Patterns of Gaze Behaviour, Social Cognition and Cognitive Profile in Children with Autism Spectrum Disorders.

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ABSTRACT

The overall aim of this study was to investigate a range of aspects in childhood autism spectrum disorders (ASD) that affects children's ability to function in their learning environments at school and in their daily life. The present study investigates a group of children 11-15 years of age diagnosed with ASD compared to a group of typically developing children of same age. A study regarding a range of aspects of cognitive profile from the Wechsler Intelligence Scale for Children, social cognition/Theory of Mind and gaze behaviour. A particular focus was set on children's abilities to comprehend and tell stories with a social content, Narratives, and in registering patterns of gaze behaviour in viewing photos of human faces.

The results indicate that ASD children have difficulties in focusing their attention to detect important features of human faces and in the ability to tell social stories. The low results in eye fixation and Narratives open for a conclusion that ASD children have difficulties to combine separate pieces of visual information and to integrate information to form stories that make a socially meaningful whole. Difficulties in ToM using Narratives were more common in ASD children than in controls. The difference between groups was statistically significant.

***Keywords*:** Autism Spectrum Disorders, Theory of Mind, Narratives, Wechsler's Intelligence Scale for Children, social cognition, gaze behaviour, face processing, eye's fixation.

Contents

Abbreviations

ADHD	Attention Deficit/Hyperactivity Disorder
ANOVA	Analysis of Covariance
AOI	Area of interest
Ar	Arithmetic subtest of WISC
AS	Asperger´s syndrome
ASD	Autism spectrum disorder (children)
ASSQ	Autism Spectrum Screening Questionnaire
Au	Autistic Disorder
BAP	Broader Autism Phenotype
C	Comprehension subtest of WISC
CD	Coding subtest of WISC
CL	Confidence Limits
DS	Digit Span subtest of WISC
DSM	Diagnostic and Statistical Manual of Mental Disorders
EF	Executive functions
FD	Freedom from Distractibility Quotient of WISC
FIQ	Full Scale Intelligence Quotient of WISC
fMRI	Functional Magnetic Resonance Assessment

Griffiths	Griffiths Mental Developmental Scale
ICD	International Classification of Diseases
MNS	Mirroring neuronal system
MD	Mean value
PIQ	Performance Intelligence Quotient WISC
PS	Processing Speed subtest WISC
SD	Standard Deviation
SS	Symbol search subtest WISC
TD	Typically developing children
ToM	Theory of Mind
VIQ	Verbal Intelligence Quotient WISC
WISC	Wechsler Intelligence Scale for Children

Introduction and classical findings

Autism spectrum disorder is a pervasive developmental disorder. The main features of the disorder are impairment of social communication and interaction (Rutter & Schopler 1987). The disorder is also characterized by disruption of normal predisposition for face perception, (Hobson, 1993; Hobson et al., 1998) facial affect and direction of eye gaze (Baron-Cohen et al.,1997, Leekam et al., 1997) as well as diminished rates of eye contact (Phillips et al., 1992) and difficulty in social interaction with others (Pierce K, Courchesne E, 2000) .The disorder have remained, despite its difficulties for the individual, an enigmatic and fascinating condition thus becoming the inspiration to many authors, filmmakers and of course researchers wanting to describe and know more about the origin of the disorder. Possibly autism and autism disorders are the most researched and documented of all child psychiatric disorders.

The concept and definition of the disorder have changed over the years and are still developing. The individual scientists whom in the beginning contributed most to our understanding of the syndrome are Leo Kanner and Hans Asperger. Kanner defined 1943 the behaviour in a group of children as "autistic disturbance of affective contact" and later named it "Early Infantile Autism", narrowly defined as "classical autism". While Asperger 1944 gave a more systematic description of a group of children that in his view differed from autistic children. His thesis Autistic Psychopathology was presented as a clinically separate entity. Nissen (1974) widened the concept to include a continuum of autistic "factors". He thought that the emotional aloofness "Emotionaler defect" found in both the Kanner syndrome and Asperger´s syndrome was the consequence of difficulties with sensory (visual, auditory and kinaesthetic) modulation and decoding. Michael Rutter (Rutter et al., 1987) returned then to a more restricted definition of the syndrome. A more comprehensive view later emerged including classical autism in the lower end of the spectrum and "high functioning autism" at the other end of the spectrum. Before 1980 no articles were published were the term "high functioning autism "was mentioned, although it was present implicitly in research over the last 30-40 years. Until now there is no sharp division between the two concepts Asperger´s syndrome and High functioning autism, they seem to cover the same condition.(Attwood, 1998).

The theoretical strivings to formulate diagnostic criteria have resulted in several lists of symptoms. The diagnose Asperger´s Syndrome was accepted as a specific diagnose in the international diagnostic manuals DSM-IV 1994/DSM-IV 2000 (APA, 1994; 2000) and ICD-10 (WHO, 1992; 1993). The condition is listed under the category Pervasive Developmental Disorders (PDD).The diagnose is pervasive in the meaning that it affects almost every aspect of an individual's life and prevails throughout life. Both DSM-IV and ICD-10 stipulates different criteria for classical autism and for Asperger´s syndrome. . The differences are altered degree of social communication and interaction, restricted interests and repetitive and stereotyped behaviour in autism. Deficits in the use of nonverbal social communicative behaviours e.g., eye-to eye gaze and facial expression and gestures. Contrary to the latter, Asperger´s syndrome individuals should not show any significant language abnormalities and more particularly no delay in language acquisition, psychomotor and general cognitive skills. For a detailed review of the two lists of symptoms see Appendix 1, Manuals for Diagnostic Criteria.

The diagnostic criteria of Asperger´s Syndrome have been a matter of different opinion and scientists have emphasized different aspects of the syndrome. A British researcher, Lorna Wing (1987), was the first to use the *concept* of Asperger´s Syndrome. She found the ordinary concept of autism to rigid and stereotyped and strived to broaden and nuance it. She put forward the idea of a continuum or spectrum of poor ability to phantasm and a limited and compulsive behaviour (Wing 1981, 1987). Christopher Gillberg et al., (1996) formulated the first systematic diagnostic criteria in 1989 and later they were revised 1991 (Gillberg, 1991). Those criteria use Asperger´s early description of cases from 1944. Another researcher, Szatmari (1998) advocates that ICD-10 uses too strictly defined criteria and then formulate another list of criteria's (Szatmari 1998, 2000). He focuses on behavioural aspects and cognition of the syndrome. Gillberg found that ICD-10 had a wider definition in criteria which enabled children with socially deviant behaviour and mute children and very shy children to fall within the criteria of Asperger´s syndrome. Gillberg then formulated a more specific and detailed list, Szatmari focusing on different aspects of behaviour and Wing with a focus on social interaction and communication. Lately researchers have focused on a broader phenotype (Broader Autism Phenotype, BAP) or a sub clinical variety of Asperger´s syndrome (Gillberg, 2002; Happé et alt., 2001; Piven et al., 1995).

Till this day there are only three syndromes that fulfil the criteria of complete behavioural phenotype and they are Lesch-Lyhans Syndrome, Prader-Willis Syndrome and Rett´s Syndrome.

There is a general acceptance that genes play an important role in the causation of developmental disorders and classical variants of autism and play a major role in spectrum disorders including Asperger´s Syndrome and atypical autism. (Bailey et al., 1993). Co morbidity with other behavioural and psychiatric disorders is also frequent. Steffenburg et al, (1991) found that 90% of her sample of autistic children had genetic, hereditary or brain abnormalities. A twin study (Bailey et al., 1998) found evidence of autism as the most heritable of neuropsychiatric disorders and neuroanatomical studies (Courchesne et al 2001) point to a biological time of onset possibly as early as the first trimester and absolutely within the first 2 years of postnatal life.

The development of emphatic and social behaviour

The necessity of social/emphatic relations and interactions is a fact when it comes to survival of both humans and some primate species. The ability to interact socially and to detect own and others expressions of feelings is probably genetically innate. The very first turning of the head (rooting behaviour), towards kin aesthetical/visual and auditive signals in the new born baby to his mother/caregiver is what brings social life to start both in a biological and philosophical sense (Emery, 2000). Both auditive and proprioceptive activation in the first trimester of a foetus is evident in several studies. After birth a sort of proto-reflexive orienting starts where the ability to shift attention to visual (or other) cues works without other inference.

The two main views regarding the origins of social impairment in autism are first that it is mainly an *affective* impairment and secondly that the impairment is *cognitive*. The face and especially the eyes are often denominated as “windows of the soul”. For humans gaze, tones of voice and body posture are the most important affective instruments of communication. The affects are the motor of development. (Tomkins 1962,1963, Stern 1991, Demos1994). The ability to affective connection in the child has an impact upon the caregiver’s response. The reciprocity of the caregivers to the baby is of no less importance to keep development

going and indulging imitative behaviour. If the mother doesn't respond with facial expressiveness of affect, so called "still-face" situations, the child's own facial expressiveness diminish and after a while the child starts acting disoriented.

The development of empathic and social behaviour is a psychobiological joint venture starting e.g. from conception (Havnesköld 1995). According to this view the reason why autistic children have difficulty in social/joint attention is a result of either deficit in intersubjective relatedness (Hobson 1993) or a deficit in socio-emotional approach (Mundy 1995). The former view then more related to an inborn ability in building affective bonds and the later more related to cognitive learning how to go about things.

A third integrative view has emerged namely that children with autism have a low-level attention or perceptual impairment affecting their ability to respond to another's head or eye movements. In some children the rooting behaviour, turning of the head from side to side in search for the nipple and sensory stimulation never occur or becomes faint and vague. Eye fixation patterns, for example when the baby stares intensely at the caregiver or other person, is a developmental step that might likewise be faint and vague, get stuck or never occur. The task at that particular stage in development is that the rooting movement and staring gaze have to come under afferent control, that is becomes oriented towards attention by enhanced sensory stimulation (Smith, 1996). The further development of skills for example to sustain joint attention could bring about the ability to read the intentions of others (Baron-Cohen 1995). There is evidence that children with autism disorders are impaired on certain aspects of face perception e.g. visual scanning of individual parts of a face, gaze and that they have difficulty in recognizing well known faces, facial expressions and emotions and to read others minds. (Scott 1985; Hobson et al 1988; MacDonald et al 1989; Baron-Cohen et al 1997; Baird et al 2000).

Mirroring neurons and the development of affective and social behaviour

Recently new research by professor Riitta Hari at The Technical University in Esbo, Finland on "the Social Brain" found that the brain contains of a system, till recently unknown, that

enables us to understand our fellow humans. This system contains of special mirroring neurons that are the base of humans´ inborn ability to imitate movements. The neuronal circuitry comprises at least Broca´s area, premotor regions and primary motor cortex. The MNS in man might play an important role in speech communication by aiding recognition of people's articulatory gestures. (Mönttönen R, Hari R et al 2005). New born babies are very good at imitating facial expressions. With experience and visual and sensory capacity intact they later refine this ability. The typical about mirroring neurons are that they behave the same when a person makes a movement like when he *sees* another person doing just the same movement. Hari et al point out that the finding of mirroring neurons also could have an impact of how the human language developed since speech is very coupled to gestures and body movements. Another scientist Giacomo Rizzolatti at the University of Parma, Italy found that when people saw pictures of other peoples facial expressions for example fear or joy their own reciprocal brain cells became activated and they could recognize the same feelings. When they saw other person's activities, their own brain cells became active as if they themselves had conducted the activities. (Rizolatti, G et al 2001).

In her article Riitta Hari (Mönttönen et al 2005) concludes that people with autism have a difficulty imitating others movements and they have difficulties in understanding a situation from another persons thoughts and feelings. Yet it is not verified that people with autism have abnormal mirroring cells but it could be possible that their mirroring cells are blocked or less developed. Both the Italian and the Finnish scientists continue new studies on this. The Swedish scientist Claes Hofsten and his colleagues have fond that 12-month-old infants shows a specialized system for action perception that guides proactive goal-directed eye movements. The infants could thereby predict other people's actions. The scientists´ explanation is that those findings might be the basis of empathy and social cognitive ability (Falck-Ytter et al. 2006).

Another study using fMRI found different patterns of activity during imitation and action in ASD and controls most evident in area at the right temporal-parietal junction also associated with a "theory of mind" (ToM) function. Overall the results suggests that ASD is associated with altered patterns of brain activity during imitation, which could come from poor integration between areas serving visual, motor, proprioceptive and emotional functioning (Williams et al 2006). Several of the scientists referred to here have found strong evidence

for the involvement of motor neuron system for a neuronal substrate of mirroring of other person's actions, feelings, sensations and intentions. The amygdale seems involved since specialized for imitation and observation of facial expressions. Then sub serving simulations of other person's action-related sensations hence makes it possible for the observer to experience what the other feels while performing motor acts (Möttönen et al. 2005), (Carr et al. 2003), (Rizolatti et al., 2001), (Williams et al. 2006). Researchers found that disability in recognizing emotional facial expressions is not a general sensory loss, but a loss in the cognitive processing that ensue the ability to *detect* emotional facial expressions, (Hansen 2000). The Swedish scientist Arne Ohman (1986) also pointed to that a biological predisposition to learning (also in an evolutionary perspective) is evident in reaction to fearful events.

