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ORIGINAL ARTICLE

Social-communicative and attention problems in infancy and toddlerhood as precursors of preschool autistic traits

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Abstract
This longitudinal study focused on early behavioural problems and autistic traits. In a stratified, population-derived sample of 119 children, mothers reported through questionnaires on externalizing, internalizing, and social-communicative characteristics of their child in infancy (14 months) and toddlerhood (37 months), and on autistic traits at preschool age (4–5 years). Children with consistently normal behaviour from infancy to toddlerhood showed lower autistic traits at preschool age than children with deviant behaviour on one or both time points. High autistic traits at preschool age were predominantly preceded by problems in interaction, communication, language, play, and affect in infancy and/or toddlerhood, but also by inattention in toddlerhood. Adequate support and specific interventions in these domains are needed in an attempt to diminish further derailment of the child's behaviour and development, and to prevent the full manifestation of ASD or related disorders such as ADHD.

Keywords Social-communicative problems · Inattention · Autistic traits · Early childhood · Longitudinal transition · General population

Introduction

Autism spectrum disorders (ASD) are characterized by serious impairments in communication and social interaction as well as by stereotyped and repetitive interests, behaviours, and activities that mostly have their onset in the first years of life (American Psychiatric Association 2013). In severe forms and nearly always in combination with general developmental delay, autistic traits are already clearly detectable within the first two years after birth, for instance, when babbling, pointing, or gesturing is absent, the response to contextual cues, initiation of social interaction, or play is limited, appropriate eye contact or gaze is lacking, and/or repetitive movements with the body or objects are made (Jones et al. 2014; Nadel and Poss 2007; Saint-Georges et al. 2010; Volkmar et al. 2005; Yirmiya and Charman 2010). For milder forms of ASD, which tend to be diagnosed at a later age, detection of autistic traits in infancy or toddlerhood is more complicated. Children with milder forms are usually higher functioning, and may initially display only few and subtle symptoms (Ozonoff et al. 2015). Moreover, it is possible that these milder social-communicative problems are preceded or accompanied by more obvious externalizing behavioural problems outside the core domains of ASD, as overlap in risk factors and presentation with other neurodevelopmental disorders like attention-deficit hyperactivity disorder (ADHD) appears substantial (Johnson et al. 2015; Leitner 2014; Mayes et al. 2012; Van der Meer et al. 2012; Visser et al. 2013).

Most studies on the precursors and early identification of ASD have been conducted in clinical samples, referred

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samples, or genetically high-risk groups (i.e. baby siblings of older children diagnosed with ASD) (Brian et al. 2015; Oosterling et al. 2010; Sacrey et al. 2015), whereas milder or later-emerging expressions of ASD in general population samples have received less attention (Deconinck et al. 2013). Naturally, all designs come with their own merits, and may complement each other. However, in the former type of studies, parents and clinicians may be biased towards being relatively more aware of precursors and symptoms of ASD, which may lead to an overestimation, whereas in the latter type of studies, families are generally less biased by prior experiences with a proband with ASD. Other advantages of population-derived studies are that firstborns can be studied, and that less genetically driven forms of ASD may be characterized by particular phenotypic profiles. Prospective population-derived studies demonstrated that children with subtler or later-emerging forms of ASD already showed early impairments in social-communicative skills (Barbaro and Dissanayake 2013) and were delayed in social, language, cognitive, and motor development (Lemcke et al. 2013). Furthermore, problems regarding repetitive behaviour, imitation, play, temperament, hearing, vision, feeding, and bowel/stool habits also seemed to unfold and differentiate during development (Bolton et al. 2012).

As such, this suggests that children from population-derived samples with subtler or later forms of ASD show (mild) core autistic traits and early emerging *developmental* problems in other areas, but less is known about preceding or co-occurring *behavioural* problems. It may be argued that particularly in less clear, later developing ASD also other indicators, like internalizing and externalizing (foremost ADHD) problems, may be present. However, this is not well documented and will be examined as the aim of this epidemiological study. In a longitudinal, stratified (low, middle, high risk) population-derived sample, we investigated through parental questionnaires which social-communicative problems and broader behavioural problems in infancy and toddlerhood preceded high autistic traits in the preschool period.

