PSYCHOPHYSIOLOGICAL INDICATORS OF EMPATHY, SOCIAL INTERACTION, AND ATTENTION IN CHILDREN WITH AUTISM

by

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Abstract

Individuals with autism do not seem to respond to social situations, especially situations that, in individuals of typical development, elicit an empathic response. This study was designed to determine if heart rate could provide a means of investigating whether the social disturbance in autism is associated with specific empathy processes, general social interaction processes, or with general attention processes.

Ten young male children with autism and 10 young male children of typical development (chronological age between 3-6.5 years) served as participants. The children were exposed to three auditory tones (a cry, a laugh, and a tone), while their heart rate was measured. The experiment took place in each child's home.

There were three between group hypotheses formulated. If the two groups responded differently to all three stimuli, the inference would be that the children with autism have a general attention abnormality. Secondly, if the two groups differed in response to the cry and laugh stimuli but not to the tone, the inference would be that children with autism are responding differentially to stimuli that are social in nature. Finally, if children with autism differentially responded only to the cry stimulus, an empathic deficit hypothesis would be supported. It was hypothesized that children with autism would respond with heart rate acceleration (personal distress) to the cry stimulus.

The results were inconsistent with all three between group hypotheses and the within group hypothesis. Rather results indicated a significant difference between the two groups in response to the laugh stimulus. Only the typically developing children had a significant deceleration response to the cry stimulus. However, the children with autism did not respond with an anxiety response to the cry stimulus as was hypothesized.

The findings from this study suggest that at least some aspect of social function is intact in young children with autism. Results are interpreted in terms of a limbic-hypothalamic deficit hypothesis. Further investigations should include a larger sample size, more ecologically valid stimuli and concurrent behavioral response measures.

Table of Contents

Page

List of Tables

List of Figures

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Chapter 1

Introduction

"Empathy is an emotion that is difficult for persons with autism to understand and express...as a child, I wanted to feel the comfort of being held, but I would stiffen up..., for fear of being engulfed by a tidal wave of overstimulation...when I was a child and other kids teased me, it really hurt and I became upset...when a client is pleased with a facility I have designed , I feel happy...I receive great emotional satisfaction by doing something that is of value to society...If the cattle become agitated or excited, I get upset" (Grandin, 1995, pp.44-45).

Temple Grandin, professor of Animal Science at Colorado State University, is a high functioning individual with autism who is well published in both the fields of autism and her chosen field of animal science. Many of Professor Grandin's personal accounts of what it is like to be autistic focus on the differences between herself and non-autistic adults in emotional understanding and experience. Much of her social understanding comes from years of experience and logical analysis of how to interact or judge situations. Professor Grandin cautions that it is necessary to disentangle social interaction problems and attention difficulties when discussing emotion issues in autism (1995). With respect to her empathic ability, Grandin (1995) acknowledges she has feelings of empathy for others, yet these feelings are more primitive than is experienced by her non-autistic friends and colleagues. This study was designed to determine if heart rate could provide a means of investigating whether the social disturbance in autism is associated with specific empathy processes, with general social interaction processes, or with general attention processes.

Empathy, as defined by Hoffman (1975) "refers to the involuntary, at times forceful, experiencing of another person's emotional state. It is elicited either by

expressive cues which directly reflect the other's feelings or by other cues which convey the impact of external events on him" (p. 126). However, a differentiation between what the self is feeling and what the other is feeling is not necessary in the early stages of empathy. This is evident in infants who experience "contagious affect" by crying in response to the cry of another infant (Hoffman, 1975; Sagi & Hoffman, 1976). This primitive form of empathy is the construct to be studied in this investigation.

Empathy is assumed by psychologists to mediate development of pro-social behaviours such as giving, sharing, and helping (Eisenberg, 1982; Feshbach, 1982; Hoffman, 1981). Yet these behaviours are infrequent or appear non-existent in many individuals with autism (Lord, 1993; Ohta, Nagai, Hara, & Sasaki, 1987). The lack of pro-social behaviours in autistic individuals has led some researchers to define autism as one of a class of "empathy disorders" (Brothers, 1989; Gillberg, 1992; Trevarthen & Aitken, 1994). The link between empathy and autism is also evident from the first publicized account of autism. Similar to Temple Grandin's description of empathy in children with autism, Dr. Leo Kanner (1943), the first physician to document the syndrome of autism, described a disorder characterized by extensive social deficits and a severe lack of responsivity to the environment. Kanner (1943) suggested in his seminal paper that autistic children "have come into the world with the innate inability to form the usual, biologically provided affective contact with people" (p.250).

Other definitions of autism emphasize a 'triad' of impairments in communication, behaviour, and social skills (Wing & Gould, 1979). Of these categories, diagnosticians place heavy emphasis on social criteria as the most robust predictors of diagnosis (Volkmar, Carter, Grossman, & Klin, 1997). Emphasis on the qualitative impairment in

social interaction is maintained in the diagnostic criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV;* APA, 1994). Research in autistic social impairment continues to be an area that, although intensely investigated (for reviews see Rogers & Pennington, 1991; Volkmar et al., 1997), still suffers from many inconsistent findings (for reviews see Bailey, Phillips & Rutter, 1996; Volkmar, 1987) and methodological concerns (Fein, Pennington, Markowitz, Braverman, & Waterhouse, 1986). Consequently, comprehension of social development in autism remains a puzzle.

Some researchers suggest that early emerging empathic responses during infancy serve as one basis for the development of social relationships throughout the rest of life (Hobson, 1993a;b; Hoffman, 1975; Sagi & Hoffman, 1976). In the case of autism, Hobson suggests that social impairments derive from "a failure to experience intersubjective engagement with others." In other words, Hobson argues that the neural processes that allow the majority of individuals to understand people as separate entities and in relation to themselves are abnormal in individuals with autism. Consequently, these abnormal processes have a detrimental effect on social and emotional development. This theory then, referred to as Hobson's " I-thou intersubjectivity model", hypothesizes that the abnormal "I-thou" process disables individuals with autism from understanding people and establishing normal social skills.

How is Hobson's argument related to the role of early-emerging empathic responses in overall social development? Hobson (1993a) believes infants are biologically primed to perceive and respond to "bodily expressions and actions of other persons" (p. 243). These primary perceptive abilities provide the foundation for emotional connectedness with others. The ability to feel empathic with the emotional states of

others may be within the realm of establishing this emotional connectedness with other people.

Hobson's theory of the social impairment in autism serves as one viewpoint in the investigation of the nature of empathic ability in individuals with autism. In fact, several researchers define autism as one of a class of empathy disorders (see Brothers, 1989; Gillberg, 1992; Trevarthen & Aitken, 1994). Diminished ability to feel empathy is also inferred as one of a host of factors associated with other observable social difficulties characteristic of autism (Kasari, Sigman, Mundy, & Yirmiya, 1990; Lord, 1993; Sigman, Kasari, Kwon, & Yirmiya, 1992; Yirmiya, Kasari, Sigman, & Mundy, 1989; Yirmiya, Sigman, Kasari, & Mundy, 1992). Although a lack of empathy is inferred in autistic individuals, an extensive search of the literature turned up only one study that has specifically examined empathy in autistic individuals (Yirmiya et al., 1992).

Empathy is not the only process that is associated with the development of the social interaction behaviour of individuals with autism. Other researchers theorize that problems in several domains of attention and arousal collectively serve as the core deficit in the social symptomatology of autistic individuals (Dawson & Lewy, 1989a; James & Barry, 1980; Kinsbourne, 1987; van Engeland, 1984). Each individual has a level of arousal that determines how he/she will react to sensory stimulation. That is, stimuli of low intensity will elicit attention in an individual who is in the state of high arousal, yet stimuli of high intensity is required in an individual who is in a state of low arousal. Many theorists regard an ineffective arousal-modulating system as a key source of attention and social impairments in autism. Research further suggests that attention deficits in

individuals with autism may be related to impairments in *social functioning* (Lewy & Dawson, 1992, Pierce, Glad, & Schreibman, 1997).

The overall purpose of this study was to provide a means of investigating whether the social disturbance in autism is associated with specific empathy processes, with general social processes or with general attention processes. Thus far, this question has eluded researchers because no methodology has been available to differentiate between specific empathic responding, general social responding, and general attention responding.

In this study, physiological heart rate responding was utilized as a means of differentiating whether differences between autistic and typical children occur between specific empathic stimuli, general social stimuli, or general attention stimuli. As well as being widely used in studies of attention, heart rate (HR) orienting response has been used as a measure of responding to empathic stimuli in typical populations of adults, children, and infants (Eisenberg, Fabes, Bustamante, Mathy, Miller & Lindholm, 1988; Hoffman, 1975; Sagi & Hoffman, 1976). Children with autism often experience behavioural and communicative difficulties such as lack of facial affect and the inability to provide self-reports. These constraints make typical behavioural indices of empathy difficult. In this study, heart rate measures allowed for physiological assessment irrespective of behavioural and communicative constraints.