Psychometric assessment in diagnosing autism spectrum disorders

One of the basic assumptions when diagnosing autism spectrum disorders is the deficit in cognitive processing. The most widely used instrument for assessing cognitive profiles and attention in children is The Wechsler Intelligence Scale for Children (WISC). The WISC provides measures of global intellectual ability in the full scale IQ and a distinction between verbal IQ and performance IQ in sub scores. The Kaufman four factor concept was created out of WISC subtests to be able to better reflect cognitive constructs than the more traditional scales referred to as FSIQ, VIQ or PIQ. Many investigators have examined the cognitive profiles of children with Asperger´s syndrome in attempts to a better global understanding of the syndrome and ways to refine diagnostic criteria. The Psychometric assessments of children with Asperger´s syndrome have sometimes given contradictory results. Many reports show that WISC profiles are quite deviant. When results in the scale precede over FIQ 85 the differences between groups fades out and more or less disappears. (Nydén, A 2000). However, children with diagnoses Asperger´s syndrome tend to have low scores in certain areas of the test. Many scientists have reported low scores on verbal tests, and high scores in visuo-spatial abilities. (Rutter 1978), (Shah & Frith 1993). Others have reported low scores in the performance part of the test like in Picture Arrangement.

Wechsler's scales reward speed in solving tasks of visual and nonverbal subtests like Coding, Picture Arrangement (sequencing part), Picture Completion, Block Design, Object Assembly,

Symbol Search and Maze. In some of those subtests bonus points are rewarded for quick and correct solutions while others have a strict time limit in solving. Some of the subtest like Object Assembly and Block design covering the "basic reasoning" group of items relating to the general intelligence factor ***g*** and also covering a general visual and speediness factor. The ***g*** factor is a psychometric measure of general ability or general intelligence. The ***gv*** factor includes "tasks that call for fluent visual scanning, Gestalt closure, mind's-eye rotation of figures, and ability to see reversals". (Lubinski. D (2004). The general speediness factor calls for "speediness in intellectual tasks relates to carefulness, strategies (or metacognition), mood (such as depression) and persistence" (Horn, 1989, p. 80). The speediness items are Picture Arrangement, Coding, Symbol Search and Object Assembly.

Aims.

A theoretical model of the different causes and levels of autism was made by Frith et al (1992) illustrating the idea of an integration perspective. This perspective refers to mental capacity as something that develops through stages of hereditary, biological/anatomical, behavioural and higher levels of cognitive functioning. This approach fits well in with the new broader theoretical framework of autism spectrum disorders (BAP). (See chapter of Introduction). It includes the possibility that if one of those stages of mental development is somehow blocked, weakened or distorted it will evidently show off in later stages as a minor but still detectable deficit. In autism spectrum disorders, as known through other research referred to earlier in this paper, several levels of mental activity is affected. The present study tries to take on this broader integration perspective, a vertical perspective, using Psychometric Assessment tapping cognitive aspects as well as experimental. It seemed fruitful to deepen the investigation by combining and elaborating the WISC to reflect yet other dimensions in the disorder. The starting point for the study is the biological level of gaze behaviour, passing through higher cognition functioning and lastly in measuring the ability to comprehend and verbalize social stories. The knowledge so far is that no previous study has taken into account the patterns of gaze behaviour, aspects of WISC cognitive profile and Theory of Mind.

To operationally define the theoretical aspects of some of those vertical levels this study aimed at investigating patterns of gaze behaviour for human faces like time spent on visual

fixation on eyes while looking at picture photos of human faces, registering WISC cognitive profiles and assessing Theory of Mind by abilities to tell social stories from WISC Picture Arrangement. The study was aiming at investigating eventual differences between groups of children with high functioning autism and Asperger´s Syndrome (ASD-children) and their typically developing controls (TD-children). The hypotheses were as follows.

Hypotheses:

A -Deficits in specific cognitive abilities in ASD-children compared to a group of typically developing children (TD-children).

B - Narratives as to Theory of Mind (ToM) are less accurate in ASD-children compared to a group of typically developing children (TD-children).

C- Abnormalities in gaze patterns in the ASD-children compared to a control group of typically developing children (TD-children).

Methods

To operationally define the theoretical aspects of some of the vertical levels mentioned earlier the method of investigations was three folded and contained the following steps:

1. Registering cognitive profiles of ASD children in comparison with typically developing children using IQ testing with The Wechsler Intelligence Scale for Children (WISC).

2. Registering ToM by assessing ability to tell social stories using a Narratives form out of WISC Picture Arrangement.

3. Monitoring and registering gaze patterns by using stimuli of 4 picture photos of human faces, 3 photos of males and one photo of a female. Pictures photos 1a – 1d.

Subjects

The sampling procedure for participants in the longitudinal study of which this study is a part, the AS/HFA and control groups have been presented in detail elsewhere. (Allik H, et al 2004). All with a diagnosis of AS and registered at three PDD habilitation centres in Stockholm. Exclusion criteria were: 1) intellectual disability and/or history of essential language delay (at the first stage of selection); 2) co morbid physical disabilities or seizure disorders; 3) use of pharmacological treatment.

For the purpose of this study families and children were invited to participate through letters of information about the aims and procedure of the study. Shortly after receiving the letter they were contacted by the author to know if they decided to participate or not. For those families who decided to participate in the study an agenda of appointments was set up covering the two blocks of testing.

Finally, out of the index group 14 + 14 children agreed to participate in the study. From the group of ASD-children one dropped out during testing and three were excluded due to technical reasons. From the group of TD -children two were exclude likewise due to technical reasons. Their parents gave their written consent in accordance with procedures and protocols approved of by the Ethical Committee at the Karolinska Hospital, Stockholm Sweden.

A between-group design was established and 10 of the children with diagnoses of ASD accepted to participate, 9 boys and 1 girl. From the typically developing children (TD) finally 12 agreed to participate, 11 boys and 1 girl. The children were all between 11 and 15 years of age at the onset of the study with an average age for the ASD group of 13 years 5 months. The average age of the TD group was 13 years and 8 months. The initial assessment of diagnoses for the 10 ASD children was done at average age of 7.6 years with a range 6 -10 years. The time laps from first diagnoses to onset of study varied from between 4 to 8 years.

Sociodemographic data regarding the children with ASD and the typically developing children were as follows. In the ASD group 8 children were attending mainstream schools and 2 children in special schools or special classes. 7 of the ASD children live together with both biological parents and 2 children live with mother, one child lives alternatively every second week with one or the other biological parent. Two of the ASD children had no siblings in the family, 6 children had one sibling, while 2 children had three siblings in the family.

In the group of typically developing children all attended mainstream schools and ordinary classes. For the TD children 9 live with both biological parents, 2 of them live with mother and one child lives alternatively every second week with one or the other biological parent. For the TD children 4 of them lived with one sibling, while 6 children lived with two siblings, one with three siblings and one with 4 siblings.

All children received from the St Erik Eye Hospital and the Astrid Lindgren Children's Hospital a total of four cinema tickets each as a symbolic gesture of gratitude for participating in the study.

All children were administered full scale IQ as measured by complete Wechsler Intelligence Scale for Children 3rd edition (Wechsler 1992). They were all assessed with Narratives form and gaze pattern paradigms alike. The WISC tests and assessments were administered by the author.

Before starting gaze behaviour testing each child went through a basic ophthalmologic investigation consisting of monocular distance visual acuity (line KM chart at 4 m), stereo

acuity testing (TNO test) and an investigation with the auto refractor. The eyes of each child were also inspected with the bio microscope to rule out any ophthalmologic pathology that would affect the testing performance.

Instruments and measures

The cognitive profiles were measured by scores from Wechsler Intelligence Scale for Children. The WISC comprises both global measures (FSIQ, VIQ and PIQ) and four factors. The WISC subtests are: Information, Similarities, Arithmetic, Vocabulary, Comprehension and Digit Span (verbal) and Picture completion, Coding, Picture Arrangements, Block Design, Object Assembly, Symbol Search and Maze. Subtest results were registered by scaled scores and calculated in accordance with the WISC manual and computer programme.

The full scale, subtest and factor results of the WISC were analysed in detail in table 4 for the two groups separately. WISC verbal and performance subtests were compared between the two groups. Factors Verbal Comprehension, Perceptual Organization, Freedom from Distractibility and Processing Speed (WISC-III 1990) were summarized and analysed.

Assessing social cognition and Theory of Mind – The Narratives.

The children's ability to Theory of Mind was measured by the use of WISC Picture Arrangement. The subtest comprise a task involving telling stories in accordance to posing sequences of pictures. To be able to assess the qualities and degree of children's cognitive social awareness a system of scoring the answers were administered. Assessments were made to see if and to what degree the subjects could identify the implied meaning of those stories. Each child was to tell a corresponding story in connection to Picture Arrangements (PA) in the WISC. The scoring system and measures for evaluation was operationalized using the basic assumptions from the system and manual elaborated by Drew Westen and Henry Segal. They used six dimensions of object relations chosen from the form and content of the stories. The six dimensions were: episode integration (the capacity to derive a coherent and integrated account of events), accuracy of casual attributions (the capacity to attribute plausible causes of events), affect tone of relationship paradigms (the degree to which described relationships or interactions are characterized by benevolent, neutral, or malevolent affective quality),

capacity for emotional investment in relationships and moral standards (the extent to which relationships are defined in other than need-gratifying terms), complexity of representations, and the accuracy of character ascription (the extent to which people are perceived accurately and without idiosyncratic intrusions).(Westen & Segal 1999). In this study we used three of those dimensions in measuring the ability to tell a social story. The children's answers were operationally defined in a coding system with scores in accordance to which degree the subject could: a) pose the sequence of pictures in order of episodic events, b) tell a correct story in describing plausible causes of events and finally: d) could define and tell the implied meaning of the pictorial sequence with relationships or interactions characterized by affect tone.

Instruments for measuring gaze behaviour in viewing human faces

The accuracy of visual attention and cognitive profile are important in the process of social communication. The human eye movement is capable of five basic kinds of movements. (See table 1). At least three of these movement systems are modularly structured, that is these subsystems operate relatively decoupled to correct different sources of error as indicated by the distinct differences between latencies. (Ballard 1987).

Table 1 Summary of primate eye movements

Movement	Description	Latency
Saccades	discrete, high-speed (300-400º/s Eye movements to foveate a target; Average rate >4/s	150 msecs
	Pursuit maintains foveation of a target Using a retinal slip	50 msecs
Vergence	binocular movements to facilitate The computation of target depth	>200 msecs
VOR	eye rotation rate= head rotation rate	14 msec
OKN	uses visual feedback to move the Eye to stabilize full field motion or protracted head notion	

(VOR – vestibular-0ccular reflex, OKN –optokinetic nystagmus) (After Ballard 1987)

One area of particular interest in the social realm is that of face perception and especially eyes in Asperger´s individuals. We used four coloured picture photos of ordinary people 1a – 1d,

one woman and three males seen in frontal position. Each face was divided into segments, areas of interest (AOI). The different AOI:s are shown as rectangular overlay areas on the pictures. The AOI:s for the four picture photos were; a) forehead b) left eye c) right eye d) nose e) mouth f) left ear g) right ear h) chin i) left cheek j) right cheek k) throat l) left background m) right background. In some of the photos AOI:s differed due to some details of the background or detail of face. The photos were presented onto a digitized computer screen, see Procedure. In the final investigation of subjects face perceptions we used a limited amount of AOI:s, focusing on eyes or not eyes. (See figure 1a-d). The measures were in milliseconds when the unit eye movements were gaze time and sum of fixation counts when the units were in gaze fixation.

Fig. 1 a-d

Fig. 1 a-d. Screen dumps of the different facial pictures that were used in the present study. The different facial AOI are shown as rectangular overlay areas on the pictures.

