

Aspects of social communication and bonding in autism spectrum disorders

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ABSTRACT

Impaired social skills and deficits in empathy are considered defining features of autism spectrum disorders (ASD). Two social phenomena, namely yawn contagion and cradling bias, have been reported to be related to a capacity for empathy. Direct systematic observation was employed to compare the incidence of yawn contagion and cradling bias in typically developing (TD) children to that in children diagnosed with ASD. Participants were matched on age, gender and, as far as possible, home language and socio-economic status. Twenty TD and 20 ASD participants, aged 7-15, observed a video containing yawning and control mouth movement clips. 20 TD and 20 ASD participants, aged 5-15, were asked to cradle a doll on three separate occasions. Cradling bias was determined by side preferred. As expected, the ASD group caught significantly fewer yawns than the TD group. Furthermore, no cradling bias was observed in the ASD group, compared to the strong leftward bias present in the TD group. The implications of deficits in these very basic social phenomena in individuals with ASD are discussed.

Keywords: social communication; bonding; autism spectrum disorder; yawn contagion; cradling bias; empathy

Humans are social beings for whom the interaction with others, whether it be in groups or in close relationships, is adaptively advantageous (Brüne & Brüne-Cohrs, 2006; Gallese, 2001). Social skills have evolved because of a need to quickly and accurately evaluate and respond to others' motives, as this can lead to securing benefits such as protection and food-sharing (Brothers, 1989; Brüne & Brüne-Cohrs, 2006). Furthermore, the ability to empathize with others plays an important role in social behaviour (Preston & De Waal, 2002). It is through the investigation of aspects of social skills and empathy that the deficits in social communication and bonding found in autism spectrum disorders (ASD) can be better understood. Kanner (1943) originally described these individuals as having “come into the world with an innate inability to form the usually biologically provided affective contact with other people” (p. 250).

Two social phenomena, namely yawn contagion and cradling bias, have been reported to be facilitated by a capacity for empathy. This research explores aspects of social communication and bonding in ASD through the investigation of these social phenomena, as social communication and bonding are facilitated by empathic processes. Direct systematic observation was employed to compare the incidence of yawn contagion and cradling bias in typically developing (TD) children to that in children diagnosed with ASD.

LITERATURE REVIEW

Autism spectrum disorders

ASD includes autism, Asperger syndrome (AS) and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS; American Psychiatric Association, 2000). Autism is defined in the text revision of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; APA, 2000) as a developmental disorder whose onset must be prior to 3 years of age and which is characterized by (1) deficits in social interactions, (2) impaired verbal and non-verbal communication, and (3) repetitive, restricted or stereotyped behaviour, interests and activities (see Appendix A). Furthermore, autistic individuals can be divided according to Intelligence Quotient (IQ) into low-functioning autism (LFA; $IQ < 70$) and high-functioning autism (HFA; $IQ > 70$) groups. AS individuals are similar to HFA individuals, but delay in the onset of language abilities is not present.

Within the spectrum, diagnosis varies according to intellectual ability, communication ability and presenting behavioural symptoms (Pellicano, 2007). All diagnoses are, however, characterized by ineffective social skills (De Bildt et al., 2005). Furthermore, a deficit in empathy is considered a defining feature of ASD (Hermans, Van Wingen, Bos, Putman, & Van Honk, 2009; Minio-Paluello, Baron-Cohen, Avenanti, Walsh, & Aglioti, 2009).

Theory of Mind, empathy and social behaviour

Theory of mind (ToM) refers to the ability to recognize mental states in others, and understanding that others can “know, want, feel, or believe things” (Baron-Cohen, Leslie, & Frith, 1985, p. 38). Much attention has been paid to the role of ToM in social behaviour (Baron-Cohen et al., 1985; Frith & Frith, 2006). The ability to infer emotions (i.e., what others feel) has often been included in the definition of ToM (Brüne & Brüne-Cohrs, 2006). However, empathy and ToM are not interchangeable terms. What exactly *empathy* encompasses, and whether it is a unitary term, is the subject of ongoing debate (Baron-Cohen, 2008; Blair, 2005; Preston & De Waal, 2002; Rueckert & Naybar, 2008).

For example, in recent studies distinctions have been made between *empathizing* and *empathy* (Baron-Cohen, 2008; Blair, 2005; Rueckert & Naybar, 2008). The cognitive process of empathizing is defined by Davis (1994, as cited in Baron-Cohen, 2008) as “the drive to identify another person’s emotions and thoughts and to respond to these with an appropriate emotion” (p. 64). This definition proposes two components to empathizing: a cognitive component (which can be seen as ToM), and an affective component (i.e., the emotional response to others’ mental states) (Baron-Cohen, 2008). Empathy, in contrast, may be broadly defined as an emotional reaction to the emotions of another individual (Blair, 2005). Blair proposes 3 main divisions of empathy, namely cognitive, emotional and motor empathy: Cognitive empathy is effectively the cognitive component of empathizing (i.e., ToM); Emotional empathy is further split into two main forms, depending on whether the individual’s response is to the external emotional display of another person (such as tears) or other emotional stimuli such as the phrase “John broke his leg,” and; Motor empathy is described as a tendency to imitate the motor responses of others, such as facial expressions and postures. Some argue that the automatic imitation of others’ external expressions of their mental state triggers a similar mental state in the individual (Minio-Paluello et al., 2009). Yet another view is that empathy encompasses numerous components,

such as emotional contagion, sympathy, cognitive empathy and helping behaviour, all of which share the same underlying mechanism (Preston & De Waal, 2002).

From an evolutionary perspective, the ability to ‘feel’ what others are feeling through imitation provides a means by which to learn which behaviours are detrimental to the individual and which are beneficial (Minio-Paluello et al., 2009). Despite the range of definitions of empathy, it is clear that empathy, however you conceptualize or define it, is implicated in the development of pro-social behaviour (Brothers, 1989; Rueckert & Naybar, 2008). For example, the ability to ‘read’ others’ emotional states or motives and respond accordingly can facilitate and assist in maintenance of social bonds.

The phenomenon of yawn contagion

Perceiving a yawn (e.g., through seeing or hearing someone yawn) has the capacity to trigger a yawn in an individual (Giganti & Ziello, 2009; Provine, 1986; Platek, Mohamed, & Gallup, 2005; Senju et al., 2007). This phenomenon, known as *yawn contagion*, can reliably be seen in individuals aged 7 and older (Anderson & Meno, 2003). It has not only been reported in humans, but also in some primates (Anderson, Myowa-Yamakoshi, & Malsuzawa, 2004; Paukner & Anderson, 2006) and even in dogs (Joly-Mascheroni, Senju, & Shephard, 2008). Despite the fact that yawn contagion has been well-documented, very little is known about the underlying mechanisms and function thereof (Senju et al., 2009).

The role of mirror-neurons in imitation behaviour, recognition, ToM, empathy and language has gained much attention (Blair, 2005; Ramachandran & Oberman, 2006; Rizzolatti & Craighero, 2004). Mirror neuron theory states that certain neurons fire whether the individual performs an action or whether the individual perceives that action being performed (Rizzolatti & Craighero, 2004). Ramachandran and Oberman (2007) posit that the perception of action, thought or emotion in another, and the execution of such action, thought or emotion in the self, share a common neural circuitry. However, imaging studies suggest that caution be exercised when making this claim with respect to yawn contagion (Senju et al., 2007). Schürmann and colleagues (2005) found that Broca’s area, an area in the brain regarded as an essential part of the mirror neuron system (Rizzolatti & Craighero, 2004), was not activated while participants observed others yawn. In addition, Lignau and colleagues (2009) found that areas thought to be part of the mirror neuron circuit were not activated when an individual first performed and

subsequently observed a specific action. Evidence for the mirror neuron theory is contradictory and insufficient at present.

Schürmann and colleagues (2005), however, argue that the underlying circuitry of yawn contagion overlaps with that involved in social cognition. They found that two areas regarded as core components of the social brain, namely the superior temporal sulcus and the amygdala (Brothers, 1990), were activated during a yawn in response to a yawn. They further provide evidence advocating a possible relationship between the susceptibility to yawn contagion and “face-processing-related emotional analysis” occurring during social interaction. (Schürmann et al., 2005, p. 1264)

Recent research has connected yawn contagion to the capacity for empathy (Platek et al, 2003; Preston & De Waal, 2002; Senju et al, 2007). For instance, Platek and colleagues (2003) found that those who are more self-aware and perform better on ToM tasks are more susceptible to yawn contagion. Brain areas associated with self-processing were found to be activated by viewing yawns. They propose that the perception of someone yawning taps into a “primitive neurological substrate” (p. 223) responsible for both self-awareness and empathic modelling, which results in the production of a yawn. In line with this, the notion of motor empathy (as defined by Blair, 2005) suggests that perceiving the mental state of another (i.e., yawning) activates corresponding representations of the mental state within the self, which in turn results in the activation of somatic and autonomic responses.