Methods

Participants and procedure

The design and study procedures were approved by the Medical Ethical Committee of University Utrecht Medical Centre. This study was part of a large screening research into the social development of young children (SOSO project). The original sample was a large general population birth cohort of all children born between August 2000 and August 2001 ($N = 12{,}297$) in the province of Utrecht, The Netherlands. At age 14 months (T1) parents of 6330 children (51.5%) and at age 37 months (T2) parents of 4237 children (34.5%) filled in questionnaires about the child's behaviour. For more information, see Möricke et al. (2013, 2014). The latter group with measurements at both T1 and T2 formed the total population for the present study (T3, age 4–5 years). Due to constraints in time and money, we were forced to limit the number of participants at this stage of the study.

We contacted a subsample of 188 families, of which 119 (63.3%) consented to participate after a complete explanation of the procedure. A random and weighted selection took place on the basis of child scores on the Early Screening of Autistic Traits Questionnaire (ESAT; Dietz et al. 2006; Swinkels et al. 2006), a questionnaire that was developed and tested as part of the SOSO project. The sensitivity for ASD and the specificity to distinguish normal from abnormal behaviour (including ASD and ADHD) were both high. The reliability and validity was also described in another previous study (Van Daalen et al. 2009). This questionnaire, administered when the child was 14 months old, consists of 14 items with "yes" (1) and "no" (0) answers. The items are based on early symptoms of ASD and cover the domains of social-communicative skills, reactions to sensory stimuli, stereotyped behaviour, and play. Generally, children with a score of three or more are considered to be screen-positive and thus at high risk for developing ASD. However, we used a cut-off of two or more, because we were also interested in children with milder autistic traits. The division over the ESAT scoring groups was as follows: low (score 0) 39.5%, moderate (score 1) 36.1%, and high (score ≥ 2) 24.4% (see Fig. 1). It turned out that boys ($n = 71$; 59.7%) were overrepresented in comparison with girls ($n = 48$; 40.3%), but the proportion was almost similar in the three ESAT scoring groups ($\chi^2 = 0.62$; $df = 2$; $p = 0.74$).

The behaviour and development of these 119 children was evaluated three times by means of parental questionnaires (see also Instruments): Utrecht Screening Questionnaire (USQ) at T1 (age $M = 14.48$ months; $SD = 0.51$), Social Behaviour Questionnaire (SBQ) at T2 (age $M = 37.32$ months; $SD = 2.43$), and Social Communication Questionnaire (SCQ) at T3 (age $M = 52.58$ months; $SD = 4.60$). At T3, 12 children had high scores (≥ 11) on the SCQ, including three children (2.5%) with a formal ASD diagnosis as assessed by other professionals. Further, the questionnaires hardly revealed information about medical concerns or clinical diagnoses.

Unfortunately, not all approached families could take part. Reasons for non-participation included unreachability, unwillingness to cooperate, incompleteness of questionnaires, incorrectness of child data, multiple handicaps of the child, etc. Because access to information about non-responders was not allowed on ethical grounds regarding privacy, we investigated possible selection bias by comparing the data of responders with demographic data