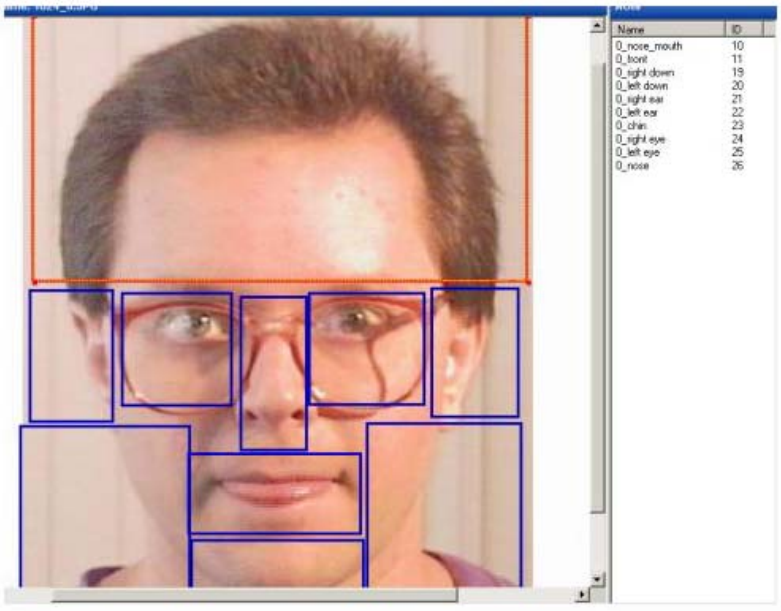


Fig 1a.

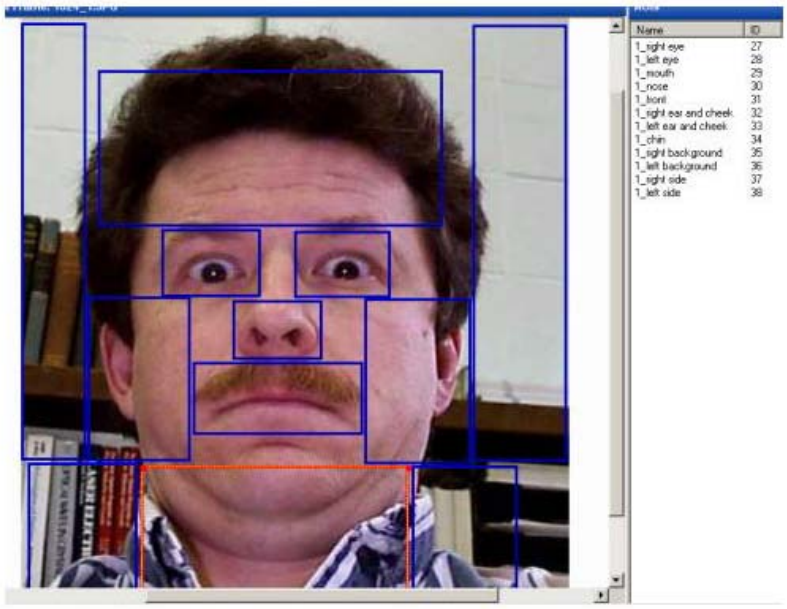

Name
ID
1_right eye 27
1_left eye 28
1_mouth 29
1_nose 30
1_front 31
1_right ear and cheek 32
1_left ear and cheek 33
1_chin 34
1_right background 35
1_left background 36
1_right side 37
1_left side 38

Fig 1b.

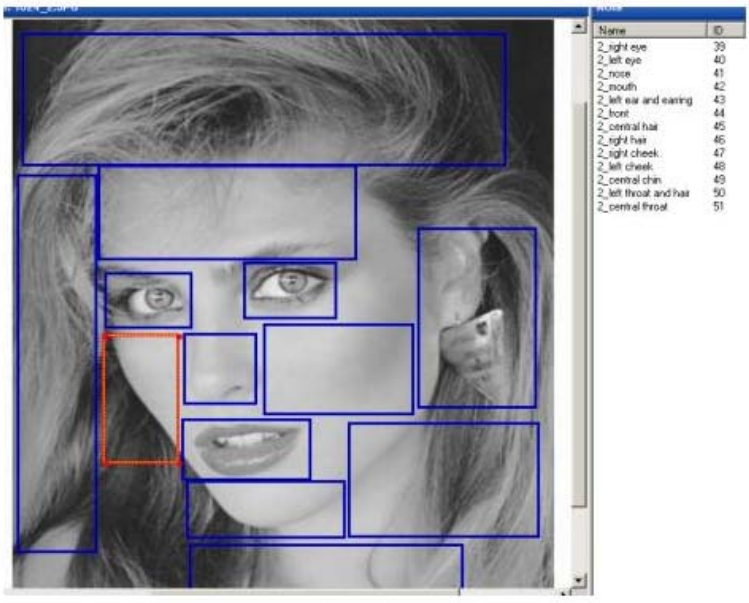

Name
ID
2_right eye 39
2_left eye 40
2_nose 41
2_mouth 42
2_left ear and earring 43
2_front 44
2_central hair 45
2_right hair 46
2_right cheek 47
2_left cheek 48
2_central chin 49
2_left throat and hair 50
2_central throat 51

Fig 1c.

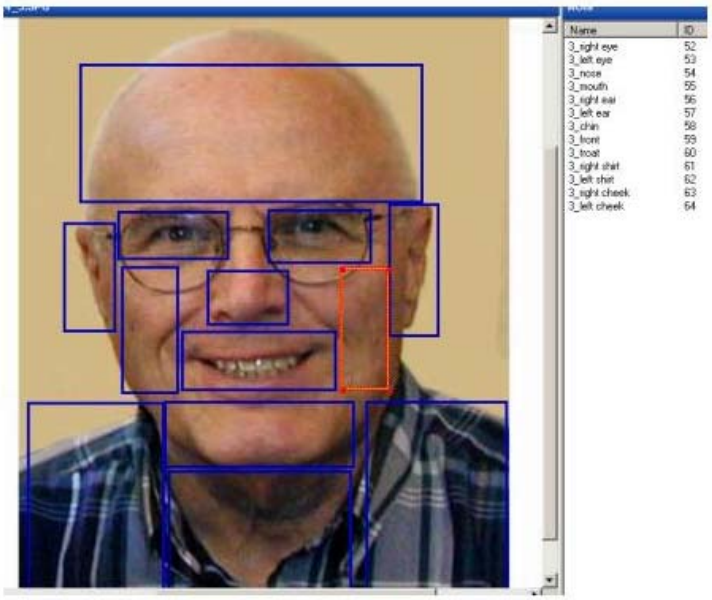


Fig 1d.

Several paradigms of eye movements in the subjects, amongst others gaze holding movements and fixation movements of eyes in different facial pictures, makes it possible to study the ability of visual attention as a coordinated processes. This study examines two of the paradigms involved in the control of visual attention. We used the paradigm, Fixation movements and gaze movements. Fixation categorized by small movements that are observed during fixation on a point/visual target. In this study we will address fixation movements in the meaning of a) tremor and b) drift. The measure was of pixels, counted as units each containing a width of 50 pixels. Gaze movements that was address here are a) vestibular and b) optokinetic. A limitation of registering gaze response time was 200 milliseconds.

Materials in measuring Picture Arrangement and Narratives

Picture Arrangement consists of 14 series of picture “cartoon” stories. Each series consist of between 4 – 6 cards. Each card (8 x 8 cm) has a white background and bright colours, depicting people and animals in different situations in sequences of stories. The first set is an introductory story to explain the outsets of the test and administered to all ages alike. In WISC-III there are two age-related starting points. Scores are two points given for correct arrangements within the time limit and for the first two tasks (3-4) and 3 points for correct

arrangement within the time limit for the following tasks (5-14). Each set of stories contains from least 3 to the most 6 cards. The cards were presented in front of the subject in random order according to the standardized procedure. The subject was then asked to arrange the cards in order, from left to right, and then to verbalize a story out of the posed cards. Every item in PA was considered containing a variety of cues of social cognition and object relations and affects tone. The ability to arrange and tell stories – Narratives was then assessed separately in a scoring system measuring the child's ability to different degrees and qualities of the task. (See Table 2).

Table 2. Coding Narratives	**Scoring**
A. Correct arrangement, correct story, implied meaning	3
B. Correct arrangement, story content essential information	2
C. Correct arrangement	1
D. Not correct arrangement, correct story, implied meaning	2
E. Not correct arrangement, story content essential information	1
F. Not correct arrangement	0

Apparatus: Equipment for Gaze behaviour testing

Gaze position during picture viewing was recorded using a newly developed IR video based remote eye tracking system (ETS), the Tobii ET-1750® (Tobii Technology AB, Stockholm Sweden) together with data analysis of software, Clear View®. This system is a binocular non-invasive 2-D eye tracker with some tolerance for head movements during recording. Tobii ET-1750 uses a CCD-camera with a maximum sampling speed of 50Hz and near infrared light emitting diodes (NIR-LEDs) to illuminate and generate even lightning and reflection patterns in the eyes. The reflection of these patterns together with other visual information (indicators for head position, eye brows etc) is recorded by the ET-1750 camera and on the basis of that the gaze direction can be calculated. The ET-1750 pulses the light by the NIR-LEDs instead of continuously illumination.

Figure 2. Child in front of the Tobii ET-1750 eye tracking system.

All components of ET-1750 are integrated in a 17" TFT-monitor wrapped in a metal casing. The ET-1750 looks like a normal computer display with camera and illuminators hidden behind filters. The display has a maximum resolution of 1280x1024 pixels and a response time of 25ms. ET-1750 manages to record both eyes as long as the eyes are kept in a "virtual box" (20x15x20cm) in front of the monitor. ET-1750 tracks both eyes position and differentiate between left and right eye but only needs one eye to be able to determine the monocular eye position. It allows head movements within the traceable area with continued good accuracy of the eye tracking. ET-1750 is able to detect a maximum gaze angle of +- 40 degrees around the centre of the screen. The system has a resolution of <0.5 deg. Calibration was made binocularly using 16 points on the computer screen.

Procedure

The testing of cognitive profiles (the WISC) and gaze tracking took place at one and the same occasion (except for one child who came in twice)) at the Bernadotte Laboratories, St Erik's Eye Hospital, Stockholm. On arrival to the laboratories each child was familiarized with the test and experimental settings. The test situation was divided into two blocks. First block for the children consisted of WISC-tests 1-8, then a 10 minute break, then WISC 9-13, another break for 10 minutes and then the second block of gaze recordings.

The procedure of testing was administered in a standardized order and the same for all children, following the protocol of the WISC. To save time and administering the test as

smoothly as possible and not to induce stress or fatigue the subtest Object Assembly was arranged on beforehand, but covered, on a side table. In due time according to test proceedings the child was presented to each uncovered item of Object Assembly. A special emphasis was made to register the Narratives of PA, they were all written down immediately as they were told. The children were told that the posing part of Picture Arrangement was time limited and therefore instructed to work as fast as they possibly could.

Gaze tracking data was collected at the same time occasions as WISC testing. After a 10 minute break the second block of gaze monitoring took part. The subject was sitting comfortably in a chair at level with and 60 cm from the ET-1750 computer screen. Stimuli in the form of pictures of faces (4 separate on 4 different screens) were presented on the screen (See fig. 1 a-d). The four different digitized photographs of facial pictures were presented on the computer screen for 15 seconds each. There was a black screen with a central yellow fixation mark on for 1 sec between the facial picture presentations. The instructions given to the subject was to look at the pictures so that they could be described after the testing. The room was dimly lit and quiet and only the subject and the experimenter were present while performing the test. Total stimuli presentation time was 65 seconds for all four pictures.

Data was collected with a sampling frequency of 30 Hz and digitized for later offline analysis. Fixation filtering was used in that the maximum distance (radius) between two points. To be registered as considered belonging to the same fixation this could be varied, but for the present analysis 50 pixels were used. In addition a filter for the minimum time of which gaze

needs to be within the radius to be considered a fixation. This could also be varied but 200 msecs were chosen for the present report analysis. Total testing time for the two blocks was about 3 hours and for ophthalmologic investigation ½ hours.

STATISTICS

Parametric methods were used in order to assess the discriminating ability of the WISC, a regression analyses was performed of mean values. The logistic regression model provides an estimate of the conditional probability of belonging to the one of two groups given the values of a set of variables.

Regression analysis (ANOVA) was used to estimate the explained variation in Narratives due to interaction with either Freedom from Distractibility or Processing speed.

Differences between groups in scoring Narratives (stories of Picture Arrangement) and differences in speed in performing Picture Arrangement were analysed with chi-square test.

Fisher's r to z intragroup and pairwais comparisons of correlation and p-value of narratives and gaze behaviour in the four photos were investigated.

The relationship between gaze behaviour for the 4 picture photos, eyes not eyes, was investigated by Pearson's correlation coefficient.

All tests were two tailed and the alpha level was decided at 5%.

RESULTS

Neurocognitive findings

The results of the first task registering cognitive profiles of ASD-subjects and TD-subjects are seen in Table 4. The mean scaled scores for all the WISC subtests ASD and TD groups are shown in Figure 2. Notice that the table 4 is shown for informative purpose of basic figures and computations and not as evidence regarding intergroup differences.
Mean values of Full scale IQ, Verbal IQ, Performance IQ and WISC factors Verbal Comprehension IQ, Perceptual Organization IQ, Freedom from Distractibility and Processing Speed are shown in Table 3.

Table 3. WISC results; mean values standard deviation and confidence levels for ASD and TD groups.