Despite the established relation between ToM ability and yawn contagion, the theory that yawn contagion *results* from ToM ability is somewhat flawed, as evidenced by the presence of this phenomenon in species who do not have the higher-order abilities such as ToM (for example, Anderson et al., 2004; Joly-Mascheroni et al., 2008; Paukner & Anderson, 2006). Instead, this unconscious social behaviour seems more likely to be related to a more primitive, automatic empathic process.

The phenomenon of cradling bias

A second well-established social phenomenon is the human preference to cradle an infant to the left of the body midline (Saling & Cooke, 1984; Salk, 1960; Sieratzki & Woll, 2002). The phenomenon is particularly prevalent in females, regardless of age or prior parenting experience, with roughly 75% of females exhibiting this bias (De Chateau, 1983; Manning & Chamberlain,

1991; Salk, 1960). This bias is less pronounced in men, but is still present, and becomes more pronounced in males who are parents (Bourne & Todd, 2004). Cradling bias has furthermore been reported regardless of the method employed for measurement (i.e., whether the cradling situation is imagined, performed or observed in photographic materials; Vauclair & Donnot, 2005). This leftward bias has also been reported in all cultures and historical periods investigated (Richards & Finger, 1975; Saling & Cooke, 1984). In addition, this bias has been found in some primates (e.g., Hopkins, 2004). Together, these findings suggest a biological basis for cradling bias, as well as possible evolutionary significance of cradling an infant to the left (Mark, 2002; Huggenberger et al., in press).

Several explanations have been proposed for this phenomenon, among which the handedness hypothesis was one of the first to emerge (Huheey, 1977; Salk, 1973). As the laterality of handedness is well-established, the rationale behind this hypothesis was that cradling bias could be explained by the evolutionary advantage it held, as the preferred hand would be free to perform tasks (Huheey, 1977). However, investigation into this phenomenon has revealed that individuals prefer cradling to the left of the body midline regardless of their dominant hand (Bourne & Todd, 2004; Manning & Chamberlain, 1991). Furthermore, it was found that preference was rationalized according to dominant hand. For example, right-handed individuals would explain side of preference as either a result of the right arm being stronger to support the infant, or the preferred hand being free to perform important tasks. In addition to this, the preference of right-side cradling has not been found in left-handed individuals (Manning & Chamberlain, 1991). In summary, numerous studies of this phenomenon suggest that the effect of handedness on cradling preference is negligible at best (Bourne & Todd, 2004; Harris, Almerigi & Kirsch, 2000; Manning & Chamberlain, 1991; Mark, 2002).

A second early explanation for cradling bias was the heartbeat hypothesis, which proposed that the mother's heartbeat has a soothing effect on the infant, because of the soporific effect of the experience *in utero* (Salk, 1973). The leftward bias then results as the heartbeat is more audible on the left side. This theory has been criticized from many angles. Firstly, Querleu and Renard (1981, as cited in Mark, 2002) question whether the heartbeat can be heard *in utero*. Another argument is that the heartbeat can be heard regardless of the cradling side, as long as the infant's ear is pressed directly against the mother's skin (Bundy, 1979). Direct evidence for the heartbeat hypothesis is lacking.

More recently, cerebral explanations, based on the well-established fact that the right hemisphere is critical for the processing of emotion, have been suggested. Weiland and Sperber (1970) demonstrated the influence of emotional factors on cradling preference by asking individuals to hold a pillow against their chests, and subsequently hold the pillow as if it were an infant they wanted to soothe and comfort. No preference was found upon the first instruction, but a leftward bias was found when trying to soothe a 'distressed infant'.

It has been hypothesized that placing the infant in the left visual and auditory fields of the caregiver allows for optimal interpretation of the infant's emotion and exposure to the more expressive side of the mother's face in return (Bourne & Todd, 2004; Manning & Chamberlain, 1991). Fairly unconvincing critiques have been levelled at this explanation. For example, cradling bias has been found in blind participants as well as mothers with congenitally deaf infants (Turnbull & Matheson, 1996), and critics argue that this counts against this explanation. However, if cradling bias is an evolved tendency, atypical individual cases such as blindness or deafness should not impact on its occurrence. Other evidence suggests that the number of right-hand cradlers may not match up with the number of individuals with atypical hemispheric dominance for emotional processing (Harris, 2009). However, Bourne and Todd (2004) provide evidence that suggests that cradling side is contralaterally correlated with the hemisphere dominant for processing of face and emotions.

A recent review of the literature by Harris (2009) provides a comprehensive discussion of the various explanations presented for this bias. What emerges from this review is the possible influence of certain emotional states in the caregiver on side of cradling. For example, a decline in leftward bias, sometimes to the point of reversal of this bias, has been found to be correlated with anxious and stressed caregivers (Reissland, Hopkins, Helms, & Williams, 2009; Suter, Huggenberger, & Schächinger, 2007). Suter and colleagues (2007) also demonstrated a decline in leftward cradling when stress was induced in caregivers. Reissland and colleagues (2009) confirmed this finding, but found that mothers who were depressed showed a leftward bias, contrary to what was expected.

As a result of these lines of thinking, recent research has begun to link cradling bias to enhancement in the quality of the caregiver-infant interaction and bond (Mark, 2002; Sieratzki & Woll, 2002; Suter et al., 2007). This hypothesis that leftward cradling enhances this interaction and bond is based on hemispheric asymmetry for emotional communication and right

hemisphere dominance for social attachment and communication behaviour. For example, it has been found that those who cradled to the right are more ‘detached’ from, and less responsive to, their infant than leftward cradlers (Turnbull & Collins, 2000, as cited in Mark, 2002).

In summary, leftward cradling bias seems to be a mechanism for the regulation and monitoring of the infant’s emotional state and a means by which the caregiver and infant can communicate and bond (Huggenberger et al., in press; Sieratzki & Woll, 2002). The caregiver’s perception of the infant’s needs results in the regulation of the emotional state of the infant and the facilitation of an optimal caregiver-infant bond (Huggenberger et al., in press; Sieratzki & Woll, 2002). The act of cradling can be seen as a primitive social behaviour with evolutionary significance (Huggenberger et al., in press). Here too, as with yawn contagion, this behaviour seems to be a consequence of an unconscious mechanism, as it just “feels right” to cradle to the left of the midline (Sieratzki & Woll, 2002, p. 174).

Yawn contagion, cradling bias and ASD

Both yawn contagion and cradling bias have been found to be absent in individuals diagnosed with ASD (Giganti & Ziello, 2009; Mark, 2002; Senju et al., 2007). More recently, however, Senju and colleagues (2009) found that individuals diagnosed with ASD can catch yawns, and can do so as frequently as typically developing (TD) individuals. Participants in this most recent study were instructed to fixate on the eyes of the person yawning, whereas their earlier study simply instructed individuals to watch the video. This suggests that it is perhaps the deficits in social communication, particularly that of making eye contact, that result in deficits in yawn contagion when individuals with ASD are placed in a ‘natural’ setting, as opposed to being instructed to pay attention to the eyes of the yawner. This finding is in line with the notion that “information gained from another person’s eyes plays a crucial role in human social communication” (Senju et al., 2008, p. 127).

A finding complicating matters is that of Giganti and Ziello (2009). They acknowledge that the absence of yawn contagion via visual stimuli found by themselves and Senju and colleagues (2009) is most likely due to a “difficulty in establishing reciprocal gaze behaviour with human partners” (p. 2). In addition to this, however, they found that hearing someone yawn did not elicit any yawns from their ASD group, whereas it did so with their TD group. This suggests that an overarching insensitivity to social cues, both visual and auditory, and not just

deficits in making eye contact, are at play here. It seems that aspects of social communication modulate susceptibility to yawn contagion.

In terms of cradling bias, individuals with ASD are known to have deficits in emotional relatedness and attachment (Mark, 2002). Implicit in this description is the notion that these individuals' capacity to bond with others will be impaired. The literature concerning cradling bias in individuals with ASD is limited to an unpublished study by Mark (2002). Mark investigated this phenomenon in a group of 25 ASD girls and found, as expected, that no leftward cradling bias was present. In fact, a slight tendency to cradle to the right was observed. Although the underlying mechanism and function of leftward cradling bias is not fully understood, this finding suggests that the underlying mechanism is 'faulty' and the function is perhaps 'missing' in ASD individuals.

In the literature concerning ASD, the deficits in social skills and relating to others have by and large been attributed to deficits in ToM abilities. ToM abilities have been linked to the capacity for empathy, which is in turn linked to social communication and bonding. However, the current literature concerning the underlying mechanisms involved in, and the functions of, the phenomena of yawn contagion and cradling bias seems to implicate more primitive empathic mechanisms, rather than higher-order ToM abilities. Of relevance here is the fact that individuals automatically catch yawns, without thinking, when perceiving another person yawn, and that individuals often explain that it just "feels right" to cradle to the left. Furthermore, the presence of yawn contagion and cradling bias in species other than humans, who do not possess higher-order abilities such as ToM, provide further evidence for the existence for these more basic, and perhaps innate, empathic mechanisms. In light of this, the deficits in social communication and bonding seen in ASD might therefore be explained by the deficit in a rudimentary form of empathy, rather than solely in terms of a lack of ToM ability.

