanical toy and the examiner, (3) pointing to an active mechanical toy or other object with or without eye contact, and (4) showing by raising objects towards the examiner's face with eye contact. The IJA_{tot} score reflects the relative frequency of all four behaviours and the IJA_{ratio} score reflects the ratio of the frequency of the pointing and showing behaviours (which are considered to be of a higher developmental level) to the total frequency of IJA behaviours. The *RJA* variable reflects the percentage of trials where children correctly turned their

line of regard in the direction of that of the examiner's visual regard and pointing gesture towards the posters.

Coding of the ESCS tasks was carried out using The Observer XT version 9.0 (Noldus, 2009) by two independent coders, master psychology students, blind with respect to diagnosis of the child. Interrater reliability was determined with single measure intraclass correlations (ICC) computed by double coding 20.69% of the videos. The interrater reliabilities were .87 for IJA_{tot}, .90 for IJA_{ratio}, and .93 for RJA.

2.2.3 Preschool Imitation and Praxis Scale (PIPS; Vanvuchelen, 2009)

This test assesses motor imitation abilities of children between 12 and 60 months old and is comprised of 30 items that measure both bodily imitation (i.e., imitation of actions without objects, either gestural or facial) and procedural imitation (i.e., imitation of action with objects). Items are chosen to assess meaningful and non-meaningful bodily imitation as well as goal directed and non-goal directed procedural imitation. AEs can be computed based on a normative sample of 654 typically developing children. For the current study, the AEs for the separate subscales (bodily imitation and procedural imitation) were used.

2.2.4 Test of Pretend Play (ToPP; Lewis & Boucher, 1997)

This test assesses functional and symbolic play development of children between 12 and 72 months by a structured observation of play with representational and non-representational materials. Items target substitution, property attribution, reference to an absent object and scripted play. Raw total scores for the total test can be converted into AEs, derived from a normative sample of 513 children. For children younger than 36 months, there is a nonverbal version in which item instructions are mostly replaced by modelling. The verbal version is for children older than 36 months with sufficient receptive language to follow test instructions. For the current study, the appropriate version was administered according to the language level of the child.

2.3 Procedure

Children were invited for a first assessment at the university lab as soon as possible after they were screened for ASD within day-care centres and with parent questionnaires (for further details, see Dereu et al., 2011). This assessment consisted of the ADOS, to assess the possibility of ASD, and the MSEL to measure the general developmental level and language abilities of the child. Three children could not move around freely in the test room during the first assessment, which is required for administration of the ADOS. For these children, the ADOS was replaced by the ESCS to get a first impression of their social-communicative behaviour. The ADOS was administered 6 months later for one of the three children who was suspected of ASD. This first assessment was carried out by one of five members of our research team, who were all officially trained in administering and scoring the ADOS. Based on the results of the initial assessment and clinical judgment of the research team, children were referred to a university based autism clinic or centre for developmental disorders, if necessary.

Following the initial assessment, children were seen for follow-up assessments with time intervals of at least 6 months until they were 4 years old. These follow-up assessments were carried out by the first author and consisted of measurements of their social communicative abilities with the ESCS, PIPS, and ToPP in this fixed order. In addition, the MSEL was repeated to assess overall development and language of the children. When children were too tired or unwilling to cooperate in further testing, the MSEL was administered during a home visit on average eight days after the assessment at the university lab (for an overview of number of assessments and ages at MSEL assessment, see Table 1). At age 4, the ADOS was repeated for all children in a separate session and the ADI-R was administered to all parents of children with a diagnosis of ASD. The results of the ADOS and ADI-R are shown in Table 2.

Informed consent was obtained from all parents prior to participation. This study was approved by the Ethics Committee of the Faculty of Psychology and Educational Sciences of Ghent University, Belgium, where the study was conducted.