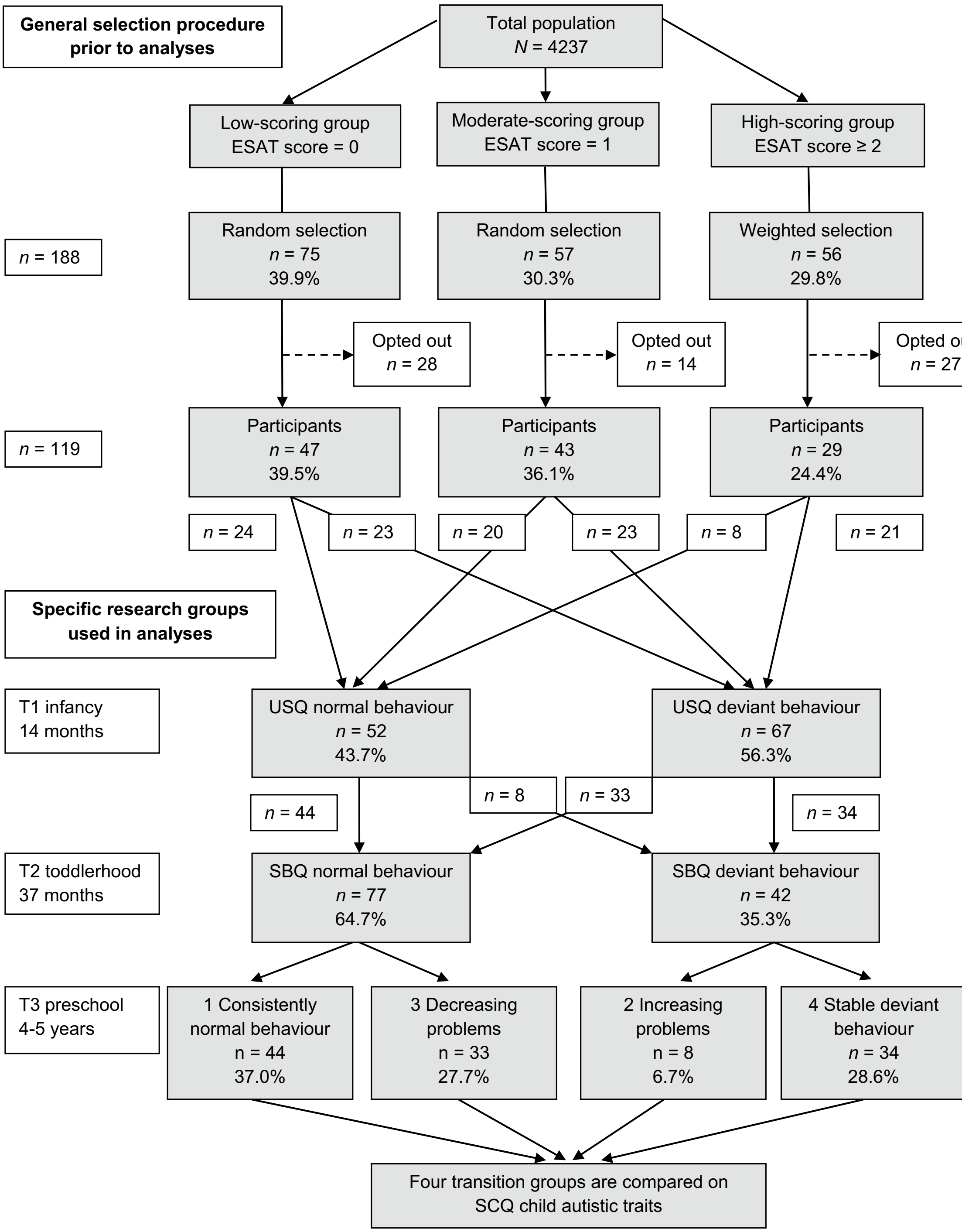

Fig. 1 Flow chart of participants

for the general population (Central Office for Statistics 2003). Of the children in the sample, 95.8% was Dutch ($n = 114$) and 4.2% non-Dutch ($n = 5$). Our sample contained more Dutch children than the population average (82.1%). Especially fathers had a higher educational level (college or university degree) compared to individuals in the general population (fathers 50.4 vs. 36.0%; mothers 42.0 vs. 38.9%). The socio-economic status (SES), based on mean level of education and occupation of both parents, varied from low ($n = 15$; 12.6%) through moderate ($n = 48$; 40.3%) to high ($n = 56$; 47.1%). Families with low SES were underrepresented, and families with high SES were overrepresented. Possibly, autochthonous and higher educated parents have more interest and means to participate in this kind of research than allochthonous and lower educated parents, which explains the skewed distribution.

Instruments

T1: 14 months: Utrecht Screening Questionnaire

The Utrecht Screening Questionnaire is fully described elsewhere (USQ; Beernink et al. 2007). It includes 74 items on externalizing, internalizing, or social-communicative problems suitable for children younger than 18 months. Previous exploratory factor analyses revealed nine factors underlying the USQ (Möricke et al. 2013), namely deviant communication, negative emotionality, deviant reactive behaviour, deviant play behaviour, demanding behaviour, social anxiety/inhibition, advanced social interaction problems, basic social interaction problems, and sleep problems. For examples of items, see Table 1. When considering all items together, internal consistency was good ($\alpha = 0.82$) and variance explained was 71.7%. Latent class analyses showed that children could be divided into five classes, labelled (1) normal behaviour, (2) normal behaviour with mild negative behaviour, (3) communication and interaction problems, (4) moderate communication problems, and (5) negative and demanding behaviour.