Social Impairment in Autism

Trying to define the extent of impairments of social functioning in autistic individuals, their causes, and their implications in the other facets of disturbances seen in autism has not been an easy task. Many theorists ascribe to the notion that early

developing social processes are disrupted in autism (Dawson & Lewy, 1989a; Fein, Pennington, Markowitz, Braverman, & Waterhouse, 1986; Hobson, 1990; Rogers & Pennington, 1991). Children with autism have shown delayed or deficient behaviours in imitation (Hertzig, Snow, & Sherman, 1989; Jones & Prior, 1985), attachment (Sigman & Mundy, 1989; Sigman & Ungerer, 1984), joint attention (Sigman, Mundy, Sherman, & Ungerer, 1986), understanding of expression of emotion (Hobson, 1986), emotion perception (Ozonoff, Pennington, & Rogers, 1989), symbolic play (Ungerer & Sigman, 1981) and in understanding mental states (Baron-Cohen,1989a,b; 1995).

Parents and educators of children with autism often report absent, inappropriate or different emotional abilities, and these children often do not seek human contact or initiate social activities with others (for review see Cohen & Volkmar, 1997). Behavioural observations of autistic children shows that they are typically withdrawn, inattentive to people and their surroundings, and avoid eye contact (Bryson, Wainwright-Sharp, & Smith, 1990; Dawson, Hill, Spencer, Galpert, & Watson, 1990; Sigman, Kasari, Kwon, & Yirmiya, 1992; Trevarthen & Aitken, 1996).

In a study by Sigman, Kasari, Kwon, and Yirmiya (1992), 30 normal and 30 mentally retarded children (MA<2 yrs.) were compared with 30 autistic children (MA<2 yrs.) on their attention, facial affect, and behaviours in response to adults showing fear, distress, and discomfort. The purpose of the study was to discern what patterns, if any, are present in autistic children that would cause them to withdraw in social situations in which individuals are displaying negative emotions, such as sadness or distress. Typical children do not evidence this withdrawal pattern. In fact, most often during these negative situations, typically developing children are interested in the distress of others.

Furthermore, most typical children show prosocial responses, such as providing comfort to another in distress, by the time they reach the age of two years old (Zahn-Waxler & Radke-Yarrow, 1990).

In the research study by Sigman et al., (1992), children were individually observed with respect to their behaviours in response to their parent and the investigator acting fearful and distressed. Coded behaviours were attention to the displays, behaviours directed to a toy and adults, and facial affect. The findings of this study revealed that the autistic children looked less at the adults than did the mentally retarded and typically developing children, and were more likely to withdraw physically from the situation. Similarly, Dawson et al. (1990) found that children with autism looked less frequently and showed less positive affect in interactions with their mothers. Thus, at least at the behavioural level, children with autism characteristically show atypical social development in affect, cognition, and emotion perception. These studies add to the vast literature proposing impaired social affect and social cognition as components of a primary deficit of autism (Baron-Cohen, 1995; Perner, 1993).

The social picture, however, is not as bleak as has been presented thus far for children with autism. Evidence exists that not every autistic individual has a pervasive lack of social and emotional responsiveness. Recent investigations have brought light to subtle, positive aspects of social ability evident in some autistic individuals (Clarke & Rutter, 1981; Dawson, Hill, Spencer, Galpert, & Watson, 1990; Dissanayake, Sigman, & Kasari, 1996; Gillberg ,1992; Kasari, Sigman, Baumgartner, & Stipek, 1993; Landry & Loveland, 1989). Although some research has shown that autistic children do not respond to other's affects (Dawson et al., 1990; Sigman et al., 1992), Dissanayake, Sigman, and

Kasari (1996) found contradictory results. The investigation by Dissanayake et al., attempted to discern whether or not children with autism were able to differentiate behaviourally between two different affective contexts as exhibited by the researchers. Thirty children with autism between the ages of 2 years, 3 months to 5 years of age participated in this study. Responsiveness to the emotional displays (of the researchers) was measured by coding the children's direction of attention and behaviour. The researchers found that children with autism showed a greater degree of attention and concern directed towards the experimenter in an angry condition as compared with a neutral condition. The investigators concluded that results such as these "illustrate that autistic children do not deliberately avoid affective situations" (Dissanayake et al., 1996, p.466).

Additionally, in the study reported earlier by Sigman et al. (1992), the autistic children were as hesitant in approaching an object eliciting behavioural displays of fear in the researchers as were the two control groups (even though the autistic children did not pay attention visually to these demonstrations). This hesitancy occurred even though the children with autism did not pay attention visually to these demonstrations. These findings suggest that although the children with autism are not engaging in any observable behaviours showing concern or affect, it is possible that they still perceive these situations.

There exist more instances of positive social behaviours in autistic individuals. Clinicians (Gillberg, 1992) as well as high-functioning, verbal adults with autism (Grandin, 1984, 1995; Grandin & Scariano, 1986; Williams, 1992) assert that autistic individuals can 'feel' if a social interaction is full of emotion, can themselves experience a wide range of emotions, and can also have a desire for social interaction.

Clearly, investigation of the social disturbance in autism has a long way to go before making the claim that it is a social deficit which underlies the cognitive and linguistic impairments characteristic of autistic individuals (Bailey, Phillips, & Rutter, 1996; Fein et al., 1986). As mentioned earlier, one team of researchers (Dissanayake et al., 1996), has provided evidence that children with autism may in fact be perceiving emotions in others, yet they are not able to behave appropriately due to lack of comprehension of the situation. This finding is similar to evidence from other studies. For example, researchers have documented developmental gains in social responsiveness from preschool to childhood (Wing, 1978), increased responsivity to others in structured situations where others actively engage these children in social interaction (Clark & Rutter, 1981), and evidence of some intact child-caregiver attachment patterns (Sigman & Ungerer, 1984) in young children with autism. All of these findings are in direct contradiction to the withdrawn characteristic of most of this population. There is further evidence that children with autism can at least respond to a basic level of human expression as it pertains to music or movement therapy (Toigo, 1992). The question remains then, as to whether or not there is an inconsistency between how children with autism are physiologically responding to social situations and what their behavioural repertoire dictates. It is within this contradiction that this study is based.

The Role of Attention in Social Functioning of Individuals with Autism

Research suggests that attention deficits in autistic individuals may be responsible for deficits in social perception (Courchesne, Akshoomoff, & Townsend, 1990; Pierce, Glad & Schreibman, 1997; Wainright-Sharp & Bryson, 1993) and deficits in social

interaction (Lewy & Dawson, 1992; Loveland & Landry, 1986). In the study by Pierce et al., (1997), researchers attempted to investigate the effects of multiple social cues on the ability to interpret social situations. The study was based on the rationale that in some studies investigating the "theory of mind" ability of children with autism, "it is unclear whether findings are due to deficits in attributing mental states to others, or whether they are due to multiple attentional requirements" (Pierce et al., 1997, p.268). The researchers hypothesized that children with autism may be able to perform well on social tasks if the attentional requirements are kept to a minimum. Three groups of children (14 children with autism, 14 mentally handicapped, and 14 typically functioning children) participated in the study. Participants watched a series of 16 videotaped scenarios that varied with respect to how many cues they contained. The types of cues included verbal content, different kinds of tone of the verbal phrases, nonverbal gestures that did not include an object and nonverbal gestures that did include an object. The participants were then asked a series of questions pertaining to the videotaped scenarios. What the researchers found was that, overall, children with autism were as good as the two other groups at interpreting social situations when the scenario consisted of only one social cue. However, when the social situations consisted of more than two social cues, children with autism performed significantly worse than the other two groups. This study further supports the notion that the deficits in social interactions of children with autism may be accounted for by minimal attention capabilities. That is, the multiple cues that are interwoven in social situations result in more of an attention load necessary for processing.

The Nature of Empathy in Autism

Hobson's argument (1986) in building a case for the 'cause' of autistic symptoms is that young children with autism fail to experience interpersonal emotional understanding which then develops into the inability to understand that other people have thoughts and emotions separate from their own. This line of inquiry is referred to as the 'theory of mind' account of deficits seen in autism (see also Leslie, 1987; Baron-Cohen, 1988; and Frith, 1989, for different interpretations of the role of 'theory of mind' deficits in autism). In general, the theory of mind hypothesis defines the autistic syndrome as one caused by a failure to perceive and understand mental states (Astington, Harris, & Olson, 1988; Baron-Cohen, 1989a; Happe, 1994; Perner, 1991). Researchers postulating the 'theory of mind' account of autism cite evidence wherein autistic individuals do not recognize other people as being engaged in situations in which they can join in (Loveland & Landry, 1986; Sigman et al., 1986), and wherein they are deficient in self-awareness (Dawson & Adams, 1984; Hobson, 1990). These manifestations are thought then, to occur because individuals with autism do not understand thoughts, beliefs and intentions in other people and hence are not able to make use of emotions. Overall, this line of thinking advances the notion that a primary deficit in "theory of mind" impedes the ability to feel empathy.