The absence of the social phenomena of yawn contagion and cradling bias in ASD provide a way in which to empirically investigate the nature of the deficits in empathy evident in individuals with ASD. However, the theoretical issues surrounding the definition of empathy complicate the interpretation of the nature of the deficits in social communication and bonding. By reviewing the literature concerning yawn contagion and cradling bias, evidence for the role of a primitive form of empathy in social interaction and bonding emerges. Further research is necessary, not only to clarify how these phenomena come about and the function/s they serve,

but also to show how this can aid in a better understanding of the impairments in social skills, communication and empathy that characterize ASD.

SPECIFIC AIMS AND HYPOTHESES

Although much research has been done establishing the occurrence of these social phenomena, only recently have three studies investigated the phenomenon of yawn contagion in individuals with ASD. Similarly, only one other study (an unpublished honours thesis) has investigated the phenomenon of cradling bias in individuals with ASD. The aim of this study was to firstly replicate the studies of Senju et al. (2007) and Mark (2002), and secondly to improve on their designs. Senju and colleagues (2007) did not match participants on gender, which is problematic as gender differences in empathy have been established (Rueckert & Naybar, 2008). Mark (2002) only investigated cradling bias in females and did not have a control group with which to compare the ASD group.

Despite the shortage of direct evidence of reduced yawn contagion and leftward cradling bias in individuals with ASD, research linking these phenomena is plentiful. For example, research suggests that both are linked to a capacity for empathy. Furthermore, it is proposed that individuals with ASD have deficits in empathy. It therefore follows that the incidence of these phenomena should be reduced in individuals with ASD. In addition to this, because these phenomena come about without conscious effort, it is possible that they reflect a more primitive aspect of empathy.

This study compared susceptibility to yawn contagion and cradling bias in typically developing (TD) and ASD children, in order to come to gain a clearer understanding of the nature of deficits in empathy in individuals with ASD. It is expected that differences in yawn contagion and cradling bias will be evident after controlling for the expected group differences in intellectual and executive functioning, as we hypothesize that these phenomena tap into a more primitive empathic response. The following hypotheses are examined:

H₁: In a population with deficits in social communication and bonding, as is found in individuals diagnosed with ASD, the incidence of yawn contagion will be reduced in comparison with its incidence in a TD population.

H₂: In a population with deficits in social communication and bonding, as is found in individuals diagnosed with ASD, the incidence of leftward cradling bias will be reduced in comparison with its incidence in a TD population.

METHODS

Research design and setting

This study consisted of two cross-sectional comparisons of two groups: an ASD group and a TD group. The method employed to collect data was quasi-experimental, as participants were divided into groups based on the pre-existing criterion of a diagnosis of ASD. The two groups were compared on scores obtained from both a yawn contagion task and a cradling bias task. The protocols employed in this study were based on previous designs utilized in this field of research (e.g., Senju et al., 2007; Mark, 2002). In both cases, direct systematic observation was utilized.

Testing took place at the various schools involved and/or at the participants' homes, depending on which was preferred by the parent/guardian. Furthermore, parents, teachers or personal facilitators were given the opportunity to observe the administration of tests. A quiet room, free of distractions, was used as the test setting.

Participants

This study formed part of a broader research project for which ethical approval has been granted by the Ethics Committee of the University of Cape Town's Department of Psychology (see Appendix B) as well as the University of Cape Town's Faculty of Health Sciences Research Ethics Committee. Permission was granted by the provincial education departments involved to recruit participants from public schools in these regions. Furthermore, permission was also obtained from the schools involved to recruit participants from their schools. Written informed consent and assent was obtained from parents or legal guardians and participants respectively before testing commenced (see Appendix C).

Twenty three children diagnosed with ASD between the ages of 5 and 15 years participated in the study. These participants were recruited from schools in the Western Cape,

Gauteng and Kwazulu-Natal which specialize in the education of children with ASD or special needs. In addition to this, participants were also recruited via support groups or personal referral. A diagnosis of ASD according to the criteria set out in the DSM-IV-TR (American Psychiatric Association, 2000), made by a qualified independent clinician, was a prerequisite for participation.

Twenty three typically developing (TD) children within the same age range participated in this study as controls. These participants were recruited from schools and daycare centres in the Western Cape. They were matched with the 23 ASD group participants on age and gender, and with the exception of 2 participants, on home language and socioeconomic status (SES). Participants were not matched on ethnicity, as Yawn contagion and Cradling Bias are not culture-specific phenomena (see Appendix D for Demographic questionnaire).

Ideally, this study would compare separate age bands in order to clearly delineate and compare any developmental trajectory evident in the ASD and TD participants. This was, however, not feasible to do within the time available for the Honours study. Matching of participants was therefore imperative to control for the effects of age, gender, home language and SES. Matching on gender was particularly important, as gender differences in empathy have been found (e.g., Rueckert & Naybar, 2008) and the phenomena under investigation are related to a capacity for empathy. The basic demographic characteristics of the ASD group ($n = 23$) and the TD group ($n = 23$) are presented in *Table 1*.

Table 1. Demographic Characteristics of the ASD and Typically Developing (TD) Groups

Demographic Information	ASD ($n=23$)	TD ($n=23$)
Age Range (Years: Months)	6:3-15:5	5:10-14:7
Age (Years)		
<i>Mean (SD)</i>	10.76 (2.59)	10.89 (2.57)
Gender		
<i>Male: Female</i>	14: 9	14: 9
Home Language		
<i>English: Afrikaans: Xhosa</i>	16: 6: 1	16: 7: 0
Ethnicity		
<i>White: Black: Coloured: Indian</i>	18: 2: 3: 0	19: 0: 3: 1
Socio-economic Status		
<i>High: Medium: Low</i>	13: 10: 0	14: 9: 0

Inclusion and exclusion criteria

Exclusion criteria for both groups included a history of head injury and/or infantile meningitis. TD participants diagnosed with any neurological condition/s as well as ASD participants diagnosed with any additional neurological condition/s were excluded from the study. In addition to this, a diagnosis or history of social disorders, such as conduct disorder or oppositional defiant disorder, attentional disorders, such as Attention Deficit/Hyperactivity Disorder, a pervasive developmental disorder, affective disorders, psychotic disorders and/or substance abuse, resulted in exclusion from the TD group. Basic comprehension (i.e., understanding of instructions to watch a video and hold a doll) in either English or Afrikaans were a minimum requirement for participation in both yawn contagion and cradling bias tasks. Both male and female participants were recruited for both investigations as these phenomena are present regardless of gender.

Of the total ASD group ($n=23$), 3 participants were excluded from the yawn contagion task because they were below 7 years of age. Research indicates that children below this age do not reliably show yawn contagion (Anderson & Meno, 2003). Furthermore, 2 participants from the ASD group and 1 participant from the TD refused to hold a doll and therefore did not complete the cradling bias task. The total sample size for both tasks was thus 20 participants per task for both ASD and TD groups.

Measures

Yawn contagion

A video consisting of clips of models either yawning or simply opening their mouths was used as the test for yawn contagion. Six individuals (3 male and 3 female) unfamiliar to the participants were recruited to act as models. The video consisted of 6 clips of yawning faces and 6 clips of mouth opening (control) faces (7s each). These clips were arranged in a pseudorandom order, with a 30-second interval between each clip, during which a silent cartoon was shown. Cartoons were used to keep the participant's attention focused on the video. Furthermore, the 30-second interval during which the cartoon was shown provided time in which the participant could respond to the previous clip. In addition, the control clips were included to investigate whether the type of clip influences the amount of yawning (i.e., to control for imitation behaviour). As an additional measure to ensure that attention was paid, the participants were instructed to count the female faces in the video and report back to the experimenter after watching the video. If at any

time the participant was not looking at the screen, he/she was reminded to pay attention. The protocol employed in this task was adapted from that used in the study by Senju et al. (2007).

Cradling bias

Cradling bias was observed on three separate occasions. For the initial trial the researcher introduced the participant to the doll saying, “This is Suzie. Suzie is very tired.” The doll was then presented at the participant’s midline in an upright position and the participant was asked to hold the doll. The participant was then asked, “Will you hold Suzie for me like you would if you want to put her to sleep”. Further instructions were given if the participant did not hold the doll in a cradling position. Cradling bias was determined by the preferred side of cradling observed across three trials. Side of preference was determined not by the arm used as main support, but rather by whether the doll’s (i.e., infant’s) face was held in the participant’s left or right visual hemispace. Three independent trials were used to ensure that the preference was a stable and a reliable source of data. The protocol utilized for this task was adopted from a study by Mark (2002).