2.4 Analyses

Results on the different measures used in this study, were plotted on a diagram. The developmental trajectories of the targeted skills were visualized separately for each individual, with the *X*-axis showing the age (in months) of the child at the time of measurement and the *Y*-axis showing the score of the child. All available data were used to estimate the individual trajectory, with two to six measurements per individual (see Table 1). Whenever data on the norm population of standardized tests was available, a reference line was drawn on the XY-diagram representing the average performances of typically developing children. No smoothing techniques such as spline models or polynomial regression (see Simonoff, 1996) were used on the individual trajectories to allow for visual inspection of intra- and interindividual variability. To quantify variability, coefficients of variation (*CV*s) were calculated. Often standard deviations (*SD*s) are used to describe variability in a sample. However, comparing *SD*s of different subsamples is problematic because the *SD* is very sensitive to the mean in a sample with higher means usually resulting in higher *SD*s. In order to solve this issue, the *CV* is often used: the *SD* of a sample divided by its mean (van Geert & van Dijk, 2002).

To compare developmental trajectories on a group level, a series of mixed design analyses of variance (ANOVAs) were conducted with Time (T_1 or T_2) as within-subjects factor and Group (ASD or non-ASD) as between-subjects factor. Because of the different number of assessments for the children, two time points were chosen for which data for most children was available and with a maximal time interval between successive time points (see Table 1). Children were on average 35.46 months old (*SD* = 2.36, *n* = 15) at the first time point (T_1) when the ESCS, PIPS, and ToPP were administered and about 35.88 months old (*SD* = 1.99, *n* = 17) when the MSEL was administered. At the second time point (T_2), children were 48.87 months old (*SD* = 1.45, *n* = 17) when the ESCS, PIPS,

and ToPP were administered and 49.14 months old (*SD* = 1.47, *n* = 17) when the MSEL was administered. Groups did not differ in ages at these two time points and in time interval between the two time points, all *F*-values < 1. When assumptions for parametric testing were violated, nonparametric tests were performed. To compare the two groups at each time point, we used the Kolmogorov-Smirnov *Z*-test, which yields higher power than the Mann-Whitney *U*-test when sample sizes are smaller than 25 (Field, 2009). The effect of Time was tested with the Wilcoxon signed-rank test. Finally, difference scores were computed by subtracting scores for the dependent variable at T_1 from scores at T_2. Kolmogorov-Smirnov *Z*-tests were conducted on these difference scores to test for differences in trajectories between the two time points for the two groups.

3. Results

3.1 General development

Nonparametric tests revealed that there were no significant differences between the two groups in DQ at T_1, z = 0.69, p = .559, r = .17, or at T_2, z = 0.89, p = .270, r = .21. For the total at-risk group, DQ increased with time, z = -2.05, p = .040, r = -.50. This increase was similar in the two groups, z = .69, p = .529, r = .17.

Looking at the individual trajectories of the DQ for all cases (see Figures 1a and 1b), most children showed an increase in the standard score reflecting their overall development over time, with the exception of two children with an intellectual disability (cases K and Q) in the non-ASD group and four children in the ASD group for which the DQ also remained more than 2 *SD*s below average (cases C, E, F, and I).

In the non-ASD group, all measures of developmental level prior to about 30 months (when the children were first seen at the university lab) were at least 1 *SD* below average. This demonstrates in this prospective sample that the children who were falsely identified as at high risk for ASD based on screening results all showed general developmental delays at initial assessment.

With growing age, the interindividual differences in this comparison group became more apparent, with a great variability in DQ at age 4, when the longitudinal study was finished. The interindividual variation quantified in the *CV* at the final assessment was .32 for the non-ASD group.

For the ASD cases, the *CV* was .45 at the final assessment, somewhat higher as seen in the non-ASD group. Visual inspection of the individual trajectories showed that the group seemed to be divided into two subgroups: the four children for whom the DQ remained very low versus the remaining five children who all had DQs of over 1 *SD* above average at age 4. The first subgroup (cases C, F, G, and I) all had ADOS severity scores at age 4 within the autism range. The second subgroup (cases A, B, D, E, and H) comprised three children with severity scores at age 4 within the autism spectrum, but also two children with severity scores at age 4 well within the autism range (see Table 2). So the more severe symptom presentations within the autism spectrum were not only seen in children with a lower DQ, but also in high functioning children (e.g., case H had a DQ of 136 at age 4 while at the mean time his severity score was 8, almost the highest number in this sample). For this high-functioning subgroup, the DQ was within normal range for all five children around 30 months. The only two children with measures prior to this age had DQs well below average when they were between 18 and 30 months and their DQ also reached the normal range between 30 and 36 months.