Table 1 Item examples of factors at T1 (14 months) and T2 (37 months)

USQ T1 14 months	SBQ T2 37 months
1 Deviant communication	1 Language problems
Uses gestures appropriately to express him/herself	Talks in full sentences
Points at things to show	Participates in reciprocal social interaction
Understands at least ten words	
Uses common names like “mummy/daddy”	
2 Negative emotionality	2 Negative emotionality
Is stubborn, sullen or irritable	Is stubborn, sullen, or irritable
Changes mood suddenly	Changes mood suddenly
Screams a lot	Seems unhappy without clear reason
Is easily upset	Is uncooperative
3 Deviant reactive behaviour	3 Attention-deficit/hyperactivity problems
Reacts when being spoken to	Cannot sit still; is restless or hyperactive
Reacts normally to sensory stimuli	Cannot concentrate or pay attention for long
4 Deviant play behaviour	4 Deviant play behaviour
Plays with different toys/objects	Plays in various ways
Plays in various ways	Plays with different toys/objects
5 Demanding behaviour	5 Demanding behaviour
Demands must be met immediately	Wants a lot of attention
Has angry moods	Cannot stand waiting; wants everything now
6 Social anxiety/inhibition	6 Deviant affective behaviour
Shows interest in other children/adults	Shows clear facial expressions
Is afraid of certain animals, things or places	Emotions are understandable
7 Advanced social interaction problems	7 Communication and interaction problems
Shows that he/she distinguishes parents from others	Directs social smile to parents and others
Babbles or makes noises spontaneously	Follows glance of parents
Follows with eyes when someone moves	Uses sounds or words to get attention or help
	Reacts when being spoken to
8 Basic social interaction problems	
Directs social smile to parents and others	
Makes eye contact easily	
9 Sleep problems	8 Sleep problems
Cannot sleep alone	Cannot sleep alone
Finds it difficult to fall asleep	Finds it difficult to fall asleep

A complete overview of items can be found in Möricke et al. (2014)

T2: 37 months: Social Behaviour Questionnaire

The Social Behaviour Questionnaire (SBQ) consists of 62 items and focuses on externalizing, internalizing, and social-communicative behaviour of toddlers. By means of exploratory factor analyses, the items could be grouped in eight factors (Möricke et al. 2014): language problems, negative emotionality, attention-deficit/hyperactivity problems, deviant play behaviour, demanding behaviour, deviant affective behaviour, communication and interaction problems, and sleep problems. For examples of items, see Table 1. When considering all items together, internal consistency was good ($\alpha = 0.84$) and variance explained was 72.5%. Again, latent class analyses disclosed that five classes of children could be distinguished, namely (1) normal behaviour, (2) normal behaviour with mild negative behaviour, (3) communication and interaction problems with negative behaviour, (4) normal behaviour with mild communication and interaction problems, and (5) negative and demanding behaviour.

T3: 4–5 years: Social Communication Questionnaire

Autistic traits at age 4–5 years were measured with the Dutch version of the Social Communication Questionnaire (SCQ; Berument et al. 1999; Warreyn et al. 2004). Four domains are covered: reciprocal social interaction, language and communication, repetitive and stereotyped behaviour, and other behaviour. It consists of 40 items with "yes" and "no" answers. Twenty-five items were reversely coded so that typical behaviour was scored as 0, and the lack of competences or the experience of problems was rated as 1. On each questionnaire, maximally two missing values per domain and four in total were allowed (< 10% of 40 items). These missing values were replaced by the individual domain means (domain score divided by the number of completed items). The minimum total score is 0, and the maximum total score is 34 or 39, depending on the absence or presence of language and speech, respectively. The official cut-off for ASD is fixed at 15, but for younger children a lower cut-off of 11 seems to be more accurate (Allen et al. 2007; Corsello et al. 2007; Wiggins et al. 2007). Since we focused on children aged 4–5 years, we chose the latter one to distinguish normal from clinical behaviour. For the total scale, the internal consistency was very good ($\alpha = 0.90$) and the variance explained was 42.2% (Berument et al. 1999).

Statistical analyses

The goal was to explore which behaviours and/or changes therein from 14 to 37 months of age preceded high autistic traits at age 4–5 years, solely based on parental questionnaire data and not on clinical anamneses. The statistical software package IBM SPSS Statistics 20 (2011) was used, applying a variable-based and a person-based approach. The variable-based approach covered the clustering of separate items into empirically derived behavioural and developmental factors by means of exploratory factor analysis. The person-based approach was twofold.