Intelligence and executive function

The *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI-R; Wechsler, 1989) was administered to assess the level of intellectual functioning of participants below the age of 6 years; The *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler, 1999) was used for participants aged 6 years and older. The WPPSI-R has been standardized for children between the ages of 2 years 11 months and 7 years 3 months. It is comprised of seven subtests, three of which, namely Mazes, Geometric Design and Block Designs, were administered to assess Performance IQ (PIQ). The WASI is a standardised and robust measure of intellectual functioning, normed for individuals between the ages of 6 and 89. It is comprised of four subtests, two of which, namely Block Design and Matrix Reasoning, were administered to assess PIQ. Only PIQ score was used as a measure of IQ, due to the deficits in language and communication often present in individuals with ASD.

The *Delis-Kaplan Executive Function System* (D-KEFS; Delis, Kaplan, & Kramer, 2001) is a standardized measure of key components of executive function (EF), normed for individuals between the ages of 8 and 89. It is comprised of nine tests, of which only the Verbal Fluency

Test and the Colour-Word Interference Test were administered to obtain a measure of EF. These subtests were selected as a measure of EF, as they are known to be correlated with Theory of Mind (ToM) performance - in this way the study addressed the possibility that yawn contagion and cradling bias are related to both EF and ToM. The Verbal Fluency Test measures both lexic and semantic generativity, and the Colour-Word Interference Test, based on the Stroop (1935/1992) Test, assesses the ability to inhibit an over-learned verbal response. These tests were administered to participants aged 6 and above. As the ASD and TD groups were matched on age, raw scores rather than scaled scores were used when comparisons were made.

Procedure

This study formed part of a broader research project involving individuals with ASD, where IQ, EF, spatial navigation and ToM tests were administered in addition to the yawn contagion and cradling bias tasks. The study reported here was concerned only with the measures of PIQ, EF, yawn contagion and cradling bias.

Consent was obtained from the parents or legal guardians beforehand. Furthermore, parents/guardians of participants were asked to complete a demographic questionnaire, which included information necessary for the selection of control group participants (i.e., age, gender, home language and SES). Written assent was then obtained from the participant before testing commenced. Testing took place over one, two or three sessions, depending on the time available for testing the participant. Tests were not administered in a pre-determined order or in pre-determined sessions, to prevent fatigue effects and also because which tests were administered depended on the age and characteristics of the participant (such as being non-verbal). The WASI, WPPSI-R, and subtests of the D-KEFS were administered according to the conventional procedure outlined in the test manuals. Administration of tests for yawn contagion and cradling bias were based on protocols utilized by previous research (as discussed in the *Materials* section above). At the end of the final session the participant was debriefed and thanked for his/her participation. Feedback reports were also sent to parents and schools.

Data analysis

Descriptive statistics were analysed first to characterize the performance on both the yawn contagion task and the cradling bias task. The main analyses concerned between-group

differences in cradling bias and yawn contagion. All statistical analyses were completed using STATISTICA version 8.0 (StatSoft, Inc., 2007).

Chi-square analyses were performed on the categorical data, and the relevant parametric and non-parametric tests were run on the continuous data. All assumptions underlying the various tests employed were upheld, except for one case. For the data on frequency of yawns caught, Levene's test for homogeneity of variance was significant. A non-parametric Mann-Whitney U test was therefore employed to compare frequency of yawns caught across the two groups.

Further analyses were performed to investigate whether differences in gender, PIQ and EF could account for the differences in yawn contagion and cradling bias across the groups. Given the number of analyses conducted, an increased possibility of Type 1 error occurs. This, however, has to be balanced against the fact that the sample size is small, resulting in reduced power. For this latter reason, it was decided that adjusting alpha to control for Type 1 error would be overly conservative, and the significance threshold was left at 0.05.

RESULTS

Yawn contagion

In the TD group, 60% of the children caught yawns, compared to only 25% of the ASD children. A chi-square test of contingency was used to test whether the presence of yawn contagion was contingent on the group to which the child belonged. The analysis yielded a significant result ($\chi^2_{(1)} = 5.01, p = 0.025$). Effect size, calculated via an odds ratio, indicated that TD children were 4.5 times more likely to catch yawns than ASD children ($R = 4.5$). In addition to this, only children from the ASD group imitated mouth movements (see *Table 2*).

A Mann-Whitney U test indicated a significant difference in the frequency of yawns caught (i.e., total yawn responses) between the groups ($z = -1.99, p = 0.047$) (see *Figure 1*). Wilcoxon signed-rank tests revealed that although the yawning clips elicited more yawns in the TD group than the open mouth movement clips did ($z = 3.06, p = 0.002$), no difference was found between the number of yawns elicited by the two different types of clips in the ASD children ($z = 0.00, p = 1.000$) (as can be seen in *Figure 1*).

Table 2. Frequencies of various responses to yawn and control clips across the ASD and TD groups.

Response	ASD (<i>n</i> = 20)	TD (<i>n</i> = 20)
Yawn after yawn clip	6	34
Yawn after open mouth clip	6	9
Total yawns (i.e., yawns caught)	12	43
Open mouth after yawn clip (i.e., imitation)	14	0
Open mouth after open mouth clip (i.e., imitation)	9	0

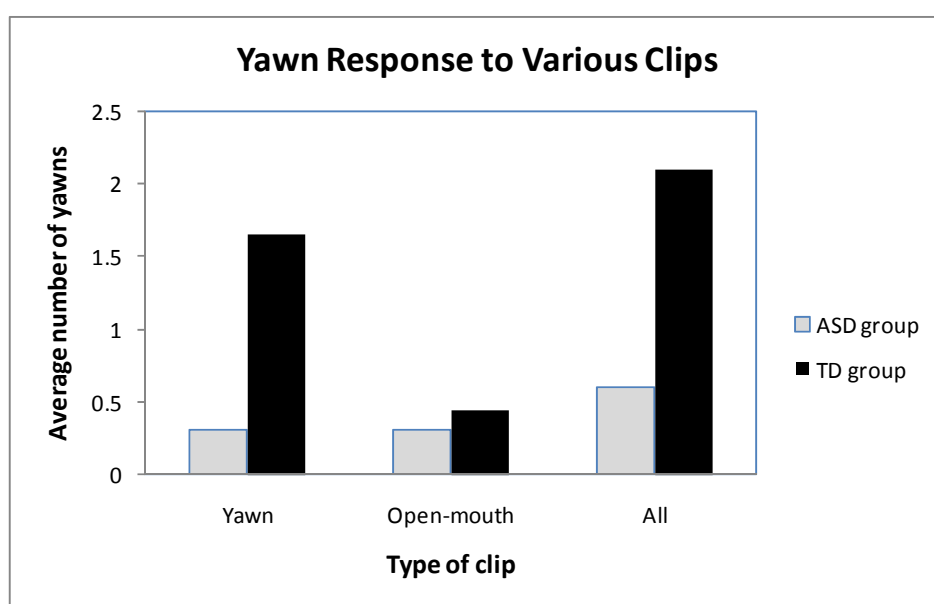


Figure 1. Average number of yawns during or after the observation of yawn clips, control clips and all clips across the groups.

In addition to these analyses, a chi-square test of contingency revealed that yawn contagion was not contingent on gender in this sample ($\chi^2_{(1)} = 1.38, p = 0.240, R = 0.45$).

Cradling bias

90% of the TD children cradled to the left, compared to 55% of the ASD children (see Figure 2). A chi-squared test of contingency yielded a significant result ($\chi^2_{(1)} = 6.14, p = 0.013, R = 7.36$), indicating that side of cradling was contingent on group membership. The odds ratio indicated that TD children were 7.36 times more likely than ASD children to cradle to the left.

As illustrated in *Figure 2*, within the ASD group, 11 participants cradled to the left and 9 cradled to the right. A chi-square test indicated that preferred cradling side within this group occurred at the level of chance ($\chi^2_{(1)} = 0.20, p = 0.655, R = 0.82$). Furthermore, a chi-square test of contingency was employed to investigate the stability of the side preference over the three trials. Stability was defined by the preference of one side for all three trials. The analysis yielded a significant result ($p < 0.001$, Fisher's exact test, FET). Furthermore, TD children were 23.22 times more likely to consistently cradle to the same side across the trials than ASD children ($R = 23.22$).