3.2 Language development

Nonparametric tests revealed that there were no significant differences between the two groups in language AEs at T_1, $z = 0.63$, $p = .572$, $r = .15$, and $z = 0.66$, $p = .594$, $r = .16$, for receptive and expressive language respectively. Also, there were no group differences in language AEs at T_2, $z = 0.66$, $p = .589$, $r = .16$, and $z = 0.69$, $p = .563$, $r = .11$, for receptive and expressive language respectively. For the total at-risk group, both receptive and expressive language AEs increased with time, $z = -3.63$, $p < .001$, $r = -.88$, and $z = -3.62$, $p < .001$, $r = -.88$ respectively. This increase was

similar in the two groups, z = .46, p = .915, r = .11 for receptive language, and z = .43, p = .919, r = .10 for expressive language.

The individual trajectories of the AEs for receptive and expressive language are shown in Figures 1c-f. For *receptive language*, most children showed about the same rate of change as seen in typically developing children. For the ASD cases, all children with a low DQ (cases C, F, G, and I) had a slower growth rate in their receptive language ability compared to typically developing children, whereas only one child with an intellectual disability in the non-ASD sample (case K) showed a slower growth rate. Children with ASD who reached a normal DQ after 30 months also had receptive AEs above the mean by the time they were 4 years old. In contrast, of the children in the non-ASD group, only the two children with the highest DQs (cases M and 0) scored above the mean of the normative sample, with most other children showing a somewhat delayed developmental pattern. For *expressive language*, the patterns that emerged were somewhat different from receptive language and more in concordance with those seen for the DQ. There was more variability seen in growth trajectories for the two groups compared to the trajectories for receptive language. This finding is reflected in the *CV*s at T_2: for receptive language, the *CV*s were .43 and .26 for children with ASD and without ASD respectively, whereas for expressive language, the *CV*s were somewhat higher at .51 and .36. For both receptive and expressive language, the *CV*s were slightly higher in the group of children with ASD compared to non-ASD cases. Some children had slower growth rates for expressive language compared to their receptive language growth rate (e.g., cases C and Q), whilst other children had a faster growth in expressive language compared to their receptive language development (e.g., cases B and P). Especially in the group of ASD cases with higher DQs, children seem to catch up with their typically developing peers for expressive language development, whereas this growth spurt was less apparent for their receptive language.

3.3 Social communicative development

3.3.1 Imitation

Comparing group means with mixed ANOVA, for both bodily and procedural imitation, the main effect of Time was significant, $F(1,13) = 15.55$, $p = .002$, $\eta^2 = .54$, and $F(1,13) = 37.74$, $p < .001$, $\eta^2 = .67$, respectively. There was however no main effect of Group, $F(1,13) = 0.04$, $p = .839$, $\eta^2 = .00$ for bodily imitation, and $F(1,13) = 0.65$, $p = .433$, $\eta^2 = .05$ for procedural imitation. For bodily imitation, also the interaction effect of Time x Group was not significant, $F(1,13) = 0.14$, $p = .715$, $\eta^2 = .00$. However, for procedural imitation, the interaction effect was significant, $F(1,13) = 5.25$, $p = .039$, $\eta^2 = .09$. Looking at the estimated marginal means, it seems as if children without ASD had better procedural imitation performances at T_1 compared to children with ASD, but children with ASD showed a higher rate of change, resulting in similar performances for children with and without ASD for procedural imitation at T_2.

The repeated measures of the imitation skills for each individual are shown in Figures 2a-d. These figures illustrate not only the great interindividual differences in imitation ability in the current at-risk sample, but also the intra-individual variability (i.e., the variability between consecutive measures within an individual). While some children with and without ASD showed about the same linear growth trajectory in their AEs as the norm population of the PIPS (e.g., cases F and M for bodily imitation, see Figures 2a and 2b), other children did not show an easily interpretable trajectory since they sometimes performed worse on the PIPS than at the previous assessment at least 6 months sooner (e.g., cases A and N for procedural imitation, see Figures 2c and 2d). This variability in the data makes it hard to draw conclusions at the group level from Figures 2a-d.