It is also feasible, however, that the relationship between 'theory of mind' and empathy occurs in the opposite direction; that is, that a deficit in early empathic responses leads to the deficits seen in typical "theory of mind" tasks. The "theory of mind" primacy hypothesis does not explain the "early social deviance displayed in persons with autism" (Volkmar, Carter, Grossman, & Klin, 1997, p. 185), and the fact that not all autistic individuals fail the "theory of mind" tasks. Furthermore, Gillberg (1992) proposes that the

difference between autistic and non-autistic individuals may be that autistic individuals have trouble "making sense of the feelings of self or others". The question remains as to whether or not children with autism differ in basic empathic responding that is assumed to occur automatically, involuntarily and as an innate response (Brothers, 1989; Hoffman, 1975,1984,1991).

Only one published study has been conducted that specifically addressed the issue of empathic responding in children with autism. In this study Yirmiya and her colleagues (Yirmiya et al., 1992) compared the ability of non-retarded autistic children between the ages of 9-16, with the ability of normally developing children between the ages of 9-14 to respond on three measures of empathy. The measures included the ability to discriminate between various emotional states, to take the perspective of another regarding those states, and to respond affectively. Children were also assessed on their ability to understand conservation, in an attempt to relate emotional responding with level of cognitive ability. Participants watched 10 videotaped segments of children experiencing a wide range of emotional experiences, and were then asked to report how they felt. The ability to feel empathy was assessed by the extent of agreement between what the child in the video was feeling and what the child with autism was feeling at that point in time. Although the high-functioning autistic children did less well on all three measures of empathy than did the normally developing children, the authors noted that the children with autism did surprisingly well (Yirmiya et al., 1992). The researchers deduced that because the more intelligent children with autism obtained better scores on empathy measures, children with autism might rely more on cognitive strategies for dealing with social situations.

The positive link between social responsiveness and intellectual ability was also evident in the study by Dissanayake, Sigman, and Kasari (1996). Interestingly, in both of these studies, there was no significant relationship between intelligence and scores on empathy measures in typical children. It may be difficult to draw conclusions from these studies as to the nature of empathy in autistic individuals. These high-functioning children represent a relatively small subset of the entire autistic population. As is stated by these researchers (Dissanayake et al., 1996; Yirmiya et al., 1992), it is possible that some autistic children have developed unique cognitive compensatory strategies to deal with a void in social understanding. In this study, heart rate reactions to a variety of stimuli varying in empathic content was examined. It was anticipated that this primitive mode of empathic responding should occur irrespective of higher-order cognitive processing (Hoffman, 1975, 1984, 1991).

Chapter 2

The Study of Empathy in Autism

Why Study Empathy?

The importance of studying empathy in autism is critical when one takes into account a dominant theoretical viewpoint that the tendency to feel empathically towards others has a genetic basis (Hobson, 1993a; Hoffman, 1975; 1981; Kessen, Haith, & Salapatek, 1970; Sagi & Hoffman, 1976; Simner, 1971; Rushton, Russell, & Wells, 1984). Further, several researchers assert that "the development of language in the second and third year of life depends on empathic motives the child has for engaging in cooperative imagination and action with companions and for appropriate emotional response to their expressed feelings" (Trevarthen & Aitken, 1996, p.604). One could infer that a deficit in empathic responding might be partly responsible for the language and communication delay characteristic of autism. Taking these lines of evidence into account, is it possible that a deficit in empathic responding in individuals with autism may be due to a *genetic* predisposition that inhibits or hinders empathic responding? In addition to Gillberg's (1992) definition of autism as an empathy disorder, Brothers (1989) proposes that the syndrome of infantile autism may provide a unique opportunity to study the neural mechanisms of empathy.

In studies of empathic responding of typical children by Hoffman (1975), the assertion is that an infants' seemingly involuntary orientation to other infants may represent a "constitutionally based, early precursor of empathy". According to Hoffman (1984, 1991), children progress through four levels of empathy development, which are characterized in varying degrees by five modes of empathic affect arousal. The first, three

arousal modes, are automatic and involuntary. The last two modes require higher order cognitive processing such as the ability to use and understand language and the ability to put oneself in another's place.

This scheme suggests that empathy is essentially an automatic, involuntary response to another persons' distress. These arousal modes require at least some cognitive processing, such as sensory registration, simple pattern matching, and conditioning (Hoffman, 1991). Therefore, Hoffman (1991) suggests that "empathy appears to be a universal, largely involuntary response – that is, if one attends to the relevant cues, one responds empathically" (p. 278). The question remains as to how children with autism respond to the early stimuli that elicit an innate empathic response in typical children.

In order to capture this basic biological empathic response, Simner (1971) investigated two-day old infants (without any known medical or genetic abnormality) to determine the nature of their empathic distress responding. The infants were exposed to three stimulus conditions: crying of another newborn, computer-simulated infant cries and an equally loud noxious stimulus. Infants responded with intense and vigorous cries in response to the cry of another infant but not to the other stimuli. Sagi and Hoffman (1976) repeated these findings with infants who were approximately one-day old thereby adding support for the notion that humans have an inborn distress reaction. Based on these studies, researchers (Lennon & Eisenberg, 1987) have defined the function of these first innate personal distress reactions as ones of precursors to pure empathetic responding which emerge in the second year of life (Zahn-Waxler & Radke-Yarrow, 1990; Radke-Yarrow & Zahn-Waxler, 1984).

Empathy is considered to be part of an innate mechanism present from birth (Brothers, 1989; Hoffman, 1975, 1991; Sagi & Hoffman, 1976; Simner, 1971). Considering that autism is classified as a disorder of empathy (Gillberg, 1991; Trevarthen & Aitken, 1994), one could infer that responses to empathic situations are impaired in autism. What impact does information of an innate empathic distress reaction have on the apparent lack of empathy in individuals with autism? Does this mean that people with autism are born without this innate mechanism or does this mean that a deficit somewhere else leads to a behavioural profile typical of an individual without this innate mechanism? The paradox is that although autism may be defined as a disorder of empathy and several researchers infer that children with autism lack empathy (Baron-Cohen, 1990; Gillberg, 1991), research targeting the nature of the empathic response in autism is scarce. As well, there have been relatively few studies that investigate the behavioural responses of autistic children to the negative emotions of others (for exceptions see, Dissanayake, Sigman, & Kasari, 1996; Sigman, Kasari, Kwon, & Yirmiya, 1992; Yirmiya, Sigman, Kasari, & Mundy, 1992). Although observation of autistic individuals may lead one to believe that they are not capable of empathic responding, systematic study has not been undertaken.

It would greatly benefit the diagnosis and treatment of individuals with autism if researchers were cognizant of the different factors contributing to the interference of age appropriate skills in empathy. The purpose of the present study was to progress beyond what is already known about children with autism in regards to their delayed or deficient social development and to investigate the involuntary autonomic responding that underlies reactions to empathic stimuli.

Definitions of Empathy

It is not clear in the literature as to what terminology should be given to these different emotional responses, however the nature of this debate has filled volumes of literature (for review see Eisenberg & Strayer, 1987). In this study, I ascribed to a widely cited definition of empathy as conveyed by Hoffman (1975). He states that "empathy refers to the involuntary, at times forceful, experiencing of another person's emotional state. It is elicited either by expressive cues which directly reflect the other's feelings or by other cues which convey the impact of external events on him" (p. 126). Of critical interest in this study was the distinction defined by Hoffman (1982) between empathy and direct emotional arousal such that the affect experienced is "more appropriate to someone else's situation than to one's own situation" (p.282). This distinction between types of empathic responding has been operationalized by C. Daniel Batson (1991) and Eisenberg and colleagues (Eisenberg, Fabes, Miller, Fultz, Shell, Mathy, & Reno, 1989) in terms of responses characteristic of sympathy and responses characteristic of personal distress. Sympathy refers to "an other-oriented response to another's distress or need, such as feelings of concern" and personal distress refers to " a self-oriented, egoistic response to another's need or distress-such as feelings of discomfort or anxiety when confronted with another's negative state" (Eisenberg et al., 1989).

Hoffman (1975; 1984; 1991) distinguishes between the different experiences of empathy as a child develops by equating the development of empathic distress with the child's development of a cognitive sense of others. Hoffman (1975) has portrayed the union of empathic affect and social-cognitive development as developing according to four levels of empathic distress. In the first level, referred to as global empathy, children

under the age of one year experience empathic distress through the simplest arousal modes. Consequently, the children are experiencing empathic distress "before they acquire a sense of others as physical entities distinct from the self" (Hoffman, 1991, p.278). During this level, children act as though what happened to someone else actually happened to them, such as is the case when an infant cries upon hearing the cry of another infant.