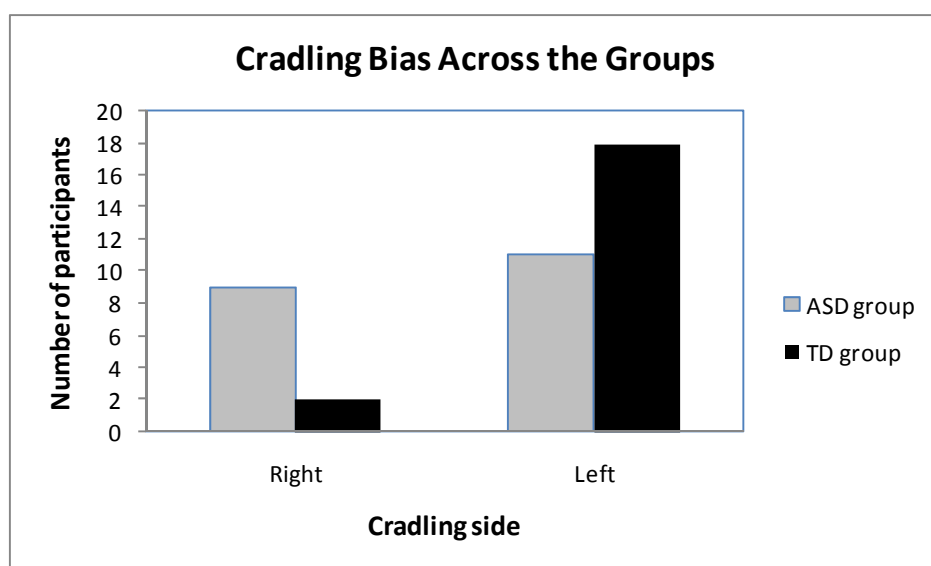


Figure 2. Raw values of left cradling and right cradling across the two groups.

Only 30% of participants were female. As males are expected to show a less pronounced bias, a chi-square test was employed to investigate whether cradling side was contingent on gender. No significant difference between side of cradling across gender was found ($p = 1.000$, FET).

General intellectual functioning

For both the yawn contagion sample and the cradling bias sample, PIQ scores of the TD children were consistent with established Western population norms (see *Table 3* in Appendix E)¹.

¹ Note that different samples, with different n 's, were used for the different tasks.

Statistically significant between-group differences in PIQ were found between the ASD and TD children for both the yawn contagion sample ($t_{(37)} = -4.66, p < 0.001, d = 1.49$), and the cradling bias task sample ($t_{(36)} = -3.91, p < 0.001, d = 1.27$).

As there was a significant difference in PIQ scores between the groups, further analyses were performed to investigate whether group differences in PIQ could account for differences in yawn contagion and cradling bias. A test for correlation was used to investigate the relationship between PIQ and number of yawns caught. The correlation was very weak and not significant ($r = 0.12, p = 0.466$). Further analysis indicated no significant association between the level of PIQ and cradling side across the groups ($p = 1.00, FET, R = 0.86$) (see *Table 4* in Appendix E for an outline of how PIQ categories were demarcated).

Executive function

Raw scores were used to compare the participants on the various executive function tasks, as some participants were younger than eight years (from which normative scaling starts) and because participants were matched on age. Analysis of variance with repeated measures was conducted to investigate differences between the groups and task types. Two tasks, one from each subtest, were selected for analysis as repeated measures. These scores were selected as measures of EF based on recent findings regarding specific executive functioning deficits in ASD children in these areas (Robbets, 2008). As expected, the ASD group performed significantly more poorly on these tasks than did the TD group for both the yawn contagion task sample and the cradling bias task sample (see *Tables 5* and *6*). Consistent with the literature on executive function in ASD, performance on both the Verbal Fluency and Colour-Word Interference tasks were impaired (Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999; Robbets, 2008). Significant interaction effects were found between group and task for both the yawn contagion task ($F_{(1, 33)} = 19.64, p < 0.001, \eta^2 = 0.37$), and the cradling bias task ($F_{(1, 28)} = 0.05, p = 0.001, \eta^2 = 0.32$).

Table 5. Repeated measures ANOVA summary table for performance on executive functioning tasks in the yawn contagion sample.

	SS	df	MS	F	p	η^2
Group	362.7	1	362.7	1.4	0.25	0.04
Error	8565.6	33	259.6			
Task	26996	1	269960	55.61	<0.001	0.63
Group*Task	9534.4	1	9534.4	19.64	<0.001	0.37
Error	16021.4	33	485.5			

Table 6. Repeated measures ANOVA summary table for performance on executive functioning tasks in the cradling bias sample.

	SS	df	MS	F	p	η^2
Group	414.70	1	414.70	1.45	0.238	0.05
Error	7996.40	28	285.60			
Task	23082.60	1	23082.60	46.54	<0.001	0.62
Group*Task	6566.20	1	6566.20	13.24	0.001	0.32
Error	13886.50	28	495.90			

Tukey's post-hoc analysis indicated that the biggest difference in EF score for both the yawn contagion sample ($p < 0.001$) and cradling bias sample ($p < 0.001$) was in Inhibition/Switching raw scores (see Tables 7 and 8). This score was therefore used as measure of EF.

Table 7. Yawn contagion task: Performance on the D-KEFS Verbal Fluency and Colour-Word Interference tasks by ASD and TD participants, aged 7-15 years.

<i>Measure</i>	<i>ASD</i> ^a	<i>TD</i> ^a	Group Differences	
	(<i>n</i> =15)	(<i>n</i> =20)	<i>p</i>	η^2
D-KEFS Verbal Fluency				
Total Correct Responses	42.87 (16.43)	61.85 (15.36)	0.001	0.18
D-KEFS Colour-Word Interference				
Inhibition/Switching	106.13 (25.28)	77.95 (19.71)	< 0.001	0.23

Note. Means are presented with standard deviations in parentheses.

^a Smaller sample sizes because of participants who could not read and non-verbal participants.

Table 8. Cradling bias task: Performance on the D-KEFS Verbal Fluency and Colour-Word Interference tasks by ASD and TD participants, aged 5-15 years.

<i>Measure</i>	<i>ASD^a</i> (<i>n</i> =13)	<i>TD^a</i> (<i>n</i> =17)	Group Differences	
			<i>p</i>	η^2
D-KEFS Verbal Fluency				
Total Correct Responses	59.62 (20.13)	74.65 (17.28)	0.011	0.25
D-KEFS Colour-Word Interference				
Inhibition/Switching	105.77 (25.83)	79.35 (20.83)	0.004	0.27

Note. Means are presented with standard deviations in parentheses.

^a Smaller sample sizes because of participants who could not read and non-verbal participants.

Further analyses were performed to investigate whether group differences in EF could account for differences in yawn contagion. A test for correlation was used to investigate the relationship between EF and number of yawns. The correlation was very weak and not significant, $r = -0.03$, $p = 0.863$. Further analysis indicated that level of EF and cradling side across the groups were significantly associated, $p = 0.041$ (FET), $R = 9.80$ (see Table 9 in Appendix E for an outline of how EF categories were demarcated).

DISCUSSION

This study has replicated what has been found by previous studies concerning the occurrence of yawn contagion and cradling bias in ASD children (see Giganti & Ziello, 2009; Mark, 2002; Senju et al., 2007). In addition, it is the first study to report the absence of cradling bias across the genders in these children. Results confirm both hypotheses tested by this study, as a reduced incidence in both yawn contagion and leftward cradling bias was found in children with ASD in comparison with TD children. How these findings relate to the deficits in empathy and social communication skills - defining features of ASD - will therefore be discussed.

Yawn contagion in Autism Spectrum Disorders

Significantly fewer of the ASD children than the TD children yawned during viewing of the video. In addition to this, the ASD children yawned significantly less frequently than the TD children while watching the video. Further analyses ruled out the possible influence of executive function, intellectual functioning and gender as confounding variables. Results therefore reflect a significant reduction in the incidence of yawn contagion in ASD children.

Although these findings replicate those of Senju and colleagues (2007), observations of the participants while watching the yawn contagion video were in line with the recent hypothesis that deficits in social communication, particularly eye contact, result in the appearance of reduced yawn contagion in individuals with ASD (Giganti & Ziello, 2009; Hermans et al., in press; Senju et al., 2009). For example, often ASD children would often look away when a clip of a human face appeared on the screen. A further observation made was that these children often covered the computer screen with their hands when a human face appeared, because the faces made them anxious. They therefore missed the visual cue to catch the yawn.

In line with the observations made, recent studies provide evidence that eye contact does in fact induce yawn contagion in individuals with ASD (Giganti & Ziello, 2009; Senju et al., 2009). Senju and colleagues (2009) demonstrate that individuals with ASD can catch yawns at the same rate as TD individuals, provided they fixate on the eyes of the individual who is yawning. Findings to date therefore suggest that although a significant reduction in the incidence of yawn contagion is found, these individuals have the potential to catch yawns. Further (tentative) evidence in this study for the ability to catch yawns is reflected in the fact that, although a significant difference was found between the two groups in yawning frequency, this p -value bordered on non-significance ($p=0.047$). It seems that deficits in social communication (i.e., eye contact) may be mediating the results obtained.

Most recently, Giganti and Ziello (2009) demonstrate reduced incidence of yawn contagion in ASD children via auditory perception of a yawn. The question of whether this reduced yawn contagion reflects the inability to attend is one which deserves some discussion. An observation relevant to this question was that ASD children often asked why the people were tired. The fact that they could identify that someone else is tired is evidence, at the very least, that they are indeed attending to the video clip. In addition to this, imitation behaviour specific to the ASD children is consistent with characteristics of individuals diagnosed with this disorder, as these individuals focus on the mouth when looking at a human face (Gigante & Ziello, 2009; Senju et al., 2008). This too illustrates that these individuals were, in fact, attending to the video. Furthermore, these ASD individuals are often cable of paying obsessive attention to non-social stimuli. What all this illustrates is that it is more likely that inattention to the social cues, and not inattention in general, that is related to the reduced yawn contagion seen in ASD children.