	ASD children n=10			**Typically developing children n=12**			
	Mean	SD	CL	Mean	SD	CL	p -level
Age	13.5			13.8			
1. Information	9.7	3.9	7.3-12.1	10.6	2.0	9.5-11.7	ns
2. Similarities	11.2	5.1	8.6-15,0	9.1	3.1	7.4-10.9	"
3. Arithmetic	7.1	3.0	5.2-9.0	9.3	1.5	8.5-10.2	"
4. Vocabulary	9.9	3.7	7.6-12.2	9.4	3.1	7.7-11.2	"
5. Comprehension	6.2	3.8	3,9-8.6	9.4	3.1	7.7-11.2	"
6. Digit Span	8.4	4.1	5.9-11.0	9.4	2.8	7.8-11.0	"
7. Picture Completion	7.9	3.4	5.8-10.0	8.9	3.7	6.8-11.0	ns
8. Coding	8.5	2.8	6,8-10,2	8.3	2.8	6.7-9.9	"
9. Picture Arrangement	8.3	2.5	6,8-9,9	10.8	3.3	8.9-12.7	"
10. Block Design	10.8	2.1	9.5-12,1	10.8	2.4	9.4-12.2	"
11. Object Assembly	10.6	2.3	9,2-12,0	9.1	4.6	6.5-11.7	"
12. Symbol Search	7.0	5.1	3,8-10,2	8.9	4.4	6.4-11.4	"
13. Maze	7.9	4.6	5,1-10,8	8.4	3.8	6.3-10.6	"
Full Scale IQ	93	15.6	83.1-102.9	97	16.5	87.4-106.6	ns
Verbal IQ	94	16.8	87.8-100.2	97	13.3	89.6-104.4	"
Performance IQ	94	12.6	85.9-102.1	98	19.2	87.2-108.8	"
Verbal Comprehension	97	17.0	86.5-107.5	97	14.1	89.1-104.9	ns
Perceptual Organisation	96	10.8	89.2-102.8	98	18.5	87.2-108.8	"
Freedom from Distractibility	86	17.0	75.5-96.5	94	10.2	88.3-99.7	"
Processing Speed	87	22.0	73.4-100.6	91	21.8	79.1-102.9	"

The two groups showed a resemblance in profile of mean values with results below the standard mean value of 100 but with somewhat higher mean values for the TD group. Full Scale IQ for ASD 93 and for TD group 97. ASD children's profile showed that they are lower in some of the subtests namely Comprehension mean 6.2, Symbol Search mean 7.0, Arithmetic mean 7.1 , Maze 7.9 and Picture Completion 7.9 as compared to the TD- group. TD-group scored in the same subtests Comprehension 9.4, Symbol Search 8.9, Arithmetic 9.3, Maze 8.4 and Picture Completion 8.9.

The results from factors were: Verbal Comprehension had the same mean value for both groups (97). Still the groups resembled each other in that both lowered their mean values

compared to the two other factors Verbal Comprehension and Perceptual Organisation. In Freedom from Distractibility very low ASD result (86) and slightly lower TD result (94), in Processing Speed lower results of ASD-group (87) and less lowered result for TD-group (91).Results from the factor Freedom of Distractibility (FD), showed to be more disperse with the gap approximately of 1 to 1 ¼ of standard deviation between the groups. Processing Speed showed the most disparate intra groups mean values with a standard deviation of 22.0 for the ASD children and 21.8 for controls. Still the groups resembled each other in that both lowered their mean values compared to the two other factors Verbal Comprehension and Perceptual Organisation. No statistically significant differences were obtained. See table 4.

Nevertheless the results show heterogeneity of cognitive abilities within the two groups and this is also the case in many other studies of ASD children and control group children. This is the case not only in the "not typically developing group" ASD-group but also in the TD-group of subjects. The standard deviation –dispersion in subtests for the ASD-group was particularly high in Similarities 5.1, Symbol Search 5.1 Maze 4.6 and Digit Span 4.1.Compared to the TD-group who had slightly heightened standard deviation in Object Assembly 4.6, Symbol Search 4.4, Maze 3.8, and Picture Completion 3.7. See table 3.

Recalling the aim of this study in B) registering deficits in specific cognitive abilities in ASD children compared to their typically developing counterparts, the most disparate mean values in WISC subtests were in Picture Arrangement, Comprehension, Symbol Search and Arithmetic. The two factors Freedom from Distractibility and Processing Speed singled out having lowered results in both groups and the mean values the most disparate between groups. Statistical computations showed no statistically significant difference but interesting enough trying to see whether any of those factors might have an impact upon the dependent variable social cognition/Narratives. The intention to follow up the aims of the study and compare those two aspects of cognition in relation to Narratives and gaze behaviour seemed a fulfilment of commitment to the initial aims of the study.

Narratives of Picture Arrangement

The results from calculations of scores in Narratives of Picture Arrangements are calculated in percentage. The figures show differences between groups. Showing a difficulty for the ASD-group in criteria A, that is to understand the implied meaning of series of pictures. They gave correct answers to a higher extent in criteria B, as shown in table 4.

Table 4.Results in Narratives scores	**ASD%**	**TD%**
A Correct arrangement, correct story, implied meaning score 3	24	79
B Correct arrangement, story content essential information score 2	48	8
C Correct arrangement score 1	7	0
D Not correct arrangement, correct story, implied meaning score 2	0	7
E Not correct arrangement, story content essential information or adequate to story arrangements score 1	13	3
F Not correct arrangement. Score 0	8	1

The results show that the ASD group has a difficulty in finding the implied meaning to stories of interactive character. Across the five different qualities of narratives individuals in the ASD group correctly told a smaller percentage (24%) of implied meaning in comparison to TD group were 79% managed to arrange the stories and find implied meaning. A higher percentage (48%) of ASD children managed to tell stories correctly arranged and with story content *essential* information, versus TD children who had a result of 8%.

7 % of ASD children managed to arrange the pictures correct, but without ability to comprehend neither the implied meaning nor the essential information of the stories. An interesting result is that 7 % of the typically developing children didn't manage to arrange the pictures correct but comprehended the implied meaning or the essential information. While 8 % of the ASD children didn't manage to arrange the pictures neither correct nor comprehend the implied meaning or grasp the essential information. Only 1% of the TD children performed in the same way.

The next step was to investigate further if groups differed in the different aspects of Narratives coded in the qualities A, B, C, D, E and F. A chi-square test was performed and all values in the different qualities were calculated to evaluate the results of Narratives.

H0 = The ASD group results in Narratives doesn't differ from expected frequencies and are no higher than can be random.

H1= The ASD group differs significantly from the TD group in the variable Narratives.

The Chi2 test showed that the value 56, 44 correspond to $p<0.001$ with 3 degrees of freedom that the ASD children have a different distribution of scores compared to TD children in ability to comprehend and tell stories in Picture Arrangement, statistical significant scores were obtained, and therefore H0 hypothesis is rejected.

Group Differences in items of Picture Arrangements

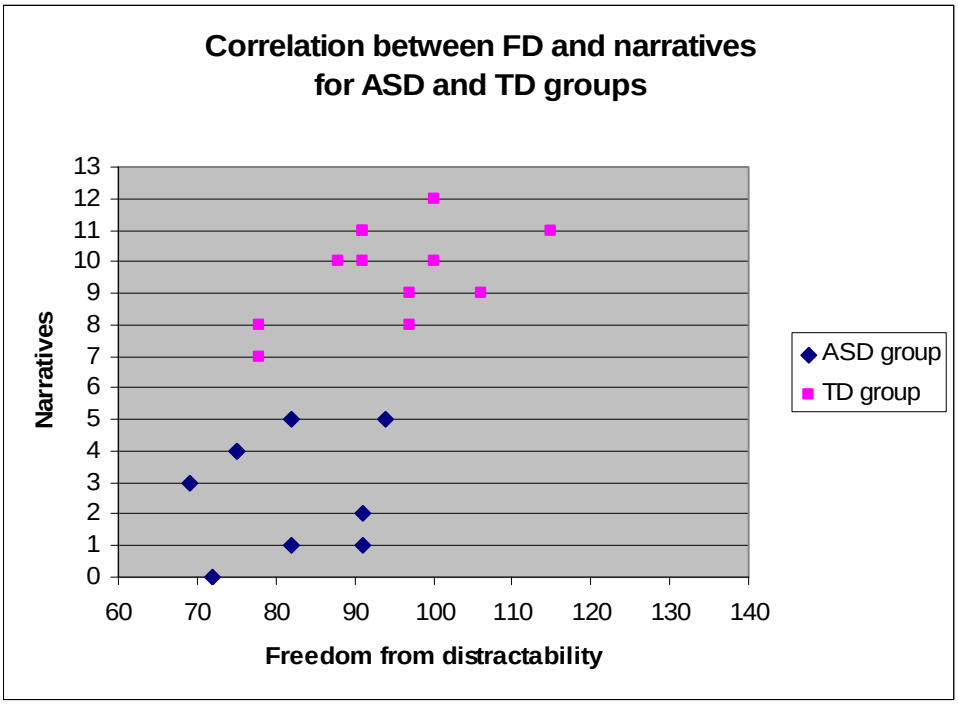
With a closer look at the different items 3-14 of PA and the quality of stories/Narratives told by the children it is possible to single out a few of the items to be more complicated and difficult for both ASD and TD children. For the ASD children to comprehend, arrange and tell stories with implied meaning the most difficult items were: item number 9, Man with a bench (18 scaled scores /30), number 12, Girl walking the dog (18 scaled scores /30) and 13, Man harvesting a field (16 scaled scores /30) and 14, House and shadow (9 scaled scores /30). For the TD-group the two most difficult items were: number 13, Man harvesting (31 scaled cores /36) and 14, House and shadow (26 scaled scores /36). The total possible scaled score for each item was for ASD group 30 and for TD group 36.

Correlation between Freedom from Distractibility and Narratives.

Recalling that Narratives difference between groups was statistically significant. The following investigations were to follow up if there be an interaction between Narratives and cognitive factors like Freedom from Distractibility and Processing Speed. Those were the cognitive factors with lower results both for ASD and TD children. One possibility could be that gaze behaviour is yet an important variable to have an impact upon the social cognitive abilities like Narratives in ASD children. In our initial suggestions and hypothesis also stipulated as differences in gaze behaviour between groups.

Freedom from Distractibility contains two subtests, Arithmetic and Digit Span. In figure 3, a combination of variables is computed to see whether a cognitive factor, Freedom from Distractibility, could have an impact upon the ability to find both correct arrangements and implied meaning in Narratives of PA.

Figure 3. Correlation between Freedom from Distractibility and Narratives for ASD and TD groups.



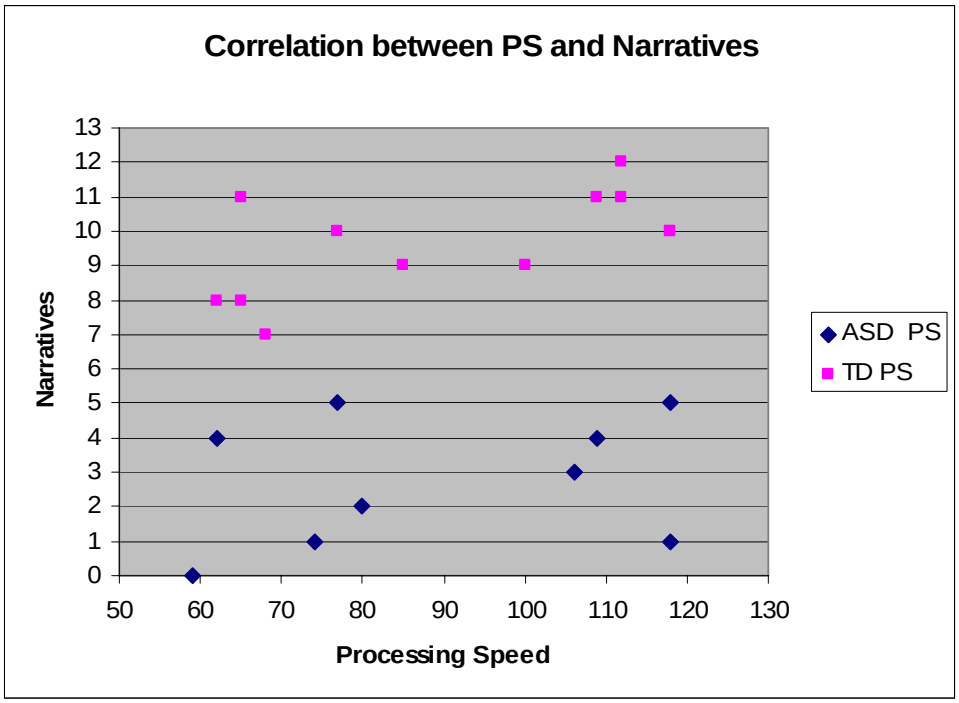
When calculating ANOVA and regression for variables the results for ASD group showed no correlation in explained variance and very small variance in narratives of 0,5 % from supposed impact from the Freedom of Distractibility variable. No significant effect of F(0.046) = p 0.84. In TD-group there is an interaction effect between Freedom from Distractibility and ability of Narratives in Picture Arrangements. Here shown as an impact of 98 percent of explained variance F (623, 5) =p 2.43. For the TD group higher scores in FD gives higher scores in Narratives. See figure 3. The results of the ASD group showed that they scored lower in both Narratives and in FD compared to the TD group. None of the results were statistically significant. The result in FD factor doesn't explain the variance in Narratives for the ASD children but a hint that ASD children could have a negative correlation between Freedom from distractibility since they have low scores in both Narratives and FD. One explanation could be that they are prone to be distracted and therefore

unable to focus on social situation. In could act the same way with gaze behaviour, low scores of FD gives low scores of total gaze time. Meaning that they look less /quicker at areas of interest because they are more distractible and therefore are not able to focus enough on social situations.