The second level, referred to as 'egocentric' empathy, is evident during the first year of life. In this level, the child may be aware that another person is in distress, but does not yet have the knowledge of the other's internal states. The child may therefore assume that the others' internal state is the same as his/her own.

During the third level, which occurs at approximately two to three years of age, a child begins to exhibit role-taking abilities. Thus, the child can now define what another person may be feeling. This leads to the fourth level where the child is empathically aroused by someone else's distress even in his/her absence.

From the above discussion, two deductions can be made. One is that the experience of empathic distress is largely automatic and involuntary. This statement is made with the assumption that the salient stimuli have been perceived (Hoffman, 1991). The second deduction is that empathic responding matures and evolves as the child's cognitive sense of other develops (Eisenberg et al., 1989; Hoffman, 1991). The major question in this investigation was whether or not the level of empathic responsiveness of children with autism was different from that of typically developing, developmentally-age matched peers.

Physiological Indices of Empathy

The answer to the inconsistency present in the literature concerning the empathic/emotional ability in autism may be addressed by studying internal physiological responding. Eisenberg and her colleagues (Eisenberg, Fabes, Miller, Fultz, Shell, Mathy, et al., 1989; Eisenberg, Fabes, Bustamante, Mathy, Miller, & Lindholm, 1988) have conducted a series of studies using autonomic markers in the measurement of empathy in typical children. The rationales for this type of inquiry was based on the fact that empathy-related reactions are internal and that past studies using self-report measures were insufficient.

There is research to support the notion that physiological indices can be used to differentiate between different types of emotional responding (see Campos, Butterfield & Klinnert, 1985; as cited in Eisenberg, Fabes, Bustamante, & Mathy, 1987; Craig, 1968; Craig & Lowery, 1969; Ekman, Levenson, & Friesen, 1983). Craig and his colleagues have investigated several facets of physiological responding upon which they have clearly delineated heart rate patterns characteristic of different emotional responses. Of primary interest in the study of empathy reactions is the finding of opposite patterns of heart rate responses in situations characteristic of being anxiety-provoking (also referred to as personal distress) versus situations characteristic of being sympathy-provoking (see Leventhal & Tomarken, 1986; Schwartz, Weinberger, & Singer, 1981). Specifically, individuals exhibit heart rate *accelerations* in situations that create *anxiety* (personal distress) and heart rate *decelerations* in situations that create an *other-oriented focus of attention* (sympathy). General psychophysiological research (Graham & Clifton, 1966;

Lacey, 1967; Sokolov, 1963) delineates that attentional receptivity to environmental stimuli, also called an orienting response, is characteristic of heart rate *deceleration*. The orienting response consists of behaviourally turning toward the stimulus, suppressing body movements and physiologically (among many other things) showing an initial slowing of heart rate (Sokolov, 1963; Graham & Clifton, 1966). Conversely, heart rate *acceleration* (Dawson & Lewy, 1989a) with a failure to habituate in continual presence of the noxious stimulus (Graham & Jackson, 1970), is indicative of a rejection of environmental stimuli, also referred to as a defensive response. In applying these definitions to the study of empathy, it can be inferred that heart rate deceleration is evident in an individual displaying sympathy and heart rate acceleration is evident in an individual displaying personal distress (see Eisenberg, Fabes, Bustamante, Mathy, Miller, & Lindholm, 1988; Eisenberg, Schaller, Fabes, Bustamante, Mathy, Shell, & Rhodes; 1988). In conclusion, research on physiological indices of emotion has provided evidence that heart rate patterns are valid in differentiating between vicariously induced states of sympathy and personal distress.

Physiological Indices of Emotion in Autism

Heart rate patterns in autism have been investigated in research on arousal modulation as a basis of understanding the nature of the autistic social deficit (see Bernal & Miller, 1970; Dawson & Lewy, 1989a,b; Hutt, Hutt, Lee, & Ounsted, 1964; James & Barry, 1980; Ornitz & Ritvo, 1968; Palkovitz & Wiesenfeld, 1980). This research using heart rate measures in autistic populations supports the conclusion that children with autism often fail to show heart rate deceleration (orienting response) to novel stimuli, as is

evident in typical populations (see Sokolov, 1963; Graham & Clifton, 1966). Rather, autistic individuals exhibit heart rate acceleration (defensive response). This research has led to the speculation that individuals with autism "turn their attention inward and reject sensory stimulation to protect themselves from the overload of information that they faced" (Burack, Enns, Stauder, Mottron, & Randolph, 1997, p.231). Because many of the autonomic studies of autistic children indicate either delayed or no response to auditory stimuli (Stevens & Gruzelier, 1984; van Engeland, 1984), it is feasible to conclude that lack of attention generally rather than lack of attention specifically to social/empathic stimuli is causing withdrawn behaviours in social situations.

In an attempt to relate autonomic responding and deficient social ability of autistic individuals, Palkovitz and Wiesenfeld (1980) studied differences in autonomic responding to three auditory stimuli. Social speech, nonsense speech, and tones, were examined in 10 autistic and 10 typically developing boys (mean CA = 7.56 years). Several interesting patterns of responding occurred in the children with autism. First, the responses of the children with autism to both of the socially relevant speech stimuli, were ones of acceleration (defensive responding). However the autistic children did also evidence an initial heart rate deceleration,(although it did not last as long as did the decelerative response in the normally-developing children). The researchers did not follow up this deceleratory response. Second, the children with autism did not have a significant response to a simple auditory tone. Last, the autistic children evidenced a constant state of hyperarousal relative to the normal children, as indicated in overall heart rate and skin conductance responses during baseline conditions. Although the research is not conclusive, many studies have reported chronically elevated levels of arousal in autistic

populations (Cohen & Johnson, 1977; as cited in Dawson & Lewy, 1989a; Hutt, Forest, & Richter, 1975; as cited in Dawson & Lewy, 1989a; Kootz, Marinelli, & Cohen, 1982).

On many grounds, the conclusions by Palkovitz and Weisenfeld (1980) are relatively weak. First, the salience of the social stimuli is weak in that the socially relevant speech stimulus (a voice saying "look at me") and the nonsense speech stimulus did not vary greatly in affective content. Second, studies in autonomic responding of children with autism have failed to account for developmental changes in children with autism such that "like cognitive and social abnormalities, physiological abnormalities attenuate as the autistic child develops" (Dawson & Lewy, 1989). It is not feasible to equate the responses of older autistic children to pre-school aged children with autism, however, past studies have utilized samples of children with ages ranging from pre-school to adolescence.

In sum, empathy research in typical populations has found a link between heart rate responding and empathic responding (Eisenberg et al., 1989). As previously discussed, the literature supports the hypothesis that children with autism may lack the ability to respond empathetically. Further, although studies involving autistic populations have looked at both the pattern of heart rate responding to social stimuli (e.g., Palkovitz & Weisenfeld, 1980) and the behavioural, emotional responsivity to empathy-inducing stimuli do exist (e.g., Sigman et al., 1992; Dissanayake et al., 1996), no literature has examined the association of heart rate responding to empathic responding in children with autism. Because social difficulties are instrumental in the classification of autism and because the deficits found in autistic individuals vary widely, this topic is of considerable interest to those who diagnose autistic individuals (e.g., psychiatrists, physicians). Also,

because these social difficulties hinder educational intervention, this topic is of considerable interest to educators and parents of children with autism, particularly if we are to enhance their ability to effectively promote positive social development.

Stimuli

The choice of stimuli used in this investigation is of considerable methodological importance. Three auditory signals were utilized. One reason for using an auditory stimulus instead of or in addition to visual displays is because some studies show that individuals with autism attend best to only one sensory modality at a time (Cesaroni & Garber, 1991; Pierce, Glad, & Schreibman, 1997; Sinclair, 1992; Williams, 1994). In the study by Pierce et al., (1997), children with autism did as well as chronological age and mental age matched groups on general attention questions and social perception questions relating to stories containing one cue (i.e., either visual or auditory). However, the children with autism did more poorly than comparison groups on social perception questions relating to stories containing multiple cues. That is, a confound may have existed in that children with autism are known to pay attention to inanimate or irrelevant aspects of a visual display. A second reason for using only auditory stimuli is to provide a means of comparison with other studies in autism using heart rate measures that use auditory stimuli (see Bernal & Miller, 1970; James & Barry, 1980; Palkovitz & Weisenfeld, 1980). Third, as noted by Thompson (1987), in natural situations, vocal cues are most arousing because of their intensity. Viewed developmentally, "vocal cues of emotion may be prepotent early elicitors of vicarious arousal since it is not until late in the first year that facial expressions are imbued with emotional meaning by infants."

(Thompson, 1987, p.138). Fourth, in at least one study (Hermelin and O'Connor, 1970), children with autism evidenced normal cortical responsiveness to auditory stimuli but fewer behavioural orientation responses. Therefore, given evidence that the autistic children at least perceive the auditory stimuli, this investigation allowed the discernment of whether or not there occurred a discrepancy between social and non-social stimuli.