For *bodily imitation* (Figures 2a and 2b), no clear group differences between cases with ASD and non-ASD cases could be found through visual inspection of the individual trajectories, since most children in both groups performed at each measure well below or around the reference line (i.e., the results of the norm population of the PIPS, so the average performance of a typically developing child of the same chronological age). However, for *procedural imitation* (Figures 2c and 2d), there seemed to be much more children without ASD who performed above the reference line in comparison to the ASD cases. Within the non-ASD subgroup, even some children with a profound

intellectual disability showed performances around the reference line (cases K and Q), whereas children who were developmentally delayed at the start of the study mostly performed above the reference line (cases L and P). Also, performances on procedural imitation in the non-ASD cases were better than for bodily imitation. Such a distinction was not apparent in the ASD cases. For the ASD cases, the trajectories for bodily and procedural imitation were more alike. In addition, for the non-ASD cases, the *CV* for procedural imitation was .24, which was lower than the *CV* for bodily imitation of .42. For the ASD cases, the variability for bodily and procedural imitation at the final assessment was more alike: *CV*s were .43 and .37 respectively. Comparing these *CV*s across groups, the variability for ASD and non-ASD cases was comparable for bodily imitation, whereas for procedural imitation this variability was greater in the ASD group.

3.3.2 Pretend play

A main effect of Time was found for this skill between T_1 and T_2, $F(1,13) = 17.48$, $p = .001$, $\eta^2 = .56$. So, in this at-risk sample, a growth in pretend play ability was evident. This growth over time was similar for the two subsamples, because the interaction effect of Time x Group was not significant, $F(1,13) = 0.48$, $p = .503$, $\eta^2 = .02$. Also, there was no main effect of Group found in this at-risk sample, $F(1,13) = 0.44$, $p = .440$, $\eta^2 = .05$.

The performances of all children in their ability to engage in pretend play are shown in Figures 2e and 2f. Again, the individual trajectories of some children (e.g., cases A and O) demonstrate that children sometimes performed worse on the ToPP than they did during the previous assessment, although this intra-individual variability was more apparent for the imitation skills. Overall, most individual trajectories in pretend play development show about the same growth rate as was apparent in the normative sample of the ToPP, although it appeared that children with ASD showed in general less pretend play on the ToPP than the children without ASD did.

Within the non-ASD group, performances seemed to be in line with their DQ and language level. For the ASD cases, this was not the case. For example, Case B showed a performance in line

with his DQ and language level, whereas case A had at every age about the same low AE for pretend play although he showed about the same increase in his DQ and language level as was seen in case B. The same observation can be made in children who continued to have a low DQ within the ASD subsample: Whereas case F and G have about the same low DQ, case F performed better on the ToPP than case G (see Figure 2e). Overall, for pretend play, the interindividual differences seemed to be greater in the ASD group in comparison to the non-ASD cases. This was reflected in the *CV*s: For the ASD group the interindividual variation was .43, whereas for the non-ASD cases the CV was somewhat lower at .30.

3.3.3 Joint attention

3.3.3.1 Initiation of joint attention

Mixed ANOVA revealed a marginally significant main effect of Time for the total amount of IJA behaviours initiated by the children, $F(1,13) = 3.83$, $p = .072$, $\eta^2 = .20$. In contrast, the main effect of Group was not significant for IJA_{tot}, $F(1,13) = 0.76$, $p = .399$, $\eta^2 = .06$. Also, no significant interaction effect of Time x Group was found for IJA_{tot}, $F(1,13) = 1.93$, $p = .189$, $\eta^2 = .10$. The Kolmogorov-Smirnov *Z*-test showed that there were no group differences found for IJA_{ratio} at T_1, $z = .86$, $p = .373$, $r = .22$, or at T_2, $z = .54$, $p = .860$, $r = .13$. Also, a growth over time in the ratio of higher level IJA behaviours to total amount of IJA was not found for the total at-risk group, $z = -0.80$, $p = .454$, $r = -.21$. Finally, there were no group differences found in the growth in IJA_{ratio} between the two time points, $z = .62$, $p = .736$, $r = .16$.