Correlation between Processing Speed and Narratives.

The relationship between the other cognitive factor Processing Speed and Narratives is yet to investigate. The significant discrepancy between ASD and TD groups in speedy performance of PA could likewise give further information when combining it with results in Narratives. The Processing Speed factor contains of two subtests, Coding and Symbol Search. In figure 5 the two variables are combined to see whether Processing Speed can have an impact upon the ability to comprehend the implied meaning in Narratives of PA subtest.

Figure 4. Correlation between Processing Speed and Narratives in ASD and TD



In the same way of thoughts as with Freedom from Distractibility it would be of interest to see whether Speed in performance of PA has an impact upon results of, and make a difference in ability in Narratives for ASD and TD children.

Results in calculating regression statistics ANOVA for ASD children showed that Processing Speed factor to a degree of 47% explained the variation in Narratives F 7.27=p 0.03. The results indicate a position positive in the linear line, that to some degree a higher score in PS the better score in Narratives. A definition of this can be that some of the ASD children increase their ability to social cognition (Narratives) if they are fast in solving the task; that is less distracted and more focused. Others have the opposite results meaning that higher results in PS factor don't help in ability to comprehend social situations and results might even be lowered. The results from calculating regression ANOVA for TD children showed that PS factor to a degree of 17% explains the variation in Narratives F 1.97 = p 0.191 The results indicate that the factor is of nearly no importance to controls when it comes to social cognition/narratives.

Speed in performing Picture Arrangement

The ASD children of this study scored high in subtests of verbal and perceptual origin and in some of the subtests. Especially on Block Design, Object Assembly and Coding. All subtests give bonus points for speedy performance or have time limit for correct solutions. Ability to perform well on those subtests is presumably, according to the Field of Dependency Theory, because of resistance to the power the field exerts on an individual's perception, of its components and characteristics. In Field Dependency the solving strategy calls for other qualities and the social attuning and considerations of all social queues comes into focus.

If deficits in cognitive aspects other than factors, like "pure" low speed in processing and then very low in Narratives then it adds to the child's total difficulties. Therefore investigations were made to se whether speed in performance of sequencing has an impact upon children's results. Results in speed of performance are presented in table 5. Nevertheless speed in Picture Arrangements can be a significant denominator in discriminating between groups in performance subtests of the WISC. Therefore a closer look as how speed is distributed

between groups has been computed to see if and possibly how important this is. When it comes to mental processing and gradual shaping (contains a moment of motor output as well) speed in sequencing PA can bee quite difficult and straining specially for younger children and possibly in particular for ASD children showing some specific social cognitive deficits. The formulation of hypothesis was as follows:

H1= the ASD group differs significantly from the TD group in the variable speed.

H0= the ASD group result in speed doesn't differ from the expected frequencies and are no higher than be random.

Table 5. Percentage in posing Picture Arrangements at speed (seconds)

	1-10sec.	11-20sec.	21-30sec	31-109sec
ASD-group	21	41	20	19
TD-group	38	36	17	9

With a comparison between ASD and TD-groups in Chi-square test of speed of performance it showed a probability $p > .99$ with 4 degrees of freedom that ASD-children have a different distribution of speed in performance than the TD-children.

When calculating for a Chi-square using the formula with 4 degrees of freedom the hypotheses were:

Chosen a significance level of 1 % I found that the given $\chi^2 \approx 19{,}93$ is higher than the critical value 18,46 and therefore the rejection of HO is obvious. This value corresponds to a probability $p \geq .99$ that the difference between groups is statistically significant.

Gaze behaviour results, gaze time and fixation counts

All areas of interest (AOI:s) were analyzed in picture photos 1a-d. In the present study some comparisons were made in areas of interest like nose and mouth, front and earring, while the main focus was on the core paradigms like i) total gaze time all photos ii) total gaze time of eyes, ii)total gaze time not eyes, iii) number of fixations in total as well as iv) number of

fixations at eyes in the four pictures. Comparisons were made between total gaze time all pictures and total gaze time eyes and total gaze time not eyes, respectively total fixation counts, and not eyes. Time measures were in milliseconds and fixation count in units of pixels in areas of interest.

In general all subjects performed well in the testing and there were no large differences found between the parameters tested and the groups. In the paradigm total time spent on gazing at faces all four pictures the total gaze time varied between 1.9 secs and 29.2 secs (mean 19.1; SD 5.9) in the ASD group whereas corresponding figures for the control group were 7.2 and 28.9 secs (mean 18.7; SD 8.4). In the other paradigm we measured the total gaze time spent on eyes exclusively and the time varied between 0.5 secs and 28.0 secs (mean 10.1; SD 8.3) in the ASD group and 1.0 secs and 23.8 secs (mean 10.1; SD 6.0) in the control group. The figures were transformed from milliseconds to seconds. (See Figures 7 and 8). The ASD children's mean value in total time spent gazing at eyes was the same as for TD children. The SD was less for TD children in total eyes gaze time, but in total gaze time all face pictures the ASD children had less SD. When analysing *median* fixation at eyes the ASD children looked less than the TD children.

Some differences in figures were obtained between median and mean values in parameters. This is probably due to the small group samples. For the ASD children the median time for the four different facial pictures correspond to totally 12 secs median gazing time at the four face pictures. Results for TD children correspond to 17 secs median gazing time for the pictures. The ASD children's total median time spent on gazing at faces was also somewhat less than the time spent by TD children. The ASD children then in order spent most time at picture 1, 2, 3 and least at picture 4. The TD children gazed most in order at face 1, then 4, 3 and least at face 2. They all spent most of the median gaze time at picture 1.

The parts of the faces that the subjects spent most time at were the eyes then nose and mouth. The fixation parameters were set to 50 pixels and 200 msecs (see for the description of the parameters). The median time the eyes were fixated amounted to 35%, 61%, 58% and 34% for the ASD/HFA group and the four facial pictures respectively. Corresponding figures for the controls were 56%, 39%, 54% and 42%. In some of the subjects, several AOI:s were

never fixated. In face pictures 2 the ASD children fixated more at nose and mouth than eyes. ASD children spent less gaze time at earring in face 2 than did the TD children.

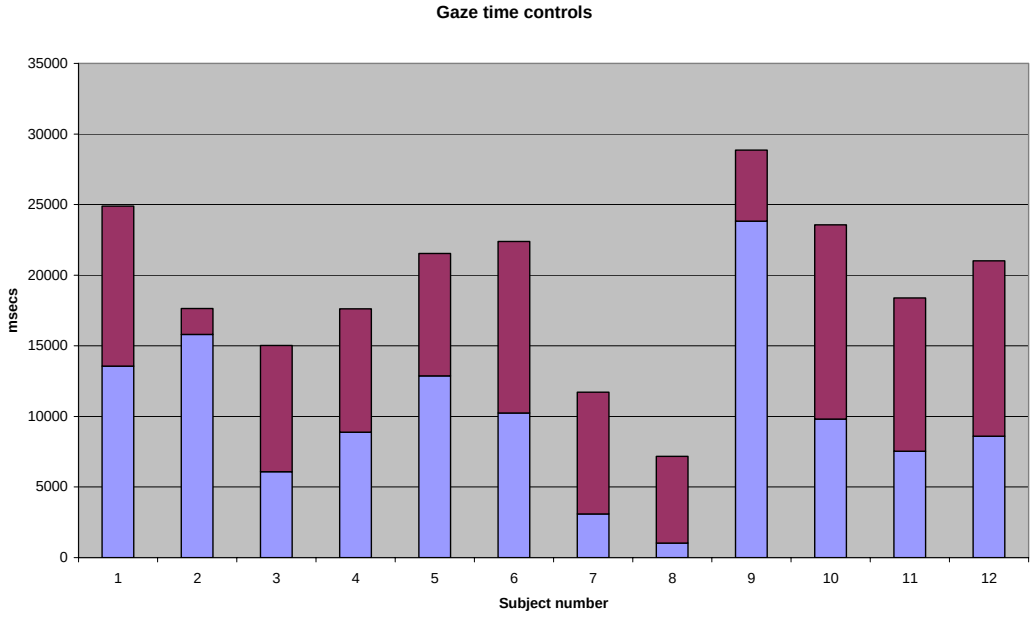


Figure 5. Total gaze time (whole bar, in msecs), eyes AOI gaze time (light blue) and non-eyes AOI gaze time (purple) in the control group.

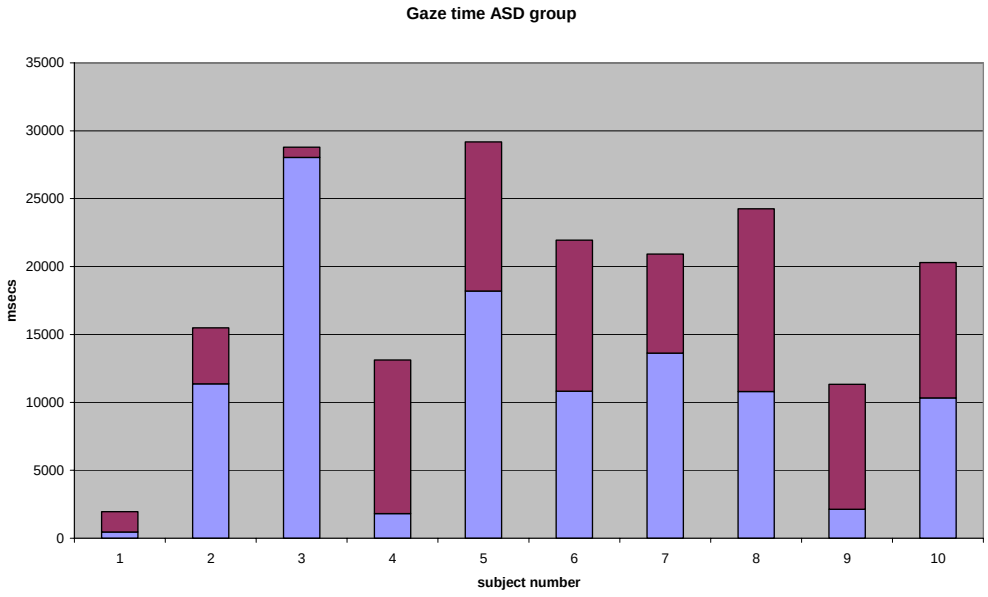


Figure 6. Total gaze time (whole bar, in msecs), eyes AOI gaze time (light blue) and non-eyes AOI gaze time (purple) in the ASD group.

When analysing times of fixation the following results were found. In median fixation count ASD children stopped 70% at eyes in face 4 and 60% in faces 1 and 3 and 50% in face 2. They fixated more at mouth and nose in face 2 than on eyes. TD children fixated most at eyes compared to other areas of interest in all faces. They spent 60% at eyes in pictures 1, 2 and 3 and less times 50% at eyes in picture 4. ASD children fixated totally most at eyes in all face pictures except picture 2. They fixated the eyes to a higher degree in picture 1, then in order picture 3, then in picture 4 and least in picture 2. When comparing areas of interest ASD children fixated in order most at eyes, then nose and mouth, then front and lastly at earring (picture 3) than TD children. The TD groups fixated most at eyes then in order at nose and mouth, earring (picture 3) and least at front. In face 1 ASD children fixated secondly most at nose and mouth and thirdly at front than did TD children. In face 2 and 4 the numbers were reversed and TD children fixated secondly most at nose and mouth. On the whole TD children spent more time fixating faces than did ASD children, the difference was ASD children 47.5 sec. and TD children 56.0 sec.

The results were that TD children fixate totally most at eyes in all picture photos than did the ASD children. See figure 7.