One stimulus, the target stimulus, consisted of a child (similar in age and gender to the study participants) engaged in sad crying. This stimulus was chosen for several reasons. First, crying is the first known trigger of empathic responding in infants (Hoffman, 1975; Sagi & Hoffman, 1976; Simner, 1971). Second, children with autism are hypothesized to be deficient in the comprehension of speech (Dahlgren & Gillberg, 1989, as cited in O'Neill & Jones, 1997; Rutter, Mawhood, & Howlin, 1992) and past studies investigating autonomic responding to social stimuli in autistic children (Palkovitz & Weisenfeld, 1980) have used verbal speech segments that were not very salient (i.e., a tape-recorded voice saying "look at me"). It is assumed, therefore, that the salience of the crying stimulus will best be able to differentiate between the groups if there is indeed a deficient empathic response in children with autism. Third, the stimulus was carefully chosen to be produced by a child that was matched according to age and gender because researchers have found that infants tend to cry more in response to cries that are similar to their own (Hoffman, 1984). For example, Martin and Clark (1982) failed to find gender differences when gender of the stimulus cry was controlled for and Lennon and Eisenberg (1987) found that children are more likely to respond to crying of another child of similar age. Fourth, a negative emotion was used because "children and adults are more likely to respond empathically to salient expressions of negative emotions in others." (Thompson,

1987, p.139). The use of a negative stimulus also allowed for comparison of responses obtained in this investigation to other investigations of the reaction to negative emotions by autistic children (see Sigman et al., 1992). In conclusion, many studies on emotional responsivity of autistic individuals have played a role in hypothesizing that disturbed empathic responding may be involved in the aberrant social picture of autistic individuals.

Although physiological indices of evoked happiness have not yet been investigated, responses to laughter were included in the present investigation. The addition of a laugh stimulus was required to discern whether or not the heart rates of children with autism are the same for both of the stimuli that are social in nature. Based on physiological explanations, the heart rate pattern for the cry and laugh should be different. That is, although heart rate should decelerate to stimuli evoking sympathy (i.e., cries), the heart rate should accelerate in situations evoking feelings of happiness (Wessels & Hopson, 1988). Crying and laughing were grouped together for the purpose of this investigation to reflect social phenomena. It was hypothesized that if the children with autism and typically developing children differentially process social stimuli, the children with autism would differ in their responding to both of the cry and laugh stimulus.

A third stimulus consisted of a tone matched in frequency, loudness and pitch to the other two social stimuli. This tone was added to provide a basis of comparison as a non-social stimulus with the other two social stimuli. It was hypothesized that if the children with autism and typically developing children differentially process social stimuli, the children with autism would differ in their responding to all three stimuli.

Statement of the Problem and Significance of the Study

This study was designed to determine if heart rate could provide a means of investigating whether the social disturbance in autism is associated with specific empathy processes, with general social interaction processes, or with general attention processes. Research on empathic physiological responding in typical children has delineated clear patterns associated with sympathy and personal distress. Using these patterns, it was of interest to compare how children with autism respond physiologically to stimuli varying in empathic content. It is anticipated that this type of physiological investigation may aid future investigations in uncovering mechanisms responsible for the autistic persons' observable deficit in empathic responding.

Other research suggests that the lack of observable behaviour in social situations evidenced by autistic individuals may be related to atypical patterns of autonomic responding (Dawson & Lewy, 1989a). Some researchers further postulate that a differential autonomic response occurs between social and non-social stimuli (Palkovitz & Weisenfeld, 1980) such that responding to social stimuli is disturbed whereas responding to non-social stimuli is intact. However this study, along with other studies in physiological responding of autistic children (e.g., Bernal & Miller, 1970; James & Barry, 1980; Stevens & Gruzelier, 1984) did not control for developmental level and degree of autistic impairment. Further, these investigations are not comparable with respect to stimuli or experimental procedures, which makes comprehension of the relationship between physiological arousal and behaviour in individuals with autism, difficult.

Results from these physiological studies are incongruent with some observational studies (e.g., Dissanayake, Sigman, & Kasari, 1996), personal accounts from people with autism (Grandin & Scariano, 1986) and studies of social functioning in autistic individuals (Howlin, 1986). These lines of investigation have shown that at least some aspects of social functioning are spared in some autistic individuals. Specifically, it has been shown that individuals with autism are able to perceive social situations and are not insensitive to the affectionate tone of their environment, even though their behaviour may indicate this to be the case. Explanations for these contradictory results were sought through study of autonomic responding to different affective contexts.

In this study, I compared the heart rate responding of children with autism with that of developmental age matched typical children in response to three sounds: a cry, a laugh and a tone. The aim of this study was to determine whether the pattern of heart rate responding in autistic children reflected a disturbance in empathy processes, a generalized disturbance in social interaction processes, or a general disturbance in attention processes.

Hypotheses

Based on the literature reviewed, heart rate patterns could have differed in at least three ways. Firstly, if children with autism responded differently from the typically developing children to all three stimuli, the inference would be that the children with autism have a general attention or perceptual abnormality. An attention theory would predict that the children with autism would respond in the same way to all three stimuli (accelerate to all three stimuli, decelerate to all three stimuli, or not respond to any of the three stimuli). Secondly, if the children with autism differed from the typically developing

children in response to the cry and laugh stimuli but not the tone, the inference would be that the children with autism are responding differentially to stimuli that are social in nature. This would lend some credence to a hypothesis suggesting a disturbance in social interaction processes in the explanation of the syndrome of autism. Finally, if children with autism differentially responded only to the cry stimulus, the inference would be that children with autism are responding differentially to a stimulus that elicits empathic responding. This finding would add more evidence for the notion that autism is a one of a class of empathy disorders (Brothers, 1989; Gillberg, 1992; Trevarthen & Aitken, 1994).

In addition to these three between group hypotheses, there were within group questions. The within group analyses were necessary to determine the direction of heart rate responses to the stimuli. Based on psychophysiological research on empathy, it was hypothesized that the children with autism would respond to the empathic (cry) stimulus with heart rate acceleration (a defensive response). No other hypotheses were put forward.

CHAPTER 3

Methodology

Participants

All participants were male and included 10 children with autism and 10 typically developing children. The characteristics of the participants are summarized in Table 1 below. Diagnoses of autism were based on the confirmation of a clinician's diagnosis made according to DSM-IV guidelines (American Psychiatric Association [APA], 1994). The children with autism had obtained a five-word level of language development, had received up to one year of early educational intervention known as the Lovaas method (for a complete description, see Appendix A), and had completed a hearing test screening to ensure lack of hearing problems.

Both groups of children were between the chronological ages of three years and six years, six months (Table 1). Several researchers have made the claim that one reason behind the inconsistent findings in the social phenomena related to autism is that studies have utilized too wide of an age range showing that there has been a failure to consider developmental changes in autistic individuals (Burack, 1992; Dawson & Lewy, 1989). The utilization of such a constrained range of ages in this study was a key feature of this investigation.

Both groups of children were recruited from local integrated preschools located in the Lower Mainland. All children had some prior experience with myself as a teacher in the preschools. This was a necessary requirement in order to decrease the anxiety of the

experimental procedure. Participation in the study was entirely voluntary and parental consent was obtained.

Table 1

Characteristics of Participants

Group	Participant	CA (mos)	DA-L (mos)	SSRS		SES
				SS	PB	
A	1	73	45	76	102	57.55
A	2	69	38	72	86	41.82
A	3	65	58	73	116	40.57
A	4	75	45	79	112	57.55
A	5	50	38	49	102	61.01
A	6	74	72	66	91	40.57
A	7	78	70	65	91	55.26
A	8	51	49	99	97	78.34
A	9	75	72	80	102	64.39
A	10	67	58	58	102	30.93
M		67.7	54.5	71.70	100.10	52.80
SD		8.35	4.49	13.61	9.33	14.15
C	11	52	58	102	97	55.40
C	12	38	39	98	85	55.26
C	13	38	42	94	85	44.39
C	14	54	54	102	102	59.44
C	15	50	50	122	85	41.93
C	16	48	48	83	85	34.90
C	17	48	50	83	107	63.64
C	18	50	56	109	85	101.32
C	19	73	72	96	85	41.82
C	20	73	72	87	85	63.64
M		52.4	54.1	97.60	90.10	56.17
SD		4.03	3.69	12.10	8.54	18.74

Note. CA= Chronological Age
DA-L= Developmental Age-Language subscale
SSRS= Social Skills Rating Scale; SS= Social Skills; PB= Problem Behaviours
SES= Socioeconomic Status
Standard Score SSRS= M = 100.00 SD = 15

Matching Procedure

Some studies postulate that the primary deficits responsible for the autistic social dysfunction are defective attention mechanisms in orienting (Palkovitz & Weisenfeld, 1980; Stevens & Gruzelier, 1984). However, the conclusions from these studies are limited because of inadequately matched control groups, wide age variations in the groups, and inadequate screening criteria. In this study, an obvious attempt was made to ensure that the heart rate data were dependent only to the presence or absence of the autism diagnosis by controlling for all of these confounding variables. First, the children with autism were recruited on the basis of meeting several strict requirements; they had to be between three and six years, six months old; have an existing diagnosis of autism; have hearing within the normal range; have attained of at least a five word spontaneous language level; and have had one year's involvement in a behavioural early intervention program. If they met these requirements, they then had to be able to sit still for at least one minute while wearing stickers. If all of these requirements were met, then the children were included in the study. Four children with autism were excluded from the study due to the inability to sit still while wearing the heart rate electrodes.