In the first step was examined which USQ factors at T1 and SBQ factors at T2 were related to high SCQ scores at T3. The solutions of prior exploratory factor analyses at T1 (9 factors) and T2 (8 factors) in, respectively, 6330 infants and 4237 toddlers were solid. The individual factor scores of the children who participated at both time points were weighted so that the values varied between 0 and 1. The sample was split in children with a high score in the research sample (SCQ $\geq$ 11) ($n = 12$), on the one hand, and children with a low score in the research sample (SCQ < 11) ($n = 107$) or unavailable SCQ score in the population sample ($n = 4118$), on the other hand. The mean weighted factor scores were calculated for the high and low/unknown scoring groups separately and then compared. Exact differences were computed with nonparametric Mann–Whitney tests. Standardized effect sizes (Cohen's d) were calculated and considered as small (0.20), medium (0.50), and large (0.80) (Cohen 1992). Correction for multiple testing was not applied, because that would have increased the chance of a type II error instead of a type I error.

In the second step was determined which homogeneous (latent) classes and derived (transition) groups existed. To prevent disintegration of data, and to enable comprehensible and meaningful analyses in the small sample at T3 ($n = 119$), the five latent classes as found in a large general population sample (Möricke et al. 2013, 2014) were reduced to two groups per time point (T1 USQ: classes 1 and 2 normal; classes 3, 4, and 5 deviant; T2 SBQ: classes 1, 2, and 4 normal; classes 3 and 5 deviant). Subsequently, children were categorized according to their longitudinal transition from infancy to toddlerhood. Four types of transition groups were formed: consistently normal behaviour (no or mild problems at T1 and T2), increasing problems (no or mild problems at T1, severe problems at T2), decreasing problems (moderate or severe problems at T1, no or mild problems at T2), and stable deviant behaviour (moderate or severe problems at T1 and T2). Then, the four groups were compared on child autistic traits (SCQ) at preschool age (T3) using Chi-square tests on dichotomized scores and ANOVAs on normalized scores. See also Fig. 1.

Results

Different factor scores for children with high and low/unknown SCQ scores

Spearman's rank correlation coefficients between USQ factors at T1, SBQ factors at T2, and SCQ domains at T3 were all below 0.60, indicating multicollinearity was acceptably low. When comparing mean weighted factor scores, the high scoring children at T3 (SCQ ≥ 11, $n = 12$) differed significantly from the children with low/unknown SCQ scores ($n = 4225$) on the factors deviant communication ($p < 0.01$, $d = 2.40$), basic social interaction problems ($p < 0.01$, $d = 1.06$), advanced social interaction problems ($p = 0.01$, $d = 0.94$), and deviant play behaviour ($p < 0.01$, $d = 0.83$) as measured at T1. Further, both groups diverged considerably on the factors language problems ($p < 0.01$, $d = 2.26$), communication and interaction problems ($p < 0.01$, $d = 1.65$), deviant affective behaviour ($p < 0.01$, $d = 1.51$), and deviant play behaviour ($p < 0.01$, $d = 1.07$) as measured at T2. These factors showed similarities with one of the core domains of ASD. In addition, at T2, both groups could also be distinguished on the factor attention-deficit/hyperactivity problems ($p = 0.02$, $d = 0.44$), which was mainly due to inattention ("Cannot concentrate or pay attention for long", $p < 0.01$, $d = 0.87$) and not to hyperactivity ("Cannot sit still; is restless or hyperactive", $p = 0.58$, $d = -0.20$). No significant differences were found on the factors deviant reactive behaviour and social anxiety/inhibition at T1, nor on the factors demanding behaviour, negative emotionality, and sleep problems at T1 and T2 (see Table 1 for item examples). See also Fig. 2.

Differences in SCQ scores between longitudinal transition groups

The crosstab with four groups had an unequal distribution of children ($\chi^2 = 16.03$, $df = 1$, $p < 0.01$), with the highest percentage for children with consistently normal behaviour (37.0%), followed by children with stable deviant behaviour (28.6%) and children with decreasing problems (27.7%), and the lowest percentage for children with increasing problems (6.7%). There were no differences in the boy/girl ratio per group ($\chi^2 = 1.39$, $df = 3$, $p = 0.71$) and no meaningful age differences at T1 ($F = 0.27$, $p = 0.85$), T2 ($F = 2.76$, $p = 0.05$), and T3 ($F = 2.03$, $p = 0.14$). See also Table 2.