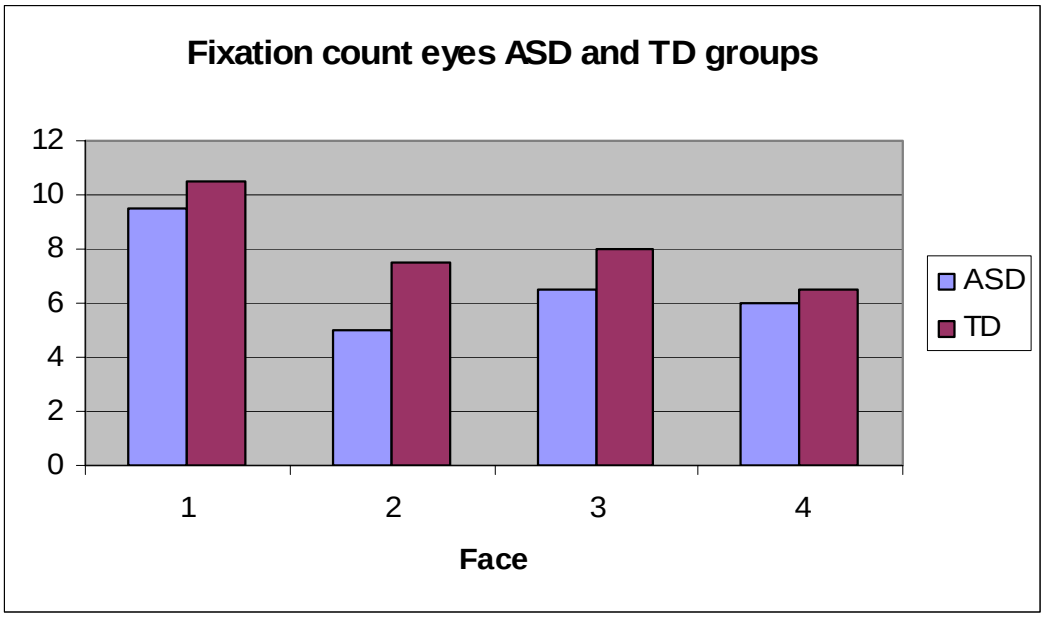


Figure 7. Total fixation count eyes ASD and TD groups

Correlation between social cognition and gaze behaviour

The observations of group differences in number of fixation counts at eyes and not eyes in the four faces pictures and the number of correct narratives (ToM) were explored further in the context of a 2 (group ASD vs. TD) mixed design analyses of variance (ANOVA) procedure. The ANOVA table for total fixation counts in all face pictures showed no statistical significant difference F (417.183) =3,417, p-value .079 between groups. The line plot for a profile of Narratives and Total fixation counts (figure 12.) showed noticeable correlation effects for the groups. The ANOVA table for difference in correlation between groups showed a statistical significance F (9.988) =59.825, p-< .0001. The same results was found in groups calculating Narratives and total eyes gaze F (13.43)= .841 p--<.0001 .

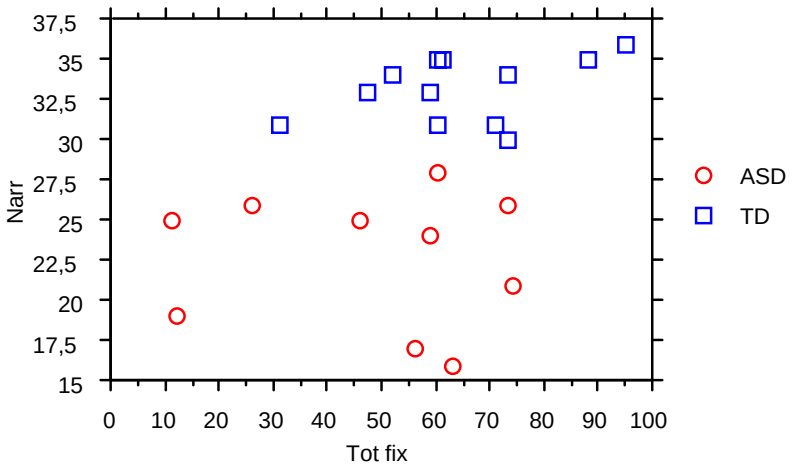


Figure 8. Correlation between total fixation count of eyes and Narratives (ASD and TD groups)

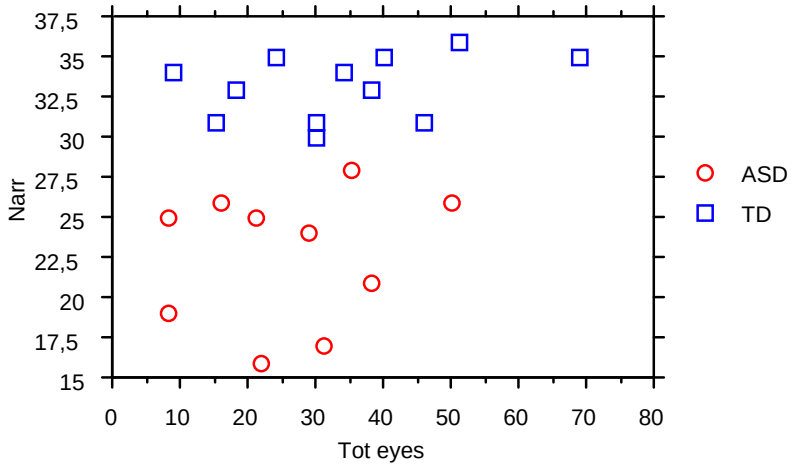


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Figure 9. Correlation between total gaze time (sec.) eyes and Narratives (ASD and TD groups)

The correlation matrix investigations made with Fisher's r to z showed as follows: the Narratives interaction with total fixation of Eyes showed an explained variance of 37 % and p value <.0946 but no significant correlation. Narratives and total gaze Eyes gave a variance of 33% p value < .14.

Table 6. Matrix of inter correlation effect in Narratives and total fixation count eyes and level of significance.

Correlation Matrix

	Tot fix	Narr
Tot fix	1,000	,366
Narr	,366	1,000

22 observations were used in this computation.

Fisher's r to z

	Correlation	P-Value
Tot fix, Narr	,366	,0946

22 observations were used in this computation.

When calculating the Fisher's r to z for all children and comparisons of total fixations and Narratives no significant differences were found.

A calculation of Fischer's r to z was performed to investigate the inter correlation between facial pictures. Some of the four face pictures showed relatedness in the subjects interest either by gaze or fixation. The results for those face pictures were more indicative for usefulness in the investigation of face perception in ASD children.

The fixation count eyes for face picture 2 correlated the most with total eyes fixations r=.930 of the variance is explained by the ability to fixate at eyes in face picture 2 ($p<.0001$). Eyes face picture 4 and total eyes gave a correlation of r= .888 and ($p<.0001$). Likewise the fixation counts for face picture 1 correlates most with total eyes fixations were r=.878 were the variance is explained by ability to fixate at eyes in face picture 1.($p<.0001$). Eyes face picture 3 gave result with total fixation eyes r=.860 ($p<.0001$). Same face picture 3 gave results for total gaze of eyes with r=.853 ($p< .0001$). Further results showed that fixation counts eyes in face picture 2 correlates the most, r=.840 with ability to fixate at eyes in face picture 4. ($p<.0001$). Eyes gaze in face picture 1 correlates to the ability to total eyes fixation with r=.802 to extent ($p<.0001$). Eyes gaze picture2 and Eyes gaze face picture 3 resulted in

r=.761 (p<.0001). Not eyes gaze 2 and not eyes gaze face picture 3 gave r=.724 (p<.0001) and eyes gaze picture 1 and eyes gaze picture 3 gave r=.718 (p<.0001).

Discussion

The present study has come to findings indicating a disruption in social communication in ASD children compared to their typically developing counterparts. The disruption is characterized by abnormal predisposition in gaze behaviour and face perception. These findings supported by several former researchers (Hobson 1988, Hobson et al., 1988) and facial affect and direction of eye gaze (Baron-Cohen et al., 1997, Leekam et al., 1997) as well as diminished rates of eye contact (Phillips et al., 1992) and difficulty in social interaction with others (Pierce K, Schreibman L,1995), and emotional recognition (Pelphrey et al 2002).

One of the strengths in the present study is the use of a highly selected sample from a longitudinal research group of children with autism spectrum disorders. Results show that all 10 children diagnosed with AS/HFA had severe impairments in social and behavioural functioning. The medical records as well as other data from interviews with parents and children indicated a pervasive impairment in children's behaviour. The initial assessments with parent and teacher rated ASSQ data in different settings (home, school) showed high rates of autistic features and behavioural problems. A broader spectrum of autistic disorders (BAP) was seen in the studied group since the sample contained both Asperger´s children and high functioning autistic children (HFA). Maybe the results would have been different if the group had been of "pure" either Asperger´s Syndrome children or "pure" low functioning autistic children. In this study the sample was more heterogeneous and which also opens up for interference from any co-morbidity of other pervasive developmental disorders such as ADHD, ADD and Tourette´s Syndrome. Some of those diagnoses have symptoms very alike. The thorough and careful diagnostic step-by-step assessment of exclusion criteria and indications of the "normal mix" of co morbidity usually seen in ASD children are the strengths of the study.

In a study by Ardila et al (1998) a sample of 300 normal subjects, right handed, aged 13-25 years, middle-class students found dispersion in scores observed on some of the "classic" psychological and neuropsychological tests. The Wechsler's scales were used for testing

cognitive profiles like this study. It was evident from that study that a particularly high dispersion in IQ scores was found in the control group just as the case in a completely normal and homogenous population. In this study no statistically significant difference in IQ was found between ASD and TD groups so differences between groups in ToM/Narratives is not simply due to general ability differences.

The relatively small sample of controls in this study makes it, on the other hand, more vulnerable to the possibility of "extremely healthy" and well functioning children and on the whole difficult to interpret the results and form statistical evidence of results. As the sample of typically developing children first was recruited by school nurses it might have been the healthier children that first were approached. Later some rate of medical problems showed in the group, mainly allergic symptoms.

Yet another consideration is the discrepancy in year of first assessment of diagnoses for the ASD children. Some of the children got their diagnoses early, some much later. Maybe it's better to have a diagnosis early in life and then get good training. This can also have an impact upon test results and answer for some of the variance in results within the ASD group.

There is a discrepancy between Speed in performance results and total gaze time for the two groups. ASD-children took longer time in seconds to perform the PA subtest than did the TD children. The results were statistically significant.($p<.001$). When viewing four facial pictures the ASD children fixated less at eyes and total gaze time was less than TD children. In other studies this quick scanning (less gaze time) of visual stimuli has been interpreted as a good general ability to process information. But in this case it does not because the results prove the opposite. A conclusion of the results is that ASD children took longer time to pose pictures, because they have a delayed ability to process information when they have to attribute mental states and to understand pictorial conventions. This could possibly be coupled to a difficulty in ability to ***verbalize*** the content. Picture Arrangements is one of the two subtests that involve semantic evaluation and put pragmatic demands upon subjects, the other subtest is Comprehension. But since there was no significant difference between groups in VIQ this was not co varied out in analyzing the results since this would have over controlled for the variable of interest Narratives. The possible interpreted of those results are that the two groups have the same semantic "technical" ability but when it comes to comprehending a sequence of

actions and unspoken social/emotional meaning of a situation the ASD children fail to recognize to full extent parts of this. They get stuck trying to find out ***exactly*** what the meaning is and by then takes to long to verbalize more complex material like telling a social story. In an study by Baron-Cohen (1989) of high functioning autistic children the findings indicate that performing high on the WISC, results in success rate in theory of mind but might not bee genuine proof of possessing a theory of mind. Another study by Happé et al (1998) found that high functioning autistic children showed an additional remaining cognitive impairment despite high performance on the WISC. Alternatively, pointed out in another study, their success in some theory of mind tasks are rather evidence of the "hacking out" of some strategy for solving the tasks. (Frith et al 1991).

Another interpretation of the results is that ASD children might very well comprehend the implied meaning of stories but doesn't realize the value of being explicit in verbalizing it to ***another*** person. Another suggested conclusion is that ASD children have different strategies (from TD children) in solving the task of posing pictures correct and at speed. This angel of interpretation fits in with the cognitive theory of Field Dependence and Field Independence. The high level ASD children have sometimes learned to use the exclusion strategy, a global strategy, for posing pictures correct in sequential order. This strategy is less time consuming, but lead to hasty and superficial conclusions and interpretations of social situations. In the end it reveals a loss of depth understanding as to the implied meaning when asked to tell the story. This can explain why some of the ASD children in this study managed to pose PA correctly but was unable to neither comprehend the implied meaning nor tell a plausible story. (See Results table 4). Yet another conclusion that couples the ability of social cognition to gaze behaviour is that when ASD children scan a picture or supposed AOI´s they become ascertain and disorganized about the value of focusing on AOI eyes or whatever to focus on. This may also have significance for cognition when posing pictures in PA because the complexity of Theory of Mind increases with number of pictures, persons and situations to assess. It is detectable which of the Narrative set of items are more difficult for ASD children than TD children. Item difficulty in the different stories became obvious, both ASD and TD children had difficulties in specific items. Some were common to both groups and some were disparate. Here dimensions of less ability for both groups to detect social/emotional aspect of characters in pictures are shown in the Narratives told. The WISC provide standardization of complexity increasing in parallel to children's normal biological development. That is why

typically developing children of age 10-11 ½ doesn't gain full scores in the lastly presented items in PA.