A matching group of typically developing children was then sought. The children in the control group had to be within the developmental age range of those children in the autistic group. Overall, these children were younger in chronological age (see Table 1). Furthermore, the children in the control group were matched on socioeconomic status and were screened to ensure they did not have any deviant social skills or problem behaviours. If these criteria were not met, the typically developing children were excluded from further

participation in the study. Three typically developing children were excluded from further participation in the study, as they did not meet matching requirements.

Measures

Heart rate. Heart rate data were recorded directly from physiograph records for each individual segment. There were nine segments (measurements) recorded for each participant (see Appendix B for a description of these measurements). In accordance with studies utilizing the heart rate as a measure of the empathic response (see Eisenberg, Fabes, Bustamante, Mathy, Miller, & Lindholm, 1988) the coded heart rate data were transformed by computing mean HR for each second period. The amount of time utilized as codable segments was determined through a pilot study. Each stimulus played for a 10 second duration and the time between stimuli was also 10 seconds. This procedure allowed equal amounts of data to be produced regardless of the child's heart rate.

Developmental age. Developmental age was assessed using the Revised (1986) Denver Pre-Screening Developmental Questionnaire (R-PDQ; Frankenburg, 1986). The Gold form was utilized for children between the chronological ages of 2-4 years and the White form was utilized for children between the chronological ages of 4-6 years. This questionnaire provides identification of developmental delays in the areas of personal – social development (PS), fine motor - adaptive development (FMA), language development (L) and gross motor development (GM). The language development subscale was utilized for the purposes of matching the autistic children with typically-developing children. The children's parents completed this questionnaire under my supervision.

Social Skills. The level of social behaviours and problem behaviours for each child were obtained using the parent form of the Social Skills Rating System-Preschool Level (SSRS; Gresham & Elliot, 1990). As mentioned, this questionnaire was given to ensure the lack of problem behaviours in the control group as well as to determine whether the scores obtained in this questionnaire correlated with the heart rate response to the auditory stimuli. The parent form is a 49-item questionnaire designed to assess positive social behaviours (SS), comprised of four subscales: cooperation, assertion, responsibility, and self control. As well, the questionnaires measure problem behaviours (PB), comprised of two subscales: externalizing problems and internalizing problems. The children's parents completed this questionnaire under my supervision.

The parent form of the SSRS social skills domain uses two types of ratings based on frequency and importance. Using a three-point frequency scale, respondents are asked to indicate "How Often" a test item occurs (0=never, 1=sometimes, 2=very often). A three-point importance scale determines "How Important" an item is in terms of the child's development for parents (0=not important, 1=important, 2=critical). The parent form also requires frequency ratings of the problem behaviour domain, using the same three-point scale as the social skills domain. An overall score is determined by totaling each of the subscales for that category and adding them together for a global score for each domain (e.g., externalizing and internalizing behaviour scores would be summed to yield a global score representing problem behaviours). A high score in the social skills domain is desirable whereas a low score on the problem behaviours domain is desirable.

This form of the SSRS has reported satisfactory reliability and validity (Gresham & Elliot, 1990). Internal consistency estimates range from Cronbach's alphas of .83 to .92 for the social skill domain, and from .80 to .89 for the problem behaviour domain.

Demographic Information (Appendix C). A questionnaire was administered for each child in order to collect information regarding maternal background (i.e., ethnicity, maternal occupation and job status, maternal level of education). Each child's mother to whom the background information applied completed the questionnaire. The main purpose of the questionnaire was to match the two groups on socioeconomic status. The 1981 socioeconomic index for occupations in Canada was used (Blishen, Carroll, & Moore, 1987). The occupational index used is "a composite of the prevailing income and education levels in each occupation". This scale was chosen because "the present index is most applicable in situations where access to data is limited to occupational titles and where one desires a unidimensional, contextual indicator which locates individuals in the Canadian occupational hierarchy at a given point in time" . The demographic questionnaire was initially administered to the children with autism in order to develop matching criteria for the selection of the comparison group made up of typical children. Appendix F provides a detailed summary of the description of the participants' mothers in this study.

Materials

Stimuli. The three stimuli were recorded professionally in a recording studio. Each stimulus lasted for 10 seconds (as determined from past literature on physiological measures of empathy), and was divided by 10 seconds of silence. The stimuli were presented in counterbalanced order across children in order to control for sequencing

effects. All stimuli were presented at a peak level of 75 dB by means of a Sony tape recorder positioned approximately 2 meters behind each child. Headsets were not utilized because it caused discomfort in the children with autism. This was evident from a pilot study conducted prior to this experiment (see Appendix D).

Electrocardiograph. A Burdick, three-lead electrocardiograph (ECG) was utilized as the heart rate recording apparatus. The children wore the electrodes on their wrists and left ankle. Cardiac contractions were obtained from a paper printout located as part of the ECG apparatus. A marker appeared on the ECG at the exact time of stimulus onset.

Environment

A pilot study was conducted prior to the formal experiment. The location was in a soundproof testing room located at the University of British Columbia. The results of the pilot study indicated it was not in the best interests to the children to conduct the study at this location as it caused some minor anxiety. [For a more complete description of the pilot study see Appendix D.]

The location of the experiment was a small, quiet room located at each child's home. Thus, anxiety due to the experimental location would not affect the heart rate reactions to the stimuli. The children were seated wherever they felt the most comfortable. Colorful stickers were placed on the electrode tape in order to make it a pleasant experience.

The ECG and the tape recorder with the audio stimuli were located on a small table, two meters behind the children. I sat across from each child and informed him that he would soon hear some sounds. Every attempt was made to lessen any startle response

associated with the audio stimuli. All children were informed of the study in advance by their parents so that they knew what to expect.

Procedure

Each child was seen in one session. One parent was in the room at all times while the experiment was underway. Parents were given a package of questionnaires and the consent form. Some parents completed the questionnaires during the session and some parents sent in the completed forms by mail at a later time. After parental permission was obtained, I played with the children and introduced them to heart rate apparatus and electrodes. Games and toys utilized were not consistent; they were dependent on each child's favorite activities. Play activities varied and consisted of such things as reading a book, playing with toy cars or playing simple board games. The time engaged in play varied for all of the children but ranged in time from 5 minutes to 15 minutes. No stimuli were presented during the first part of the session.

After the play was finished, I explained to the children the procedure of the experiment. Each child was told that first they would get to wear some stickers on their two wrists and one ankle. When they were successfully wearing the stickers, I told them that I would attach some wires to the stickers. The children were ensured that this would not hurt. At this time, each child had a chance to practice wearing the stickers with the electrodes. During this time, while the children were wearing the stickers and wires, they were instructed that they needed to sit very still, "just like being in a rocket ship". I then told the children that next I would play some sounds of a child on the cassette player. Finally, I reminded the children to sit very still. At that time, each child's parent started

the tape. The tape, and consequently the heart rate recording, lasted for one minute. Following presentation, five to fifteen minutes were spent playing with the child while the parent either completed the questionnaires or asked questions about the experiment.

Measurement and Scoring of Physiological Activity

Heart rate data were hand-scored from the electrocardiograph record for each individual condition (i.e., baseline and onset of stimulus) for the last three codeable beats prior to the onset of the stimulus, the first three codeable beats at the onset of the stimulus, and the second three codeable beats after the onset of the stimulus. This occurred for all three stimuli. These measures were then converted to average heart rate per second using the standardized measurement procedure (see Appendix E) as outlined in the electrocardiograph procedure manual (Burdick, 1988).

Data Analysis

The purpose of the study was to examine if children with autism differ in heart rate response patterns from typically developing children to three auditory stimuli (i.e., cry, laugh, tone) and to examine the pattern of these differences between the groups. Response patterns across the different stimuli were examined using a doubly repeated-measures (2 x 2 x 3; group by heart rate change to stimulus onset by stimulus type) analysis of variance (ANOVA). Heart rate change to the stimuli and type of stimulus (i.e., cry, laugh, or tone) was the two within-subjects factors and group was the between-subjects factor. This design is referred to as a split-plot design and is defined as a hybrid of a standard factorial ANOVA (for the between subjects factor) and a repeated measures design (for the within subject factors). This procedure is recommended by the Society for

Psychophysiological Research (Jennings, Cohen, Ruchkin, & Fridlund, 1987; as cited in Eisenberg et al., 1989). A priori planned contrasts were run to determine if the mean heart rate response to stimulus onset between the group of children with autism and the group of typically developing children was significantly different for each of the three stimulus types.