Figures 3a and 3b show the total *amount* of behaviours used to initiate joint attention by each child in rates per minute. In both groups, children showed during the ESCS between zero and six IJA behaviours per minute. Also, number of total IJA behaviours seemed not to be related to DQ with many IJA behaviours in some cases with low DQ (e.g., cases C and Q) and less frequent IJA behaviours in some cases with high DQ (e.g., cases B and M). Looking at the graphs, most of the non-ASD cases showed every assessment between 1.50 and 3.50 IJA behaviours per minute. There was

no obvious increase or decrease in this number between 18 and 54 months, although the inter-individual variation seemed to be larger at the final assessment around age 4, at which point the *CV* was .56 and scores ranged from about 1.00 to 6.00 rates/min. In contrast, for most of the children with ASD there was a larger interindividual variability with scores ranging from 0.25 to 4.00 rates/min at the first assessment, but at the final assessment this variability seemed to be comparable to that seen in children without ASD, the *CV* was .52 and scores also ranged from about 1.00 to 6.00 rates/min. There also seemed to be an increasing number of IJA behaviours between 36 and 54 months old in children with ASD. Only two children, cases A and B, showed less than two IJA behaviours per minute at each assessment.

The overall *quality* of IJA was expressed by a ratio score, which represents the percentage of behaviours of a higher developmental level to IJA relative to the total amount of IJA behaviours used by the child (see Figures 3c and 3d). Again, there seemed to be less interindividual variability in the non-ASD cases compared to the group of children with ASD, although at the final assessment about an equal amount of variability was present in both groups, *CV*s were .75 and .70 for cases with and without ASD, respectively. For both groups, there was substantial variability within individuals over different assessments (e.g., case A showed no higher level behaviours at the first assessment and about 70% of his IJA bids 6 months later were of a higher developmental level [although the total amount of IJA remained low for this child], see Figure 3c). Because of this great variability between and within cases, no clear developmental trajectory in the quality of IJA behaviours could be detected.

3.3.3.2 Response to joint attention

To compare the RJA of the two groups, nonparametric tests were used. There was no effect of Time on RJA, z = -0.11, p = .916, r = -.03. Also, no group differences were found in the RJA performance at T_1, z = 0.59, p = .452, r = .15, or at T_2, z = 0.57, p = .430, r = .14. However, there was a marginally significant difference between the two groups in the computed difference score, z = 0.97,

p =.077, *r* = .25. There seemed to be a greater raise in RJA scores in the ASD group compared to the non-ASD cases.

Looking at the individual trajectories of *RJA* between 18 and 54 months (see Figures 3e and 3g), almost all cases (with ASD or without the disorder) followed the distal point of the examiner in over 85% of the bids on at least one assessment. Only two cases responded less well to these RJA bids of the examiner: case G and Q. Both children had very low DQs at each assessment. At the final assessment, the interindividual variability seemed somewhat higher in the non-ASD group, *CVs* were .23 and .33 for the ASD and the non-ASD cases, respectively. Due to ceiling effects, no obvious developmental trajectory for RJA could be seen in this age group, although in some children intra-individual variability could still be noticed (e.g., cases A and L).

4. Discussion

The main objective of the current study was to investigate the developmental trajectories of imitation, joint attention, and pretend play. We adopted an explorative approach in which we looked at the individual trajectories of an at-risk sample for ASD.

4.1 Social communicative development and its relation to general or language development

Our first aim was to explore the individual trajectories of social communicative skills and to look if their development was intertwined with general development or language. Clear parallels between social communicative development and general development or language development, as sometimes suggested by other findings (e.g., Charman et al., 2000; Stone, Ousley, & Littleford, 1997; for findings of no clear relation between amount of change in social communicative development and change in language, see Anderson et al., 2007) were not so apparent at the individual level. For example, some non-ASD cases with low DQs performed at least average on imitation tasks, while

other cases with ASD, a high DQ, and above average language skills performed rather poorly on pretend play tasks.