When a "pure" variable of speed in performance is introduced a difference between groups was found. The PA sequencing part (set free of the Narratives part) was administered and time in seconds registered for each group. This variable shows a statistically significant difference between groups in speed of performance possibly due to the above mentioned high involvement of social visual cues from the pictures.

It seems logical to conclude that ASD children of this study be lower in information processing of visual queues, when the task also involves analysing and verbalizing social events. They showed low results in subtests considered belonging to a Field Dependent style of cognition like Picture Arrangement the Narratives part, Comprehension and Arithmetic (as presented in the WISC). The WISC Arithmetic is presented in a certain way telling an arithmetic problem in a social context, this makes it more complex. In this aspect, due to loss of consistent, time-enough-spent visual inputs and thereby loosing important information, the process of analyzing social situations (since they are not static but moves on all the time) might become chaotic and fragmented and takes longer time for ASD children to complete and to interpret.

Theoretical and Methodological considerations of Wechsler's scales

Several of the subtests in WISC related to the theory of Field Dependence and Field Independence. That is how we perceive, learn and relate to people rather than to the content. In the WISC the items Picture Completion, Block Design and Object Assembly are all considered items of relative Field Independence. Ability to perform well on those items is presumably because of resistance to the power the field exerts on an individual's perception, of its components and characteristics. In this study the ASD group had difficulties with items like Picture Arrangements both in comprehending content and in speed of performance. The item considered relatively connected to Field Dependence. Other tests that cover the area of cognitive style is the Rod-and-frame test, the Body Adjustment test and the nonverbal Embedded Figures test (Within et al., 1977; 1971). It would have been interesting to compare some of those tests with the WISC. The ASD children of this study score high on some of

those particular subtests. Ability to perform well on those subtests is presumably because of resistance to the power the field exerts on an individual's perception, of its components and characteristics. In Field Dependency the solving strategy calls for other qualities and the social attuning and considerations of all social queues comes into focus.

The ASD children of this study show lower results in information processing of visual queues, when the task also involves comprehending and verbalizing social events. They show low results in subtests considered belonging to a Field Dependent style of cognition like Picture Arrangement, Comprehension and Arithmetic (as presented in the WISC). The WISC Arithmetic is presented in a certain way telling an arithmetic problem in a social context, this makes it more complex. In this aspect, due to loss of consistent, time-enough-spent visual inputs and thereby loosing important information, the process of analyzing social situations (since they are not static but moves on all the time) might become chaotic and fragmented and takes longer time for ASD children to complete and to interpret. On the contrary the *factor* PS doesn't seem involve much of social cognition (subtests Coding and Symbol Search) or Field Dependency aspects since its components is not involving any judgements of social characteristics, affect tone and the like.

Using Wechsler scales to define the cognitive functioning of the children have some statistical complications worth discussing. The idea behind the construction of Wechsler scales is that of two basic assumptions. 1. Cognitive ability (intelligence) is normally distributed in a population and 2. The (statistical) error is likewise normally distributed in a population. From this point of view it is possible to calculate and analyse data from mean value (M) and standard deviation (SD). Since I used the intervals of confidence in the individual analyses this too builds upon the statistical and theoretical considerations mentioned above. But, those calculated values are strictly theoretical and does not in full extent allude to "the real world". That is why in reality, when standardizing and normalizing data results can look very different from what we expected. (P-A Rydelius personal communication). One explanation to this in the study is that the more individuals in a sample the easier to obtain a normal distribution of scores and secondly the more items that adds to scores the better for normal distribution of scores. Another explanation to this is that the statistical error is asymmetrical.

The basic assumption in Wechsler scales is that the standard error is constant and symmetrically distributed for individual and scale that is the same error goes for individuals with low, average and high intellectual ability. (Kaufman 1994). More modern statistical expertise advocates that this is not the case. The findings is that the error is less around the average centre of the scale and higher at "the tails" of the distribution (Roid & Sampers 2004). The different parameters in considering the methodology and results are not only in numbers of subjects but it also contains: number of items, number of individuals in each age group and sample, actuality of items (validity) and that the error looks different due to where on the scale the individual is, and then the individual himself is a unique being. All those parameters might not to full extent be considered in psychometric assessment scales, e.g. like the Wechsler scales (v. Knorring, unpublished report 2006).

Methodological considerations eye tracking

Since the system of eye tracking operates with some tolerance for head movements there is no need for head stabilization devices such as bite boards, head and/or chin rest etc. A further advantage of this study is that a head movement stabilization device may be of disadvantage especially in the patient group that was studied. The equipment therefore has a minimal physical and psychological influence on the test subject. Video based ETS like ET-1750 has been shown to be suitable eye tracking methods in several different areas such as investigating visual perception and vision search patterns (Tiersma ES, Peters AA, Mooij HA, Fleuren GJ. 2003), preferential looking, detect abnormal gaze behaviour in relation to social stimuli and dyslexia research (Luca M, Pace E, Judica A, Spinell D, Zoccolotti P 1999).

Due to technical reasons 5 children (3 HFA and 2 controls) had to be omitted from the analysis so that the final analysis was performed on 10 HFA children and 12 control children. Each recording was inspected in Clear View® and each data sample where the ET-1750 could not locate the eyes (eye blink etc.) was deleted, using a validity code that was set with each sample.

The different stimuli (facial pictures) were divided into areas of interest (AOI) covering for example right eye, left eye, nose etc. so that each picture gave rise to 10, 12, 13, and 14 AOI´s respectively (see fig 1 a-d) covering most of the whole facial picture. Small areas of the facial

pictures representing about 10% of the whole picture area and without any obvious interest to the viewer (mostly background) were not covered by an AOI. Both the number of fixations (fixation count; fc) as well as viewing time (gaze time; gt) for each AOI in each picture was analysed. Some of those areas were never fixated by the children. Given the results indicating no significant differences between groups concerning eyes non eyes gaze time we found that face picture 2 gave evidence that ASD individuals may reply more to other parts of the face that is the nose and mouth area, than the eyes. In general the sequences regarded as fixation by the Clear view program increased with increasing number of pixels as well as increase in gaze time. For the detailed analysis of the gaze behaviour (gaze time and fixation count) the combination of 50 pixels and 200 msec was chosen. A follow up study with other paradigms of gaze behaviour like scan paths to show the way and order in which the subjects conduct their gaze could be of interest for example in studying proto declarative behaviour the kind of social behaviour of joint attention.

The four facial pictures used have no standard norms for this kind of study. From the statistical investigation some of them show to fit the purpose better and gave statistically significant results. The results show that some face pictures were highly correlated to results of fixation at eyes, and one was not. A set of face picture photos standardized for the group would be of benefit for a follow up investigation of the aims of the study. Nevertheless some of the face pictures used seemed to fit the purpose better and gave statistically significant results.

Conclusions

The present study assessed whether patterns of gaze behaviour, social cognition and specific aspects of cognitive profiles were different between groups of ASD children and of typically developing children. Several subtests of the WISC calls for a fluent, speedy visual scanning, Gestalt closure, mind's –eye rotation of figures and ability to see reversals as mentioned earlier. The ability to solve problems and tasks at considerable speed is connected to core aspects of general intelligence ***g***. The WISC, FSIQ shows no difference between the two groups. When psychometric assessment and tests of gaze behaviour were combined children with Asperger´s syndrome render results showing that social cognition and speed in cognitive processing is a divider between them and controls. It might be that when elementary cognitive

tasks are aggregated across different ***modalities***, in this study visual as in gaze behaviour, and ***content domains*** like verbalizing Narratives, **and** ***tasks*** like speed/reaction time in posing PA the discrepancies between groups becomes detectable and diagnostic criteria for the syndrome can be formed.

The investigation is based on subjective and objective measures. Main results indicate that some of the problems are more common amongst children with ASD than in typically developing controls. The results obtained by measuring abilities in Narratives (ToM) and Speed in performing PA, Processing Speed and fixation show that difficulties are more common in ASD children. ASD children showed less accuracy in social cognition (ToM) in the ability to comprehend and verbalize stories out of pictorial devices. Social (ToM) abilities could increase when TD subjects also showed higher scores in ability to focus on cognitive tasks. That is when they had higher scores in Freedom from Distractibility. For ASD children the results showed the opposite, low scores in FD were coupled to low scores in Narratives.

In comparison between groups, ASD children in this study showed deficits in specific cognitive abilities like Processing Speed and Freedom from Distractibility. ASD children displayed abnormalities in gaze behaviour such as fewer fixations on important features of human faces like eyes. Gaze patterns of ASD children showed totally less time spent in looking at eyes in all four pictures compared to TD children. Fixation count showed that the TD children fixated more at eyes than did the ASD children.

Significant between-group differences were obtained in Narratives (social cognition) and gaze behaviour fixation of eyes. Interaction effects in some in some facial pictures were obtained. The results of facial pictures intercorrelations would be of interest in a new study with lager sample of participants. The results do not evince that the cognitive profiles differs between ASD and TD children.

Gaze patterns of ASD children showed totally less time spent in looking at eyes in all four pictures compared to TD children. Fixation count showed that the TD children fixated more at eyes than did the ASD children.

Social (ToM) abilities could increase when subjects also showed higher scores in ability to focus on cognitive tasks. That is when they had higher scores in Freedom from Distractibility.

When posing picture arrangement and telling social stories ASD children demonstrated a lack of comprehension to the implied meaning of social stories and had a slightly different pattern of gaze behaviour. They showed reduced interest in eye fixation and reduced fixation totally in all facial pictures compared to controls. The conclusion is that deficits in fixation of eyes and totally fewer fixations may lead to less orientation towards events in social situations that is important for the individual, and if this is consistent with high degree of distractibility and slow processing speed it could become vital for negative adjustment to social- and educational environments. Baron-Cohen (1995) have stated that individuals with autism have a modular impairment in sharing attention with others, called the shared attention mechanism (SAM), which follows a difficulty in acquiring a theory of mind mechanism(ToM).

When the ASD children pose Picture Arrangement and tell social stories they demonstrate a lack of comprehension to the implied meaning of social stories.

The conclusion is that Asperger´s children's deficits in fixations and total gaze time of eyes lead to less ability in orientation towards events in social environments and situations that is important for the individual, and if this is consistent with high degree of distractibility and slow processing speed judging social situations and too rapid visual scanning of faces it becomes vital for negative adjustment to social- and educational environments. Baron-Cohen (1995) have stated that individuals with autism have a modular impairment in sharing attention with others, called the shared attention mechanism (SAM), which follows a difficulty in acquiring a theory of mind mechanism(ToM). A study by Klin et al (2002) found that the best predictor of ASD was reduced eye region gaze and fixation time and deficits in social cognition, results that are supported by the findings in this study.

ASD children in this study who score low in distractibility (FD) also have difficulties in concentration and focusing that may lead to slower information processing. This kind of distractibility symptoms without hyperactivity may not be of same origin as for children diagnosed with ADHD/ADD (combined type). Neurobiological studies have found the

disorder in ADHD children to be coupled to a dysfunction in the hind associative cortical areas and some of the sub cortical structures, possibly within the hippocampus system. (Barkley 1990). This promotes the idea that autism spectrum disorders have *symptoms* in correspondence to ADHD/ADD but the neurobiological origins may be of different kind.

It is quite possible and very likely that neurobiological variables interfere with those developmental aspects also coupled to the early attachment to a care giver. Those variables could very well be a lack of motor/sensory/ perceptual skills. Here the introductory chapter concerning new research on brains mirroring neurons can add a new dimension to the knowledge of autism spectrum disorders. Maybe a high degree of distractibility is yet another symptom coupled to those neuroaspects mentioned. Likewise could a slow processing of interpreting social events and less time spent on scanning of visual queues like eyes hinders the ability to develop Theory of Mind and social communicativeness. Those deficits in individuals with an autism spectrum disorder could very well be results of neuronal blockings of specific mirror neurons. If a child doesn't use her social cognitive abilities or for any reason doesn't train it from an early age loose the ability that was innate by neuronal networks.

The results in Narratives display that ASD and TD children to some extent share the same developmental age-related problems in detecting and comprehending the social cognitive part in PA items. TD children in the study had difficulties with the last 2 items in PA, which seem quite in order with the standardization and norms of the test. In some of the other items the ASD children display difficulties which are not due to age related, maturation process difficulties.

To the best of our knowledge the current study might be the first to provide a combination of social cognitive (Narrative), cognitive profile and gaze behaviour aspects in investigating differences between school-aged ASD and TD children.