Other important observations worth mentioning were made. Instructing participants to count the female faces seen during the video, to ensure that attention was focussed on the video, worked against the task. Participants, particularly those in the TD group, were often seen counting on their hands and focussing on remembering a number, instead of paying full attention to the video clips. In contrast, ASD participants would sometimes turn to the experimenter and exclaim that they see a female face, and thereby miss the visual stimulus. These observations reflect on a flaw in the design of the experiment.

Cradling Bias in Autism Spectrum Disorders

As expected, no cradling bias was present in the ASD group, compared to the strong leftward bias present in the TD group. This replicates findings by Mark (2002), but improves on the study, as a control group was utilized. Further confirmation of the absence of a bias is reflected in the instability in side of cradling over the three trials per participant. Together these results suggest that cradling side is chosen at a level no greater than chance, and that preference in side cradled is not fixed in participants belonging to the ASD group. This supports an argument that the underlying function of this behaviour (i.e., enhancing the quality of the caregiver-infant interaction and bond) may be absent in these individuals. These individuals are merely holding the doll because they were instructed to.

The influence of gender is particularly important in the investigation of the incidence of cradling bias, as a difference in the degree of leftward cradling bias has been established between the genders in the TD population (Bourne & Todd, 2004). This study is the first to investigate cradling bias across the genders in individuals with ASD. Although participants were matched on gender, among other variables, gender influences were further investigated both within and across the groups. No significant differences were found in cradling bias between the genders. Given the small sample size, however, further investigation is necessary.

Further analyses ruled out the possibility of an association between intellectual functioning cradling. EF, however, was found to be significantly associated with side of cradling. As the data is categorical, this test of association was the only measure available with which to attempt to control for the influence of this variable. EF is better in TD participants, and the leftward bias is strongly present – hence the association. An ANCOVA would have partialled out the variability in cradling bias due to EF, which the test of association is unable to do. It is thus

difficult to interpret the association as indicative of EF impacting on cradling bias. The fact that this bias is present in non-human primates, particularly as this bias is present in non-human primates (Hopkins, 2004).

The limitations of various hypotheses such as the heartbeat and handedness hypotheses in explaining the phenomenon of leftward cradling bias are evident in the literature reviewed. Cerebral explanations, particularly the recent argument concerning the role of cradling in the quality of caregiver-infant interaction and bonding, are emerging as more likely explanations. Observations made during performance of this task can be explained in terms of this particular argument. For example, when asked to hold the doll (i.e., cradle it) as if putting it to sleep or soothing it, the TD group would immediately place the doll in the cradling position and look at the doll's face. In contrast, participants from the ASD group sometimes held the doll at arm's length, often were hesitant to hold it, and sometimes refused. Furthermore, they more frequently held the doll against their chests, and did not look at it when holding it. Although this could be due to the deficits in pretend play often found in these individuals, it could also be a reflection of the deficits in relating to others both socially and emotionally. In addition to this, many of the schools from which the ASD participants were recruited focus much attention on teaching these children pretend play, resulting in no deficiency in pretend play in many of these children.

Cradling Bias and Yawn contagion: Social Communication, Bonding and Empathy

The phenomenon of yawn contagion and the phenomenon of cradling bias are both concerned with an individual's ability to relate to other individuals, which in turn are linked to the ability to socialize and empathize. Yawn contagion is concerned with the 'outer' facilitators of relating to others, such as making eye contact (i.e., aspects of social communication), whereas cradling bias is concerned with the ability to bond emotionally with another individual, and can therefore be seen as an 'inner' facilitator of relating to others. These aspects of relating to others illustrated by yawn contagion and cradling bias were first noted by Kanner (1943) in his original description of Autistic individuals. For example, Kanner pointed out that deficits in making eye contact were often present in Autistic individuals. This is evident in the phenomena of yawn contagion. Furthermore, the absence of cradling bias may help illustrate what Kanner was referring to when he spoke of these individuals' "innate inability to form the usually biologically provided affective contact with other people" (p. 250).

The two phenomena under investigation illustrate very clearly these social and emotional aspects of relating to others. The reduced incidence of yawn contagion and the absence of a cradling bias in a natural setting in ASD children illustrates that these individuals often have deficits in relating to others on both levels. As maternal-infant bonding and relatedness occurs before any other social interaction occurs, it therefore follows that the deficits in emotional relatedness (i.e., bonding) evident in these individuals could be a facilitator of the deficits in social communication which emerge at a later stage of development.

It cannot be denied that ToM is a higher-order capacity which facilitates social and emotional relatedness, and that relating to others draws on this capacity. However, the phenomena under investigation are more likely to occur as a result of a more basic capacity for empathy (or relating to others), perhaps something that precedes and possibly facilitates ToM development. The tentative exclusion of association between these phenomena and PIQ and EF (i.e., in the case of yawn contagion), as well as the fact that yawn contagion and cradling bias are observed in some species other than human beings, who do not possess higher-order mental abilities such as ToM, provides further evidence for more primitive empathic processes at play here.

The findings of this study provide tentative evidence that individuals with ASD do not necessarily lack the potential to relate to others in terms of the outer cues of communication, as evidenced in their ability to catch yawns. However, the absence of cradling bias provides tentative evidence that an innate capacity to relate to others, whether it be in a social situation or in a close relationship such as the caregiver-infant relationship, is absent in these individuals. A better understanding of the underlying mechanisms of yawn contagion and cradling bias and their relation to the term we call empathy would help with the illustration of the potential for relating to others in individuals with ASD. Instead of talking about an overarching term called empathy, which clearly resists definition, focussing on pinpointing the emotional and social strengths and weaknesses of these individuals could prove useful for managing these deficits and improving their ability to interact with and relate to others.

Limitations and Future Directions

Mark (2002) discusses the implications of certain characteristics often present in individuals with ASD which can hinder the research process. For example, reduced capacity for social interaction,

resistance to novelty, preference for objects as opposed to humans, and a reduced capacity for pretend play, can become problematic obstacles when working with individuals with ASD. These characteristics might not be seen as limitations, but they do indeed make the research process more arduous, particularly because the research tasks involve pretending a doll is an infant and require that focus be placed on human faces. Resistance to novelty can be problematic, as these individuals can become very distressed when routine is changed or new people (i.e., the experimenter) is introduced to him/her. Familiarization with the researcher is one way of addressing this. As this study formed part of a broader research project, each participant was seen for up to 6 sessions, lasting 90 minutes each. If sessions were shorter, more sessions were required. As a result of numerous sessions, participants were familiarized with the researcher.

A major limitation to both the cradling bias and the yawn contagion investigations is the small sample utilized. This is a result of the time frame within which this project had to be completed. As a result, only tentative conclusions can be drawn from these findings. Future investigations are necessary and will benefit from larger sample sizes. For example, investigation of the incidence of these phenomena in the various ASD subcategories could provide some insight into the impact of ‘severity’ of impairment on relating to others. Furthermore, investigating these phenomena in separate age bands could assist in delineating and comparing any developmental trajectory evident in both ASD and TD individuals. To date, no studies concerning either yawn contagion or cradling bias have been conducted with ASD participants above the age of 16.

As differences in empathic processes and expression have been established across the genders, and these phenomena are related to this capacity for empathy in a broad sense, one potentially fruitful line of research concerns differences in the incidence of these phenomena across the genders. For example, a leftward cradling bias has been found to be less pronounced in the TD male population. Furthermore, reduced spontaneous facial mimicry has been found in women with autistic traits (Hermans et al., 2009). Despite this, not one of the previous studies concerning yawn contagion in individuals with ASD matched participants on gender, when drawing comparisons. In addition to this, the one study done on cradling bias in individuals with ASD only looked at this bias within a female ASD group. However, investigation of gender

differences can prove to be challenging as the number of males diagnosed with ASD relative to females is 4:1 (Tidmarsh & Volkmar, 2003).

Recent research implicates right brain systems in the underlying mechanisms of yawn contagion and cradling bias (e.g., Bourne & Todd, 2004; Hermans et al., 2009; Huggenberger et al., in press; Vauclair & Donnot, 2005). This is consistent with the involvement of right brain systems in empathy and social and emotional behaviour (Rueckert & Naybar, 2008). Furthermore, the involvement of right brain systems in attachment behaviour has been established (Shore & Shore, 2007). More recently attachment theory is being reconceptualised into a regulation theory, which would implicate the role of non-verbal cues such as gaze in the regulation of emotion. This is reflected in the reduced incidence of yawn contagion and the absence of a cradling bias in individuals with ASD. All this suggests that a better understanding of these phenomena, these individuals, and the aetiology of ASD can emerge from investigating the neurobiological basis of attachment and regulation behaviour. Measures of attachment and emotion regulation should be expanded on in future research.