4.2 Variability in developmental trajectories

Second, we studied the variability in social communicative competence, general development, and language in this at-risk sample. Variability between children was sometimes larger in the ASD cases compared to the non-ASD cases, for instance for pretend play development. For DQ, great variability between non-ASD cases was always present and seemed to increase over time, whereas for ASD-cases, there seemed to be a clearer distinction between two subgroups: one group of children who were initial developmental delayed, but showed a large growth rate resulting in normal to high scores by the time they were 4 years old, and one group of children who remained intellectually disabled. To a somewhat lesser extent, the same patterns of growth were evident for the language development. Such greater heterogeneity in individual trajectories for children with ASD compared to children with other developmental disorders was also noticed by Anderson and colleagues (2007) for growth in verbal abilities. In addition, these authors also acknowledged from visual inspection of the individual trajectories that the distributional pattern for the autism group seemed bimodal with more individuals clustered at the high and low ends.

Next to the interindividual variability in the growth patterns of the DQ, language skills, imitation, joint attention, and pretend play skills, there was also great intra-individual variation present across time points for some cases. Although this variation is often seen as measurement error, it may also reflect the fact that development is in nature nonlinear (van Geert & van Dijk, 2002). A more dynamic approach to development regards variability as an essential element in the developmental process which indicates forthcoming change: Intra-individual variability is large during a developmental transition. Also, dynamic systems theory tells us that children may function at different levels of development at the same time and that children may therefore not always perform on tasks to their best abilities, with dips in their trajectories noticed before a developmental

transition is made (Thelen & Smith, 1993). This is often forgotten in the interpretation of test results, but remains however very important to acknowledge. For clinical practice, this intra-individual variance means that one should interpret AEs on standardized tests like the PIPS and ToPP with caution (see also Oud & Mommers, 1990). For example, Vanvuchelen and Vochten (2011) showed that when the PIPS is administered repeatedly, only total scores that differ more than 6 points represent actual change over measurement error. Between 36 and 48 months, this represents a difference of about 6 months in age equivalents and implies that a measurement at one time point may be 6 months off in the estimation of the AE. Although using the PIPS and ToPP may have some value in the diagnostic process (Lewis, Boucher, Lipton, & Watson, 2000; Vanvuchelen, Roeyers, & De Weerdt, 2011), assessments with a duration of about half an hour may be insufficient to measure the true developmental level of a child. Ideally, longitudinal research with more occasions per individual (e.g., every two weeks) is needed to assess the fluctuations in performances and thereby the true range of abilities. However, this would ask for more naturalistic observations of social communicative abilities to prevent learning effects of repeated testing with standardized tests.

4.3 Delayed versus deviant social communicative development in children at risk for ASD

By exploring the individual trajectories of social communicative development, we also wanted to see if this development was delayed or deviant in children at risk for ASD. Because we used standardized test to measure imitation, joint attention, and pretend play, the results of our cases could be compared with the results of the normative samples, if available. When we looked at the imitation and pretend play development displayed in Figure 2, it was very clear that there is great variability in growth rates within this at-risk sample. Some children in both groups (so with or without ASD) seemed to develop at the same rate as the normative sample (see Lewis & Boucher, 1997; Vanvuchelen, 2009), although they achieved lower scores. This indicates a delayed development, as some authors concluded about the social communicative development found in children with ASD (Carpenter et al., 2002; Rutherford et al., 2007; Williams et al., 2004). However,

other children developed clearly at a slower rate, or seemed not to improve in score at all, indicating a deviance from the typical developmental trajectory. This was especially noticed in children with very low DQs, in both ASD and non-ASD cases.

For joint attention measures (see Figure 3), no normative sample was available to compare our results to. Although the ESCS has been used to study joint attention development longitudinally, these studies were primarily conducted in much younger children (e.g., Mundy et al., 2007), because the targeted behaviours of the ESCS normally develop between 8 and 30 months. However, Schietecatte (2010) studied the development of joint attention skills longitudinally in a group of typically developing children between 12 and 36 months of age. She found no increase in the total amount of IJA between 12 and 36 months, with an average of 3.5 IJA bids per minute. However, she found a significant increase in the ratio score of higher level IJA to total amount of IJA behaviours over time. Our results between 36 and 48 months are exactly the opposite: There was no effect of Time for the ratio score of higher level to total amount of IJA, whereas the total amount of IJA did increase in the at-risk group. This difference in findings may originate from the differences in ages of the children. For RJA, both Schietecatte (2010) and our data showed ceiling effects. In fact, in typically developing children, over 85% of children were able to follow gaze from 24 months onwards (Schietecatte, 2010).