The use of WISC factors and elaboration of Picture Arrangement into the variable Narratives as described earlier was highly recommendable for the documentation of social cognitive ability, since the WISC is a well-known standardized and normalized instrument for testing

cognitive profiles. Recommendations were also given to use another modality (vision) by measuring ability in attentiveness to eyes in documenting patterns of gaze behaviour.

Other strengths of the current study pertain to the inclusion of children with a broad range of ASD/HFA, a limited age-range and the use of a control group of typically developing children similar to the ASD group in IQ, age and gender.

However the generalizability of the results is limited since the data were based on a small sample of children. This seems to be common of most research on autism disorders and visual scanning/ gaze behaviour which explains itself by the children's core difficulties to participate per see. Yet another weakness of the study is that the 4 face picture used as stimuli was not standardized for the age group when investigating gaze patterns.

Future research in the area of childhood AS/HFA may address the need for:

1. Development of methods for early detection and diagnoses of the impairment.

2. Carefully designed training in homes, nurseries and schools for ASD children in visual attention and comprehension of social situations.

3. Parental and teacher's training to the importance of the matter should be routine in maternal and educational units as soon as diagnoses are settled.

In learning more about the mechanisms dedicated to the processing of social communicative and emotional functioning in autism spectrum disorders we look forward to continue this study with a lager number of participants, with psychometric and experimental settings to increase the understanding and knowledge of the disorder. All in the endeavour of science to help out in making the lives and situations better for many young children and adults who suffer setbacks of the disorder. We likewise look forward to know other studies of neuronal imaging techniques, psychometric assessments combined with paradigms of somatosensory and emotional aspects of autism spectrum disorder.

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APPENDICES

APPENDIX 1. Manuals for Diagnostic Criteria

There are two different manuals for categorizing Childhood Autism and Asperger´s Syndrome namely The International Classification of Diseases (ICD-10) and The Diagnostic and Statistic Manual of Mental Disorders (DSM-IV. In both manuals the syndromes fall into the heading category of Pervasive Developmental Disorders and received official diagnostic status under this category in the beginning of the 1990-ies. In this study we relate to diagnostic criteria from the manual ICD-10 as follows.

ICD-10 research criteria for Childhood Autism

A Abnormal or impaired development is evident before the age of 3 years in at least One of the following areas:
(1) receptive or expressive language as used in social communication;
(2) the development of selective social attachments or of reciprocal social interaction;
(3) functional or symbolic play.

B A total of at least six symptoms from (1), (2) and (3) must be present, with at least two from (1) and at least one from each of (2) and (3):
(1) Qualitative abnormalities in reciprocal social interaction are manifest in at least two of the following areas:
(a) failure adequately to use eye-to-eye gaze, facial expression, body posture, and gesture to regulate social interaction;
(b) failure to develop (in a manner appropriate to mental age, and despite ample opportunities) peer relationships that involve a mutual sharing of interests, activities and emotions;
© lack of socio-emotional reciprocity as shown by an impaired or deviant response to other peoples emotions, or lack of modulation of behaviour according to social context, or a weak integration of social, emotional and communicative behaviours;
(d) lack of spontaneous seeking to share enjoyment, interest or achievements §with other people (e.g. a lack of showing, bringing or pointing out to other people objects of interest to the individual)

(2) Qualitative abnormalities in communication are manifest in at least one of the Following areas:
(a) a delay in or total lack of development of spoken language that is not accompanied by an attempt to compensate through the use of gesture or mime as an alternative mode of communication (often preceded by a lack of communicative babbling);
(b) relative failure to initiate or sustain conversational interchange (at whatever level of language skills is present), in which there is reciprocal responsiveness to the communications of the other person;
© stereotyped and repetitive use of language or idiosyncratic use of words or phrases;

d) lack of varied spontaneous make-believe or (when young) social imitative play.

(3) Restricted, repetitive and stereotyped patterns of behaviour, interests and activities are manifest in at least one of the following areas:

(a) an encompassing preoccupation with one or more stereotyped and restricted patterns of interest which are abnormal in content or focus; or one or more interests abnormal in their intensity and circumscribed nature though not in their content or focus;

(b) apparently compulsive adherent to specific, non-functional routines or rituals;

(c) stereotyped and repetitive motor mannerisms that involve either hand or finger flapping or twisting, or complex body movements

(d) preoccupation with part-objects or non-functional elements of play materials, such as their odour, the feeling of their surface, or the noise or vibration that they generate.

C The clinical picture in not attributable to the other varieties of pervasive developmental disorder; specific developmental disorder of receptive language (F80.2) with secondary socio-emotional problems; reactive attachment disorder (F94.1) or disinhibited attachment disorder (F94.2); mental retardation (F70-F72) with some associated emotional or behavioural disorder; schizophrenia (F20.-) of unusually early onset; and Rett´s syndrome (F84.2).

ICD-10 research criteria for Asperger´s Syndrome

A There is no clinically significant general delay in spoken or receptive language or cognitive development. Diagnosis requires that single words should have developed by 2 years of age or earlier and that communicative phrases be used by 3 years of age or earlier. Self-help skills, adaptive behaviour, and curiosity about the environment during the first 3 years should be at a level consistent with normal intellectual development. However, motor milestones may be somewhat delayed and motor clumsiness is usual (although not a necessary diagnostic feature). Isolated special skills, often related to abnormal preoccupations, are common but are not required for diagnoses.

B There are qualitative abnormalities in reciprocal social interaction (criteria as for autism).

C The individual exhibits an unusually intense, circumscribed interest or restricted, repetitive, and stereotyped patterns of behaviour, interests, and activities (criteria as for autism; however it would be less usual for these to include either motor mannerisms or preoccupations with part-objects or non-functional elements of play materials).

D. The disorder is not attributable to the other varieties of pervasive developmental disorder; simple schizophrenia (F42-); schizotypal disorder (F21); obsessive-compulsive disorder (F42-); anankastic personality disorder (F60.5) reactive and disinhibited attachment disorders of childhood (F94.1 and F94.2,

Appendix 2. WISC Picture Arrangements.

Subject´s Information to Picture Arrangements

The instructions are as follows: Put the cards together in order to tell a story as fast as you can. It´s on time. Lay the cards from left to right. When you have finished posing the cards tell the administrator. The time taking stops. Then tell a story containing what you think happens in the posed pictures series.

1 **Soda machine**, 3 cards. Trial task: A girl stands before a soda machine. She is thirsty and wants to buy a soda. She looks in her purse for money to put in the machine. She puts her money in the machine, gets a soda and drinks it.

3.**Creek**, 4 cards. A boy is walking towards a creek, or stands bye a creek. He wants to cross over without getting wet/falling in/drowning. He sees no bridge but some wooden hoardings a side the creek. He puts the hoardings together and manages to cross the creek without getting wet or falling in, etc.

4. **Having a snack**, 4 cards. A girl is in a kitchen, she is hungry and she takes out milk, then bread and jam to make a sandwich. She puts glass, plate and a knife on the table. While she prepares the sandwich the cat comes into the kitchen from behind so the girl can´t see it. The cat is hungry as well. The cat comes up behind her and when she turns away the cat jumps up on the table and starts drinking milk from the girl´s glass. When she notices this she is surprised/ annoyed/angry and tries to stop the cat.

5**. Drifting boat**, 5 cards. A boy at the key is trying to untie a small boat. He wishes to take a tour, but loses the grip of the rope and the boat is drifting away from the key. While he is doing this a couple of dogs come running chasing a cat. The cat is afraid and runs up to the boy as he is leaning over the boat. The cat uses the boys back to climb on board the boat. The boat is drifting further out and the boy looses grip of the rope and falls in the water and some of the dogs too. The dogs still tries to reach/ catch the cat. The cat is in the boat alone. The cat got away. The cat managed to get away/ is saved/is happy/.

6. **Robbery**, 4 cards. A cowboy enters a shop intending to make a robbery. He is a bad guy/ a thief/ he isn´t just. He tells the shop assistant he want to buy a rope and points at a rope hanging on the wall. He takes the rope and ties the shop assistant to a rocking chair and then takes all the money from the cash register.

7. **Planting a three**. 5 cards. A boy is in the garden with his mother/older woman . Mother or woman gives the boy a shovel and tells him to plant a three that is standing in a sack a side. The boy starts to dig, and while digging up comes some warms. The boy doesn´t want to plant the three/becomes tired/wants to have fun. So when his mother is occupied elsewhere in the garden he goes off, sneaks away, gets his fishing rod and escapes to a creek nearby fishing. He is having fun/looks happy/ very pleased and relaxed fishing.

8**. House on Fire**, 5 cards. A boy or a girl is alone (parents out) in his home looking out of the window. The child seeing the neighbour´s house on fire. The boy/girl is alarmed/scared and calls the fire brigade. Fire brigade arrives and puts out fire. When leaving after completed mission, the firemen waves at the boy/girl who happily waves back. His/her parents arrive home learns what happened and are proud of him/her pleased with him/her and praise the child.
The child feels good / is happy about it all.

9. **Accident**, 5 cards. A man stands reading a news paper. Behind him comes another man carrying a bench. The man carrying the bench doesn´t see the man who stands reading. He bumps into the mans head with the bench and he falls. The carrier puts down the bench and walks up to the hurt man. The mans head is hurting/aching; he is dizzy, he isn´t well. The bench man asks him if he is all right, if he is hurt, tries to apologize, helps him up. Then the two men shake hands to confirm that everything is all right and there are no hard feelings.

10 **Crossing the street**. 5 cards. A mother duck/father duck, with ducklings tries to cross a heavy traffic street to reach a nearby lake/pond. The driver´s doesn´t let them/doesn´t se them to cross over and the mother duck gets angry/ annoyed/scared and flaps her wings and squeaks. A woman police officer/ traffic guard, sees this and stops the traffic, helps the mother/father duck and ducklings to cross the street. The police officer then waves to the ducklings or makes a signal of safety to the ducklings. The duck´s little family walk safely cross the street and make it to the lake.

11**. Rain** 5 cards. A girl is leaving the house and her father points out of the window to make her observe that it looks like rain coming up. He offers her an umbrella but she says annoyed/sad no thanks. She leaves the house but after a short walk it starts to rain. She then runs back to the house to get the umbrella. Her father is waiting with the umbrella, saying: what did I say! She looks a little wet/ashamed and now takes the umbrella. She leaves again and walks happily/pleased in the rain with the umbrella.

12. **Walking the dog**, 6 cards. A girl is out walking the dog. The dog pulls the leach. The girl loose the leach and the dog run off and put himself in a dirty puddle. The dog likes this/is happy and looks content. The girl how tries to clean the dog, she gives him a shower with a hose to get him clean of the dirty water. The dog doesn´t like it/he is mischievious/ angry and waves his fur free of water. This makes/ he makes the girl soaking wet. He looks little angry/nosy/bad. Then the girl and dog walks along, the dog happy and the girl angry/annoyed and wet.

13 Harvesting the field, 4 cards. A man and his wife/girlfriend/friend are out in the field in the morning. They hug each other and the man is to start harvesting the field. He asks his wife/girlfriend to bring him lunch and to eat with him later on. At lunchtime the wife brings him lunch and they eat together. After that he continues to harvest and in the afternoon when he is finished and the wife/girlfriend comes back for him and they walk away/ walk home together.

14 A winters´ day, 6 cards. A small cottage in the countryside. Snow on the roof of the house and all around. An only sapphire to the right and a horizon with the sun rising. The sun then moves in the sky during the day, morning, mid-day, afternoon and evening, casting shadows from the house and the tree. By observing the shadows it is possible to understand what time of the day it is and to pose the cards in right sequential order.

Appendix 3. Instructions in assessing Narratives

Following the manual of Westen & Segal scores were given according to the assessment of each participant´s story on Picture Arrangements 3-12. The first trial set was not counted for and the assessment started at age level 9 years. The assessments were operationally defined in 6 dimensions of the participant´s ability to place pictures in logical sequence (score 1) and then tell a story attributed to plausible causes of events (score 2) and attuned to either dimensions 3-6 (score 3). If a child displayed any of the abilities from stages 3-6 he/she gained the score 3.

1 Episode integration (the capacity to derive a coherent and integrated account of events) Coding a score of 1

2. Accuracy of casual attributions (the capacity to attribute plausible causes of events) Coding a score of 2

3. Affect tone of relationship paradigms (the degree to which described relationships or interactions are characterized by benevolent, neutral or malevolent affective quality). Coding a score of 3

4. Capacity for emotional investment in relationships and moral standards (the extent to which relationships are defined in other than need gratifying terms) Coding a score of 3

5. Complexity of representations (the ability to ascribe a will or intention to characters coupled to an interpersonal experience of relationships between self and others). Coding a score of 3.

6. Accuracy of character ascription (ability to see and label characters in relatively simple and realistic situations without distortions and projective idiosyncratic traits). Coding a score of 3. (Westen & Segal s. 5-9).