CONCLUSION

The incidence of the social phenomena of yawn contagion and cradling bias was investigated in ASD and TD children. A reduced incidence of yawn contagion and an absence of cradling bias was found in the ASD group. These phenomena reflect the deficits in relating to others found in ASD. Yawn contagion and cradling are basic social phenomena that occur in other social animals as well as humans, and have been linked to a capacity for empathy in humans. Although much focus in the literature regarding ASD is placed on higher-order processes linked to empathy, such as Theory of Mind, it seems that more basic processes should also be investigated. Yawn contagion and cradling bias are good candidates for this investigation, as as yawns are caught without thinking and it just “feels right” to cradle to the left. The absence of these phenomena in individuals with ASD suggest that more basic empathic processes may be deficient. As can be seen, research regarding the incidence of cradling bias and yawn contagion in individuals with ASD is still in its infant stages. Further investigation of these phenomena is necessary to gain a clearer understanding of the social and emotional deficits present in ASD. This would be useful in improving management and treatment of individuals with ASD.

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Appendix A

DSM-IV-TR Diagnostic Criteria for Autistic Disorder

- A. A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):
1. qualitative impairment in social interaction, as manifested by at least two of the following:
 - a. marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
 - b. failure to develop peer relationships appropriate to developmental level
 - c. a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
 - d. lack of social or emotional reciprocity
 2. qualitative impairments in communication as manifested by at least one of the following:
 - a. delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)
 - b. in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
 - c. stereotyped and repetitive use of language or idiosyncratic language
 - d. lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level
 3. restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
 - a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
 - b. apparently inflexible adherence to specific, nonfunctional routines or rituals
 - c. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
 - d. persistent preoccupation with parts of objects
- B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.
- C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

Appendix B

Ethical approval from the UCT Department of Psychology Ethics Committee

UNIVERSITY OF CAPE TOWN



Department of Psychology
Research Ethics Committee
Rondebosch, 7701
Tel: 27 21 6504608 Fax: 27 21 6504104
E-mail: kevin.thomas@uct.ac.za

02 May 2008

REFERENCE NUMBER: 2008004

Michelle Robberts
Department of Psychology
University of Cape Town

Dear Ms. Robberts:

PROJECT TITLE: Theory of mind abilities in children with autistic spectrum disorders and normally developing children

Thank you for your submission to the Department of Psychology Research Ethics Committee.

It is a pleasure to inform you that the Committee has **granted approval** for you to conduct the study, on the **condition** that you address the following:

- In your application form, you state that you will be recruiting 160 participants and that each of them will be involved in three test sessions. This procedure requires a time commitment from the researcher that is beyond the scope of an Honours project.
- In point #5 of your informed consent document (the purpose of the study), you give information (“theory of mind”) that participants are unlikely to understand; please find a way to put re-state this part of the document in terms that are accessible to the intended readers.
- The first paragraph of your informed consent document should be modified to make it clear that parents are being asked to allow their child to take part in a research study.
- No assent forms have been provided for the children. The Committee thinks it is important that the children themselves should be given an opportunity to agree (or decline) to participate, and that this assent is obtained by the researcher and not simply left to the discretion of the parent.

Please make the appropriate revisions to the satisfaction of your research supervisor.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator and the research supervisor.

Please quote your REFERENCE NUMBER in all your correspondence.

Yours sincerely,

Professor Johann Louw
Chairman, Department of Psychology Research Ethics Committee

Appendix C

Informed consent and Assent forms

Dear Parent(s),

Thank you for taking part in our study!

If you would like your child to participate in the study, please complete the demographic questionnaire provided. This information is necessary for our study in order to identify any possible conditions that would exclude your child from being able to take part in the study and to identify possible factors that could influence theory of mind development or spatial navigation in any way. UCT administration also requires some information about your household to make sure that children from all demographic groups are included, and no groups are left out or discriminated against. Therefore please answer all questions as accurately and truthfully as possible.

We understand that some of this information may be sensitive, but please be assured that all information will be kept strictly confidential. Neither you nor your child will be discriminated against, or lose any privileges, as a result of information given. Only certain authorized researchers at UCT will be able to view the information. The information will then be saved as part of a dataset which may only include information that cannot directly identify you or your child. For example, the dataset may not include you or your child's name, address, telephone number, ID number or any other photographs, numbers, codes or so forth that link you or your child to the study. If the results of the research are published neither you nor your child will be identified in any way.

If you have any queries or concerns please feel free to contact us on 082 597 8518 (Michelle Robberts).

Thank you for your participation.

Michelle Robberts
Department of Psychology
University of Cape Town

UNIVERSITY OF CAPE TOWN
DEPARTMENT OF PSYCHOLOGY

Theory of mind development: A comparison of children with autism spectrum disorders and typically developing South African children.

Principal Researcher:

Susan Malcolm-Smith
Lecturer
Department of Psychology
University of Cape Town
021-650-4605

You are invited to take part in a research study comparing theory of mind development in children with autism spectrum disorders and typically developing children. Theory of mind is the ability to understand what other people want, feel and believe, and being able to predict people's actions using this knowledge. Thus, theory of mind is very important for everyday social interactions. We know that people with autistic spectrum disorders have impaired and delayed theory of mind abilities, as well as impaired social and communication skills.

This study will look at the differences in theory of mind ability between high functioning autistic /Asperger's syndrome children, low functioning autistic children, and typically developing children aged 3 to 16 years. Approximately 250 children will participate in the study.

Theory of mind has not been studied in South African children. This study will aid in the understanding of theory of mind development by seeing whether South African children develop these abilities at the same age as previously studied children from other countries. It will also increase our understanding of how theory of mind ability differs in low-functioning and high-functioning autistic children compared to typically developing children at different ages.

If you consent to your child participating in this study, your child will be involved in two cognitive assessment sessions (each about 40 minutes long for children younger than 7 years and 90 minutes for children 7 years and older), where abilities like memory, language and social perception will be assessed. These abilities are assessed by completing several straightforward pencil and paper or computer-based tasks. You, or another caregiver, may be present at the testing session. There are no risks involved in participating in this study. If at any time during the experiment you or your child finds any of the procedures uncomfortable, you are also free to discontinue participation without penalty. At the end of the study, both you and the school will receive feedback about what we found.

We will take strict precautions throughout the study to keep your personal information safe and confidential. Your information will be kept without your name or other personal identifiers, only a code in a locked file cabinet or on a password-protected, secure computer. The data gathered from this research may be published, but your child's contribution will remain anonymous.

Should you have any questions or queries about the research or your participation, please do not hesitate to contact Michelle Robberts: (cell) 082 597 8518, (email) Michelle.Robberts@uct.ac.za

Way-Finding in autism spectrum disorders

1. Invitation and Purpose

Your child is invited to take part in a research study about way-finding in autism spectrum disorders. We are researchers from the Department of Psychology at the University of Cape Town. The study aims to understand better how children diagnosed with an Autism Spectrum Disorder (ASD) learn and remember aspects of the space around them compared to Mentally Challenged and Typically Developing children of the same age. Approximately 150 children will participate in this study.

2. Procedures

If you decide to allow your child to take part in this study, we will ask them to take complete a series of pencil-and-paper tests as well as a computer-based test. The tests will assess your child's general intellectual functioning, their general spatial abilities as well as their spatial navigational abilities. There will be two sessions and each session will take about 60-90 minutes. You, another caregiver, or a teacher may be present at the testing sessions. Your child will be allowed to take breaks whenever requested during the sessions.

3. Risks, Discomforts & Inconveniences

There will be minimal risk involved in the research and your child will not be asked to perform any potentially harmful tasks. The only possible risk is that your child may feel uncomfortable or become fatigued during the testing. If they do they will be allowed to take a break. They may also withdraw from the tasks at anytime. At the end of the study general feedback will be provided.

4. Benefits

The information from this study may help improve our understanding of autism spectrum disorders, particularly with regard to general spatial abilities and spatial navigational abilities in individuals with autism spectrum disorders.

5. Privacy and Confidentiality

Information collected during each session will be stored in locked filing cabinets or in computers with security passwords. Only certain people have the right to review these research records. These people include the researchers for this study and certain University of Cape Town officials. The data gathered from this research may be published, but your child's contribution will remain anonymous. All the sessions will be conducted in a private room at the school.

6. Money Matters

Participating in this study will not cost you or your child anything. You or your child will also receive no compensation for taking part in this study.

7. Questions

If you have questions or concerns about the study please contact the principal investigator Kevin G. F. Thomas, PhD: (office) 021-650-4608 (email) Kevin.Thomas@uct.ac.za or Natalia M. Ing (cell) 082-663-7028 (email) Natalia.Ing@uct.ac.za.

Consent Form

The study has been explained to me, and my questions have been answered

understand that participation in this study is voluntary, and that I may withdraw my child at any point.

I understand that my child will not be identified except by an initial, and that this anonymity will be maintained throughout the study and when the research is published.

consent to allow my child to participate in this study.