4.4 The choice of method for analysing data

Finally, we wanted to compare results of more commonly used statistical tests with the information derived from visually inspecting the graphical representations of the individual trajectories. Analyses in which group means were compared or nonparametric alternatives based on ranking test scores only indicated that there was growth present in this at-risk group in their imitation ability, pretend play skills, total amount of initiated joint attention behaviours, DQ, and language measures. Regarding group differences in growth rate between the two time points, analyses revealed that children with ASD had a higher rate of change than children without ASD in

their procedural imitation capacity and in their responses to joint attention. For both skills, children with ASD seemed to catch up with their peers by the time they were 4 years old. However, no significant group differences were found in imitation, joint attention, or pretend play. So, little differences were found between children with ASD compared to at-risk children without ASD in the developmental trajectories of their social communicative skills. This is in contrast with studies that showed how impairments in imitation, joint attention, and pretend play could clearly discriminate children with ASD from developmentally delayed or typically developing children (e.g., Baron-Cohen, Allen, & Gillberg, 1992; Osterling & Dawson, 1994; Robins et al., 2001). However, our sample comprised of an at-risk sample: All children screened positive for ASD on a screening instrument early on in life. Since most screening instruments incorporate items about the social communicative skills, it is possible that the children without ASD in this sample still showed some atypical social communicative development early on in life. For example, Toth, Dawson, Metzoff, Greenson, and Fein (2007) examined the early development of non-autistic siblings of children with autism and found evidence of impaired social communicative skills in these children from 14 months onwards compared to toddlers with no family history of autism.

However, without visually inspecting the individual trajectories, the only conclusion we could make based on the current sample, was that there was growth in social communicative skills between 36 and 48 months. The analyses cannot give us insight in the individual differences in this growth or tell us if development is rather delayed or deviant for a certain individual. Therefore, visual inspection of the individually plotted developmental trajectories and comparison with a norm population is needed.

4.5 Limitations and directions for future research

As stated in the introduction, this study was exploratory in nature. Therefore, the sample was comprised of a limited number of cases. Replication of this research in a larger sample is needed. Also, larger samples would enable other statistical methods like latent class growth analysis, which

tries to find subclasses of children from individual trajectories with about the same rate of change (Hox, 2002). Such statistical methods might give some insight into the factors that influence the individual differences in growth patterns in social communicative development found in this exploratory study.

Also, because of the prospective nature of this follow-up study after screening positive for ASD, matching cases who eventually were diagnosed with ASD to cases without the disorder but with similar intellectual or language capacities was not possible. As a result, differences found in social communicative development may (partially) be attributed to differences in general development or language level. The current results need to be replicated within larger samples of at-risk children with a large range in language and intellectual capacities.

Another shortcoming of the current study is the large attrition rate. Next to children who were excluded from the study, for various reasons, a lot of parents declined participation to the follow-up study. A closer look at the available data of all children, who were offered participation to the current study, showed that the developmental quotient of children who did participate in the follow-up was significantly lower than that of children who did not take part in the study. It is possible that parents of children who once screened positive for ASD, but had developmental quotients well within the normal range, saw no reason to invest their time in the study or to put their child to the burden of 6-monthly assessments. Therefore, caution is warranted when generalizing the current results to all children with a positive screen for ASD. Further research, in which children with a positive screen for ASD but without early developmental delays are also included, is necessary.

In addition, all children in the study came from families with middle to high SES, which was expected, since the cases were drawn from a screening project in children attending day-care centres in Flanders. Especially higher educated mothers rely on child minding facilities in Flanders (Vanpée, Sannen, & Hedebouw, 2009). It is possible that the results are not generalizable to children from families with a lower SES.

Finally, we chose to administer standardized tests. As a consequence, these tests could not be administered more frequently because of the risk for learning effects. However, to measure the true competence and learning curve of an individual more accurate, more occasions are needed. Future research should also consider measuring social communicative abilities within more naturalistic observations and with smaller time intervals between consecutive measurements.