Independent samples t-tests were calculated for preliminary data on each of developmental age-language subscale (DA-L), problem behaviours (PB), social skills (SS), and socioeconomic status (SES), with the two groups of children (autistic and typically developing) as the between subjects factor. All statistical tests were evaluated using significance levels of $p < .05$.

CHAPTER 4

Results

Socioeconomic Status

To ensure that matching was successful, the two groups of children were compared with respect to socioeconomic status (SES). Using an independent samples t-test, no significant differences were found between the autistic and typically developing children in socioeconomic status [t (18) = -.454, p = .655]. See Table 1 for means and standard deviations of the matching characteristics of the two groups.

Developmental Age

As seen in Table 1, the typically developing children were matched to the children with autism with respect to developmental age on the language subscale (DA-L) of the Revised Denver Prescreening Developmental Questionnaire (1986). As expected, there was no significant difference between the autistic and typically developing children in developmental age [t(18) = .073, p = .943] using an independent samples t-test.

Problem Behaviours and Social Skills

Preliminary analyses using an independent samples t-tests were also conducted to ensure that the typically developing children in the control group were not experiencing any serious problem behaviours (PB) or social skill (SS) disorders that could account for their heart rate reactions (See Table 1, p.30). A comparison of the autistic and typically developing children using an independent samples t-test revealed significant differences between the groups in both problem behaviours [t(18) = 2.5, p = .022] and social skills [t(18) = -4.496, p = .001]. In both instances, the autistic children exhibited significantly higher rates of problem behaviours (M = 100.10) and a lower rate of social skills (M =

71.70) than the typically developing children (M = 90.10 and M = 97.60, respectively). There was, however, one child in the group of typically developing children who did receive a high score in problem behaviours (PB = 107.00). When this child's score was dropped from the analysis, there was still a significant difference between the children with autism and the typically developing children with respect to problem behaviours [$t(17) = 3.3$, $p = .035$]. Because of this result and the fact that this child's pattern differed markedly from that of the children with autism on other selection criteria (i.e., this child received a favourable, high score in social skills), this child was included in further statistical analyses.

Correlational Analyses

Correlational statistics were carried out to determine whether any of the matching criteria (i.e., social skills, problem behaviours, developmental age-language subscale, or socioeconomic status) were associated with the heart rate change scores in each of the two groups. No significant correlations emerged.

Heart Rate Data

Reliability. Two independent raters measured the heart rate during the onset of the first stimulus, one of whom was unaware of the research hypotheses and participant diagnoses. Interrater reliability calculated for all 20 participants, as measured by percent agreement, was strong (98%).

Baseline data. The children with autism had higher baseline heart rates prior to the onset of the three stimuli, however the difference between the two groups was not statistically significant. This is consistent with previous findings in the literature (see

Dawson & Lewy, 1989a). To account for this state of hyperarousal, the heart rate response prior to and following stimulus onset was a factor in the primary data analyses. Baseline and heart rate responses to stimulus onset for all three stimuli for the two groups are summarized in Table 2 below.

Table 2

Means and Standard Deviations of Baseline and Heart Rate Change at Stimulus Onset

	Autism Group		Control Group	
	Mean	SD	Mean	SD
Baseline 1	108.64	12.50	99.73	7.33
Cry	107.92	14.74	95.93	6.24
Baseline 2	111.04	10.62	100.43	7.57
Tone	110.67	13.07	102.93	8.90
Baseline 3	109.24	12.66	100.25	5.30
Laugh	105.00	14.47	103.41	9.82

Note: Baseline 1 = Heart rate prior to cry stimulus onset

Baseline 2 = Heart rate prior to tone stimulus onset

Baseline 3 = Heart rate prior to laugh stimulus onset

Primary Analyses. The full model examined in this study looked at group (autistic, typically developing), by heart rate change at stimulus onset (baseline, stimulus onset), by stimulus type (cry, tone, laugh). This is a 2 x 2 x 3, mixed model, doubly repeated measures analysis of variance (ANOVA) with group as the between-subjects independent

variable, heart rate change at stimulus onset as the within-subjects variable, and the stimulus type as the repeated measures, within-subjects variable. See Table 3 for a summary of the variable means and standard deviations.

Stimulus type. There was a significant main effect for stimulus type [$F(2,36) = 6.30$, $p < .005$] indicating that across groups, the children responded differentially to each of the three stimuli. That is, the cry, the tone, and the laugh stimuli each elicited a different kind of responding in the two groups of children in this study. However, this statistic in and of itself does not pertain to the research questions of this investigation. The significance of this statistic is explained in terms of the interactions that follow. There were no significant main effects for group or heart rate reaction to stimulus onset.

Stimulus type by group interaction. There was a significant interaction effect of stimulus type by group [$F(2,36) = 4.45$, $p < .019$] indicating that the pattern of heart rate responding to the three stimuli is associated with group identification. That is, the children with autism responded differently from the typically developing children to the three stimuli. The two groups did not differ significantly with respect to their heart rate reactions to stimulus onset [$F(1,18) = 2.312$, $p < .146$]. That is, the children with autism cannot be differentiated from the typically developing children with respect to the magnitude of their reactions to the stimuli from baseline. No significant interaction was found between heart rate response to stimulus onset and type of stimulus, meaning that the children with autism did not have a heart rate response to each of the stimuli that was significantly different from the typically developing children.

The group x heart rate change at stimulus onset x stimulus type interaction. There was a significant 2 x 2 x 3 interaction [$F(2,36) = 3.89$, $p < .030$] indicating that for the

three types of stimuli, the two groups of children responded differentially with respect to heart rate response at stimulus onset. That is, between the cry, the tone and the laugh, the children with autism differed in heart rate response to stimulus onset from the typically developing children.

Next, *a priori* planned orthogonal contrasts were carried out to examine what was accounting for the significant interactions of both group by stimulus type and the interaction of group by heart rate change at stimulus onset by stimulus type. Three separate contrasts were run for the three different stimulus types (i.e., cry, tone, and laugh) to determine if the heart rate reaction at stimulus onset was significantly different in the children with autism from the typically developing children. There was a significant difference in heart rate responding at onset of the cry stimulus between the children with autism and the typically developing children [$t(18) = -2.369$, $p < .029$]. As illustrated in Figure 1a, the children with autism decelerated only slightly in response to the cry stimulus, whereas the typically developing children expressed a marked deceleration in heart rate response to the cry stimulus.

There were no significant differences between the children with autism and the typically developing children in heart rate response to the onset of the tone stimulus [$t(18) = -1.551$, $p < .138$] nor the laugh stimulus [$t(18) = .288$, $p < .777$]. These results can be further explained through examination of the heart rate patterns as illustrated in Figures 1b and 1c. In response to the tone stimulus, neither the children with autism nor the typically developing children had a marked response; both groups of children responded with a slight deceleration (see Figure1b). However, the pattern of response to the laugh stimulus for the children with autism is in opposite direction than the response in the typically

developing children. Whereas the typically developing children responded with heart rate acceleration to the onset of the laugh stimulus, the children with autism responded with a heart rate deceleration (see Figure 1c).

Table 3

Summary Repeated Measures ANOVA Table

Source	SS	df	MS	F	p
Between					
A	2076.17	1	2076.17	3.44	.080
S(A)	10864.86	18	10864.86		
Within					
B	10.34	1	10.34	.548	.469
AB	43.63	1	43.63	2.31	.146
SB(A)	339.73	18	18.87		
C	206.05	2	103.02	6.30	.005*
AC	145.61	2	72.80	4.45	.019*
SC(A)	588.80	36	16.36		
BC	56.90	2	28.45	1.62	.212
ABC	136.65	2	68.32	3.89	.030*
SBA(A)	632.90	36	17.58		

Note: $p < .05$
A = Group
B = Heart rate change to stimulus onset
C = Stimulus type (cry, tone, laugh)

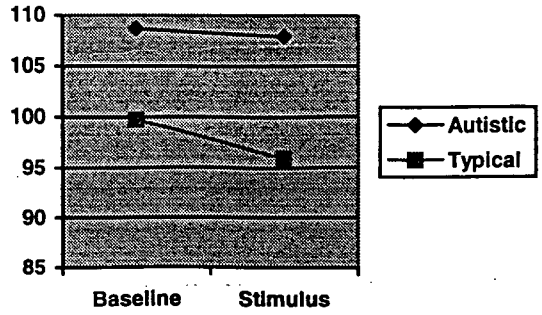

Figure 1a. Heart rate response to the cry stimulus from baseline to stimulus onset for children with autism and typically developing children.