To investigate whether the longitudinal transition from T1 to T2 was related to autistic traits at T3, the four groups were compared. They differed significantly when using the dichotomized SCQ scores (< 11 or ≥ 11) ($\chi^2 = 11.70$, $p < 0.01$), and marginally when considering the normalized SCQ scores ($F = 2.56$, $p = 0.06$). The group with stable deviant behaviour

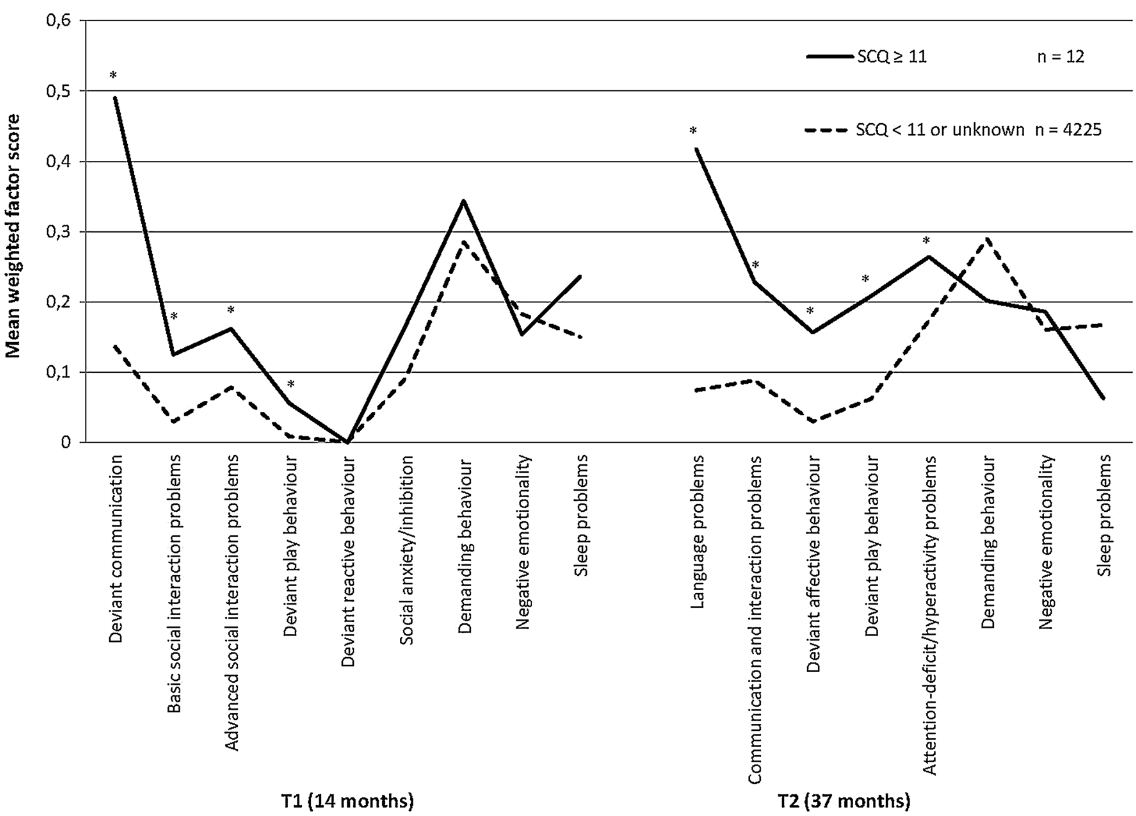

Fig. 2 Mean weighted factor scores of USQ (T1, 14 months) and SBQ (T2, 37 months) by SCQ scores[#] (T3, 4–5 years). *Significant difference in mean weighted factor score ($p < 0.05$). [#]SCQ scores were only known for 119 children included in the present research sample; 12 children had scores ≥ 11, 107 children had scores < 11; for the remaining 4118 children, SCQ scores were unavailable

scored highest ($M = 0.32$, SD = 0.94; 23.5% SCQ ≥ 11), and the group with consistently normal behaviour scored lowest ($M = -0.23$, SD = 0.79; 0.0% SCQ ≥ 11); the groups with increasing and decreasing problems scored in between ($M = 0.03$, SD = 1.24; 12.5% SCQ ≥ 11 and $M = -0.15$, SD = 0.96; 9.1% SCQ ≥ 11, respectively). See also Table 2.