Child's name _____

Signature of parent/guardian _____

Date _____

I have explained the study to the participant, and in my opinion s/he understands that participation is voluntary and is able to give informed consent.

Researcher _____

Signature _____

Date _____

Use of Samples/Data for Future Research

With your permission, we would like to store the unused parts of your child's tests for use in future research. This is your choice entirely and you are free to say no and your child will still be able to take part in the study. Please check the boxes that apply to your choice:

do not want my child's samples to be used for any future research

You may use my child's samples for any future research about spatial navigation

Please indicate below if you would like to be notified of future research projects conducted by our research group:

_____ (initial) Yes, I would like to be added to your research participation pool and be notified of research projects in which I or my child might participate in the future.

Method of contact:

Phone number: _____

Cell phone number: _____

E-mail address: _____

Mailing address: _____

UNIVERSITY OF CAPE TOWN
DEPARTMENT OF PSYCHOLOGY
Assent Form

Hello! We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about how people understand how *other people* are feeling, and what they think. This is called theory of mind.

If you agree to join this study, you will be asked to listen to a few stories and look at some pictures. I will then ask you some questions about the stories. You will also be asked to do some tasks like drawing pictures, telling me about the meaning of some words, and building puzzles with blocks.

There will be two sessions, both about an hour and a half long. If you get tired, we can take a break at any time. You can also have a parent or guardian with you if you want.

You do not have to join this study. It is up to you. No one will be mad at you if you don't want to be in the study or if you join the study and change your mind later and stop.

Any questions?

If you sign your name below, it means that you agree to take part in this research study.

Date (MM/DD/YEAR)

Signature of Child/Adolescent Participant

Appendix D

Demographic questionnaire

Participant no.: _____ Date: _____

DEMOGRAPHIC QUESTIONNAIRE

A. Child's Information:

1. Name: _____
2. School: _____
3. Age: _____
4. Date of Birth (dd/mm/yy): _____
5. Sex (circle one): Male Female
6. Ethnicity: White Black Indian Coloured Asian
 Other If other please specify: _____
7. Home Language: _____
8. Handedness (circle one): Left Right Ambidextrous
9. Number of siblings: _____
10. Number of **older** siblings: _____
11. How often does your child use a computer?
Never ____ A few times a year ____ Once a month ____ Once a week ____ Every day ____
12. Has your child ever experienced a head injury? (e.g., being hit on the head with an object and losing consciousness as a result)
 YES NO
If yes, please give details: _____

13. Has your child ever experienced any of the following medical conditions:
 - a. Neurological problems (e.g., **epilepsy**, meningitis, cerebral palsy, encephalitis, Tourette's syndrome, brain tumour)
 YES NO
If yes, please specify: _____
 - b. Depression YES NO
If yes, please specify: _____
 - c. Memory problems YES NO
If yes, please specify: _____
 - d. Problems with their vision YES NO
If yes, please specify: _____

- e. Problems with their hearing YES NO
 If yes, please specify: _____
- f. Is he/she currently taking any prescription medication? YES NO
 If yes, what medication(s)? _____

11. Has your child ever been diagnosed with a social disorder such as conduct disorder or oppositional defiant disorder (ODD)?
 YES NO

If yes, please specify: _____

12. Has your child ever had a communication disorder? (For example: Having problems with understanding or producing speech, slow vocabulary development, difficulties recalling words or problems with producing sentences appropriate for his/her age.)

YES NO

If yes, please specify: _____

13. Has your child ever been diagnosed with a pervasive developmental disorder (PDD) such as autism, Asperger's syndrome, Rett's disorder or childhood disintegrative disorder? (Tick the appropriate block).

No developmental disorder _____

Autism _____

Asperger's Syndrome _____

PDD – Not Otherwise Specified _____

Other (please specify): _____

14. Has your child ever experienced learning difficulties such as dyslexia or attention-deficit / hyperactivity disorder (ADD/ADHD)?

YES NO

If yes, please specify: _____

B. Parent Information:**1. What is the total yearly income of the household in which you live? (Tick the appropriate block):**

[NOTE: This should be total household income, not personal income.]

0-35000: _____ 36000-75000: _____ 76000-125000: _____ 126000-175000: _____
 176000-225000: _____ 226000-275000: _____ 276000-325000: _____ 326000-375000: _____
 376000-425000: _____ 426000-475000: _____ 476000-525000: _____ more than 526000: _____

2. Highest level of education reached for mother, father and/or guardian (please circle appropriate number).

	Biological mother	Biological father	Guardian
1) 0 years (No Grades / Standards) = Never went to school	1.	1.	1.
2) 1-6 years (Grades 1-6 / Sub A-Std 4) = Didn't complete primary school	2.	2.	2.
3) 7 years (Grade 7 / Std 5) = Completed primary school	3.	3.	3.
4) 8-11 years (Grades 8-11 / Stds 6-9) = Some secondary education (didn't complete high school)	4.	4.	4.
5. 12 years (Grade 12 / Std 10) = Completed high school	5.	5.	5.
6. 13+ years = Tertiary education Completed university / technikon / college	6.	6.	6.
7. Don't know	7.	7.	7.

3. Parental employment: (Please circle appropriate number)

	Biological mother	Biological father	Guardian
1. Higher executives, major professionals, owners of large businesses	1.	1.	1.
2. Business managers of medium sized businesses, lesser professions (e.g. nurses, opticians, pharmacists, social workers, teachers)	2.	2.	2.
3. Administrative personnel, managers, minor professionals, owners / proprietors of small businesses (e.g. bakery, car dealership, engraving business, plumbing business, florist, decorator, actor, reporter, travel agent)	3.	3.	3.
4. Clerical and sales, technicians, small businesses (e.g. bank teller, bookkeeper, clerk, draftsman, timekeeper, secretary)	4.	4.	4.
5. Skilled manual – usually having had training (e.g. baker, barber, chef, electrician, fireman, machinist, mechanic, painter, welder, police, plumber, electrician)	5.	5.	5.
6. Semi-skilled (e.g. hospital aide, painter, bartender, bus	6.	6.	6.

driver, cook, garage guard, checker, waiter, machine operator)			
7. Unskilled (e.g. attendant, janitor, construction helper, unspecified labour, porter, unemployed)	7.	7.	7.
8. Homemaker	8.	8.	8.
9. Student, disabled, no occupation	9.	9.	9.

4. Material and financial resources (please circle appropriate number).

Which of the following items, in working order, does your household have?

Items	Yes	No
1. A refrigerator or freezer	1.	1.
2. A vacuum cleaner or polisher	2.	2.
3. A television	3.	3.
4. A hi-fi or music center (radio excluded)	4.	4.
5. A microwave oven	5.	5.
6. A washing machine	6.	6.
7. A video cassette recorder or dvd player	7.	7.

Which of the following do you have in your home?

Items	Yes	No
1. Running water	1.	1.
2. A domestic servant	2.	2.
3. At least one car	3.	3.
4. A flush toilet	4.	4.
5. A built-in kitchen sink	5.	5.
6. An electric stove or hotplate	6.	6.
7. A working telephone	7.	7.

Do you personally do any of the following?

Items	Yes	No
1. Shop at supermarkets	1.	1.
2. Use any financial services such as a bank account, ATM card or credit card	2.	2.
3. Have an account or credit card at a retail store	3.	3.

Appendix E

Additional results of data analysis

Table 3. PIQ means and differences between the ASD and TD groups for both tasks.

	<i>ASD</i>	<i>TD</i>	<i>Group Differences</i>		<i>Effect Size</i>
			<i>t</i>	<i>p</i>	<i>d</i>
Yawn contagion Sample ^a	82.05 (14.26)	104.00 (15.11)	-4.66	< 0.001	1.49
Cradling Bias Sample ^b	83.67 (13.62)	102.35 (15.64)	-3.91	< 0.001	1.27

Means are presented with standard deviations in parentheses.

^a $n = 38$, $df = 37$

^b $n = 37$, $df = 36$

Table 4. Cradling bias task: Performance IQ scores for both the ASD and TD groups.

Performance IQ	ASD (<i>n</i> = 18)	TD (<i>n</i> = 20)
Range	61-105	79-131
Mean (<i>SD</i>)	83.67 (13.62)	102.35 (15.64)
Level*		
<i>High: Low</i>	10: 8	10: 10

Note. The mean value for PIQ in each of the groups (i.e., ASD and TD) was used as a demarcation between high and low PIQ for the respective groups.

Table 9. Cradling bias task: EF scores for both the ASD and TD groups.

Executive Function	ASD (<i>n</i> = 15)	TD (<i>n</i> = 17)
Range (in seconds)	66-180	45-120
Mean (<i>SD</i>)	109.87 (30.97)	79.35 (20.83)
Level		
<i>High: Low</i>	8: 7	9: 8

Note. The mean value for EF in each of the groups (i.e., ASD and TD) was used as a demarcation between high and low EF for the respective groups.