4.7 Conclusion

Taken together, the current findings suggest that it is difficult to sketch an overall picture of the social communicative development of children at risk for ASD, because of the great interindividual and intra-individual variation in social communicative abilities. The study illustrates the importance of looking at this variability instead of only comparing group means in studying these abilities and shows that impairments in social communicative abilities are neither universal nor specific to children with ASD. The group of children with ASD is very heterogeneous, maybe more so than typically developing children. The current results stress the importance of an individual approach for children with ASD. Also, these results indicate that it is not feasible to address the issue of a delayed versus a deviant social communicative development based on analyses that compare group means of children with ASD and children with other developmental disorders or typical development. Both profiles were evident in the current sample and will probably be present in each sample of children with ASD.

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Table 1

Overview of number of assessments and age at administration of the Mullen Scales of Early Learning (MSEL; Mullen, 1995)

Number of assessments		6	5	4	3	2	1
ASD cases	Case A		20.90	26.00	34.67	42.33	49.87
	Case B		18.87[a]	26.40[b]	33.13	39.80	48.57
	Case C				36.10	44.00	49.00
	Case D			31.40	37.90	44.47	50.30
	Case E			29.27	38.97	45.57	51.33
	Case F			24.33	33.90	-[c]	48.33
	Case G		23.67	-[c]	36.13	41.97	47.80
	Case H			27.90	34.20	40.83	46.67
	Case I				38.60	45.17	52.03
Non-ASD cases	Case J			25.20[a]	35.27	40.90	47.63
	Case K		22.27[a]	30.43	36.10	-[c]	47.93
	Case L		17.23	24.20	32.13	40.93	48.03
	Case M	19.63	25.50	32.53	37.00	43.53	49.07
	Case N		25.00	31.40	37.43	44.10	51.30
	Case O		23.00	28.67	34.77	40.60	48.70
	Case P		25.17	32.97	38.50	44.97	50.40
	Case Q			29.80	35.17	41.80	48.73

[a] These children could not move around freely through the test room at the initial assessment. Therefore, in addition to the MSEL, the Early Social Communication Scales (ESCS; Mundy, Delgado, Block, Venezia, Hogan, & Seibert, 2003) was administered instead of the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999).

[b] For this child, in addition to the MSEL and measurements of social communicative abilities, also the ADOS was administered.

[c] These children were invited for a following assessment approximately 6 months after the last assessment. However, the parents of the children chose to skip this one assessment because of time constraints.

Table 2

Overview of the results on the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) and Autism Diagnostic Interview-Revised (ADI-R, Rutter, Le Couteur, & Lord, 2003)

		ADI-R Soc [a]	ADI-R Com [b]	ADI-R RRB [c]	ADI-R onset [d]	ADOS initial [e]	ADOS final [e]
ASD cases	Case A	16	11	5	4	6	9
	Case B	18	11	4	4	4	5
	Case C	12	5	5	5	4	5
	Case D	9	11	8	3	6	5
	Case E	10	8	7	3	6	6
	Case F	16	5	13	5	6	6
	Case G	20	12	7	5	7	6
	Case H	11	7	6	3	1	8
	Case I	11	13	2	3	6	7
Non-ASD cases	Case J	-	-	-	-	-	3
	Case K	-	-	-	-	-	5
	Case L	-	-	-	-	4	1
	Case M	-	-	-	-	1	2
	Case N	-	-	-	-	1	3
	Case O	-	-	-	-	4	2
	Case P	-	-	-	-	1	1
	Case Q	-	-	-	-	1	2

[a] *Soc* = Social interaction score with a cut-off score of 10 or above.

[b] *Com* = Communication score with a cut-off score of 7 or above for nonverbal children and a cut-off score of 8 or above for children with phase speech.

[c] *RRB* = Repetitive and Restrictive Behaviours score with a cut-off score of 3 or above.

[d] Cut-off score of at least one of the abnormalities apparent before age 3.

[e] Scores represent autism severity scores with scores 1-3 representing non spectrum severity of symptoms, 4-5 autism spectrum severity, and 6-10 severity of symptoms as seen in autism (Gotham, Pickles, & Lord, 2009).

Figure captions

Figure 1. Individual trajectories of developmental quotients and language development between 18 and 54 months.

Figure 2. Individual growth in imitation and pretend play skills between 24 and 54 months.

Figure 3. Individual differences in joint attention behaviours between 18 and 54 months.