Discussion

In a longitudinal, stratified (low, medium, high risk) population-derived sample, we investigated through parental questionnaires which social-communicative problems and broader behavioural problems in infancy (age 14 months) and toddlerhood (age 37 months) preceded high autistic traits in the preschool period (age 4–5 years). Children with consistently normal behaviour from infancy to toddlerhood showed lower autistic traits at preschool age than children with deviant behaviour on one or both time points. Children with high autistic traits at age 4–5 years already had elevated scores on ASD-related factors at ages 14 and 37 months, but scored also high on inattention (as part of the factor ADHD problems) at age 37 months.

The finding that children with high autistic traits at age 4–5 years scored substantially (and mostly strongly) higher on deviant play, affective behaviour, social interaction and communication, as well as on language problems in infancy and/or toddlerhood converges with studies in high-risk samples (Jones et al. 2014). It also suggests that subtler and serious forms of ASD are quite alike in the type of precursors, although there may be variations in the number and severity of symptoms, depending on the sample. However, 9/12 (75.0%) children in our general population sample had not received a formal diagnosis by the time of assessment (age 4–5 years). It is plausible that the questionnaires used are more suitable to identify general social-communicative problems than specific disorders within the autistic spectrum. This may implicate the need for improvement of adequate screening methods to detect (at least a subgroup of) children with abnormal developmental patterns potentially indicative of ASD, and to monitor their behaviour regularly and proactively, for instance, at well-baby clinics (Barbaro and Dissanayake 2009; Bradshaw et al. 2015; Oosterling et al. 2010; Zwaigenbaum et al. 2015a, b).

When zooming in on behaviours outside the ASD domain, high autistic traits at preschool age (4–5 years) were to a moderate degree preceded by increased levels of inattention in toddlerhood. This partly concurs with recent reviews showing overlap in developmental pathways towards ASD and ADHD at early age (Johnson et al. 2015; Leitner 2014; Visser et al. 2016), although the source or mechanism lying beneath inattention may be different in both disorders, and the expression of inattention at this young age may deviate from that in older children. However, in sharp contrast to findings in ADHD research (Arnett et al. 2013; Sonuga-Barke and Halperin 2010) and ASD studies (Clifford et al. 2013; Garon et al. 2016; Zwaigenbaum et al. 2013), high autistic traits were not preceded by increased levels of

Table 2 Descriptives of four groups at child age 14 months (T1), 37 months (T2), and 4–5 years (T3), and differences on child autistic traits at T3

		Group 1 T1 normal, T2 normal	Group 2 T1 normal, T2 deviant	Group 3 T1 deviant, T2 normal	Group 4 T1 deviant, T2 deviant	*F; p* χ^2; *p*	Comparison; *p*
Children[a]	*N*	44	8	33	34	16.03; < 0.01*	
	% of total	37.0	6.7	27.7	28.6		
Sex (boys)	*N*	29	4	18	20	1.39; 0.71	
	% within group	65.9	50.0	54.5	58.8		
Age in months	*M* (SD) T1	14.45 (0.47)	14.57 (0.37)	14.45 (0.52)	14.53 (0.58)	0.27; 0.85	
	M (SD) T2	38.11 (2.34)	36.85 (1.74)	37.05 (2.56)	36.66 (2.34)	2.76; 0.05	1 > 4; 0.05
	M (SD) T3	51.40 (5.25)	54.88 (2.39)	52.83 (4.03)	53.33 (4.35)	2.03; 0.14	
SCQ ≥ 11 Dichotomized score	*N*	0	1	3	8	11.70; 0.01*	1 < 2; 0.02*
	% within group	0.0	12.5	9.1	23.5		1 < 3; 0.04*
							1 < 4; < 0.01*
SCQ normalized score	*M* (SD)	−0.23 (0.79)	0.03 (1.24)	−0.15 (0.96)	0.32 (0.94)	2.56; 0.06	

*Significant difference between groups ($p < 0.05$)

[a]Division is based on 119 children. Comparison of four groups, $df = 3$

Groups were based on changes in broadly defined behavioural problems (externalizing, internalizing, and/or social-communicative)

SCQ Social Communication Questionnaire demanding behaviour, negative emotionality, and sleep problems in infancy and toddlerhood in our population-derived sample. The difference may perhaps be explained by the severity of children's problem behaviours, with children in high-risk studies possibly having higher levels of co-occurring early regulation and externalizing problems compared to children in population studies. Furthermore, the items in our study may have been too low in number and specificity to measure these constructs adequately. Finally, the age differences between our sample and the samples in the studies mentioned previously may have played a role. If replicated, our findings may suggest that demanding behaviour, negative emotionality, and sleep problems are not very strong predictors of later-emerging ASD. Instead, these behaviours may be reflective of general difficult temperamental characteristics or regulation problems, which will only cascade towards disorders like ADHD in a proportion of children (Beernink et al. 2007; Gurevitz et al. 2014). However, these behaviours may also be quite normative at these young ages, and may disappear when the child grows older and learns to regulate emotions and behaviour.

The strengths of this study lie in the stratified population-derived sample, the early originating longitudinal assessments, and the broad focus on social-communicative problems as well as internalizing and externalizing behaviours. However, a main limitation is the low inclusion rate of 63% due to factors regarding contact and cooperation with parents, completeness and correctness of data, and child characteristics. Attrition is not uncommon in longitudinal studies (Teague et al. 2018). Besides, we ascertained that the included and excluded sample only differed in educational level and socio-economic status of the parents, but not in child age, gender, nationality, and initial ESAT score. The sample size was modest, especially of the group with increasing problems from infancy to toddlerhood ($n = 8$) and of the group of children with high autistic traits at age 4–5 years ($n = 12$). Because only three children had a formal ASD diagnosis at the time of investigation, it was difficult to make solid predictions. The comparison with the large population-derived sample revealed clinically relevant results with regard to high autistic traits in general, but was not suitable to draw conclusions about different pathways leading to various forms of ASD. Bigger samples with a larger number of children with high autistic traits as well as a more representative distribution of children among subgroups with regard to child sex, parental SES, and familial ethnicity will increase the validity of the results. Another limitation is that predictions of autistic traits were based on composed behavioural factors, but separate items may give more specific and concrete information, as was the case with the factor ADHD problems and the accompanying items. So, analyses on the item level may lead to stronger clues about early behaviour problems related to ASD or ADHD, and may offer new possibilities to improve screening and intervention tools. A final limitation is that we hardly used standardized measures with professionals as informants and mainly relied on parental reports. Data regarding child behaviour at age 14 and 37 months were given by only one parent, generally the mother. In future research, it is preferable to include more elaborate assessments and to gather information from both parents as well as other informants (day-care employees, preschool teachers, health care workers) at all time points so that more exact comparisons can be made.

In conclusion, the parental questionnaire data revealed that children with consistently normal behaviour from infancy to toddlerhood showed lower autistic traits at preschool age (4–5 years) than children with deviant behaviour on one or both time points. High autistic traits at preschool age are mainly and strongly preceded by early manifested and stable social-communicative problems in infancy and toddlerhood, and only to a moderate degree by other behavioural problems (inattention in toddlerhood). Regular monitoring by child care practitioners from a young age onwards is essential, especially when a continuation or increase of autistic traits is recognized. Adequate support and specific interventions in these domains are needed in an attempt to diminish further derailment of the child's behaviour and development, and to prevent the full manifestation of ASD or related disorders such as ADHD (Boyd et al. 2010; Dawson 2008; Dawson and Bernier 2013; Zwaigenbaum et al. 2013, 2015a).

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Compliance with ethical standards

Conflict of interest In the past 3 years, Buitelaar has been a consultant to/member of advisory board of/and/or speaker for Janssen Cilag BV, Eli Lilly, Bristol-Myer Squibb, Schering Plough, UCB, Shire, Novartis and Servier. He is not an employee or a stock shareholder of any of these companies. He has no other financial or material support, including expert testimony, patents, and royalties. The other authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study involving human participants were approved by the institutional research committee. The study has been performed in accordance with the international ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed consent Informed consent was obtained from all individual participants included in the study.

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