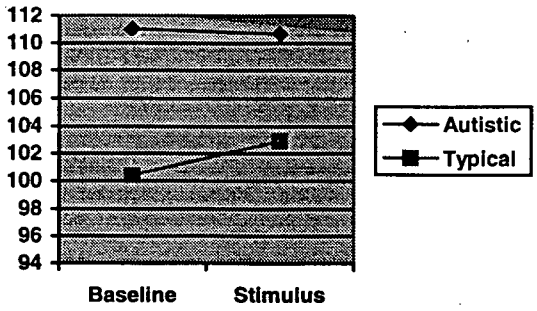

Figure 1b. Heart rate response to the tone stimulus from baseline to stimulus onset for children with autism and typically developing children.

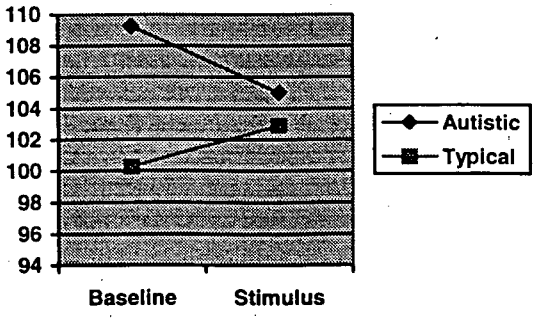

Figure 1c. Heart rate response to the laugh stimulus from baseline to stimulus onset for children with autism and typically developing children.

CHAPTER 5

Discussion

This study was conducted in order to determine how the heart rate patterns of children with autism compared with the heart rate patterns of typically developing children in response to auditory tones of different affective content; a cry, a laugh and a tone. Based on previous research, there were three patterns of responding that could occur in the present investigation. Each of these patterns can be interpreted by one of three different theoretical positions with regards to the nature of the deficits seen in autism.

One theoretical viewpoint is that a faulty attention mechanism is responsible for many of the deficits seen in autism (Pierce, Glad, & Schreibman, 1997; Lewy & Dawson, 1992). Support for this position would be provided if the results of this study found significant differences between the groups of children with autism and typically developing children to all three auditory tones (i.e., cry, laugh and tone). A second theoretical viewpoint interprets the deficits seen in autism as being specific to social characteristics (Ozonoff, Pennington, & Rogers, 1989; Travis & Sigman, 1998). A discrepancy in heart rate responding to both the cry and the laugh stimulus when compared with the tone in children with autism when compared to typically developing children would lend support for a social deficit hypothesis. The third theoretical viewpoint is that children with autism are deficient in empathy characteristics and it is these deficiencies that underlie the autistic symptomatology (Brothers, 1989; Gillberg, 1992; Trevarthen & Aitken, 1994). For this theoretical viewpoint to be supported in this investigation, the children with autism should

be differentiated from the typically developing children only on the heart rate response to the cry stimulus.

There are several important findings in this study. One finding is that the heart rate pattern of response to the three stimuli is different in the children with autism than it is in the typically developing children. Second, the cry, tone and laugh each elicited a different response to onset of the stimulus and this was different in the children with autism than it was in the typically developing children. Third, the cry stimulus appeared to elicit a statistically significant different heart rate response in children with autism than in the typically developing children. Finally, the children with autism responded to a laugh stimulus with a heart rate deceleration rather than the heart rate acceleration that is evident in typically developing children.

Specific Disturbance in Empathy.

Typically developing children have been shown to evidence heart rate deceleration in situations that elicit empathic responding (Eisenberg, Fabes, Bustamante, Mathy, Miller, & Lindholm, 1988). A deceleration in heart rate to an empathic situation denotes an orienting response to that situation. Some researchers hypothesize that children with autism are deficient with respect to responding in empathic situations (Brothers, 1989; Gillberg, 1992; Trevarthen & Aitken, 1994). Based on these literatures, it was hypothesized that children with autism would respond in a manner characteristic of aversion or personal distress to the empathic stimulus in this study (i.e., the cry stimulus). Aversion or personal distress is denoted by an increase in heart rate. In this study, both the typically developing children and the children with autism responded to the cry (empathy) stimulus with a heart rate deceleration. This was the expected reaction for the

typically developing children, but not for the children with autism. That is, the children with autism did not evidence the expected heart rate acceleration. Instead, the group of children with autism decelerated slightly to the cry stimulus and the typically developing children had a marked deceleration in heart rate to this stimulus. The magnitude of this difference in deceleration between the two groups was statistically significant. This result suggests that children with autism do have a quantitatively different response (though not qualitatively) to empathy – eliciting stimuli when compared with typically developing children. However, the hypothesis that the empathic stimulus will elicit a reaction characteristic of aversion or personal distress cannot be accepted based on the findings of this study.

This study does not support the position that a deficit in empathy characterizes individuals with autism. This conclusion comes from the analysis of the heart rate response pattern to the laugh stimulus between the children with autism and the typically developing children. No significant within group differences were found in the heart rate response to the onset of the laugh stimulus between the two groups of children. Based on the patterns of between group differences in the direction of heart rate change however, this result becomes interesting given several recent discussions in the field of neuropsychiatry. The results of this study showed that the children with autism react with a decrease in heart rate response to the laugh stimulus. The typically developing children responded with heart rate acceleration to the laugh stimulus, which is consistent with the typical physiological reactions to stimuli eliciting pleasure (Wessels & Hopson, 1988). Opposite physiological reactions are supposed to occur to stimuli eliciting pleasure than to those occurring to stimuli eliciting distress. The limbic system and more specifically, the

hypothalamus within the limbic system control several emotions. Different emotions are associated with different patterns of autonomic nervous system activity. In response to emotions such as anger, fear or pleasure, the limbic hypothalamus sets in a coordinated set of physiological reactions- blushing, sweating and a more rapid heartbeat (Wessells & Hopson, 1988). The heart rate response of the typical children in this study involved a significant acceleration. This is the normal physiological response associated with pleasurable conditions. Conversely, the children with autism responded with a significant heart rate deceleration (typical of an orienting, information-gathering response). The non-significant finding between the two group means to this stimulus results from the fact that both groups had a similar magnitude of response difference. The statistic is not accounting for the direction of change.

Specific Disturbance in Attention.

The evidence from the two groups to both the cry and laugh stimulus begin to suggest that children with autism have a heart rate response pattern that is characteristically different from the heart rate response pattern of the typically developing children. It is feasible to suggest then, that the heart rate responses of the children with autism are interpreted by the attention hypothesis in autism that postulates that a lack of orienting attention accounts for the predominant 'social aloofness' typical of young children with autism. A second theoretical viewpoint tested in this investigation was that if the children with autism do not respond differentially between the three different stimuli, this would suggest that children with autism are different from typically developing children with respect to orienting attention abilities. An attention theory would predict

that the children with autism would respond in the same way to all three stimuli (accelerate to all three stimuli, decelerate to all three stimuli, or not respond to any of the three stimuli).

The attentional viewpoint as an explanation for the results of this study is discounted from the evidence found. No significant differences between the two groups in their heart rate responses to the tone stimulus were found. Further observation of the pattern of responses shows that both groups had only slight deviations from baseline in response to the tone stimulus. Additionally the significant group by stimulus type interaction suggests that both the children with autism and the typically developing children have a differential heart rate response pattern to the three different stimuli. That is, a different response occurs to the cry, than it does for the tone and the laugh. Furthermore, a significant three-way interaction suggests that the heart rate response from baseline to stimulus onset differs for each of the three different stimuli and also differs between the two groups. Therefore, the current study does not support the conclusion that children with autism exhibit differences in psychophysiological reactivity to the range of environmental stimuli. That is, the children with autism do respond to the stimuli, yet the patterns of response to the cry and laugh were different from the typically developing children. As well, the two groups of children respond similarly to the tone stimulus. It is more plausible that for children with autism, there is some defect in the processing of information after the initial processing of stimuli.

Recent studies in attention and autism have re-examined past studies that have concluded that the autistic social deficit is just a simple problem in reflexive orienting abilities (see Burack, Enns, Stauder, Mottron, & Randolph, 1997 for review; Minshew &

Goldstein, 1998). These authors suggest that a better interpretation of the differences exhibited in attention between autistic and non-autistic individuals can be attributed to the executive control of attention.

Evidence of Disturbance in Mechanisms of General Social Interaction.

To re-iterate, the children with autism in this study do not experience heart rate acceleration to the cry stimulus. This finding lends partial support for the notion that it may not be an aversion to empathic situations that underlies the lack of emotional responsiveness seen in children with autism. Very recent studies also support this notion. In a study not yet published (Corona in press; as cited in Travis & Sigman, 1998), the authours conclude that the behaviour and heart rate responses found in children with autism do not suggest that it is a lack of awareness nor an aversion to emotional displays that mediates their lack of social responsiveness. In another recent study, investigators studied 20-month-old infants with autism on tasks of empathic responding, pretend and functional play, joint attention and requesting behaviours, and imitation (Charman, Swettenham, Baron-Cohen, Cox, Baird, & Drew, 1998). This study was novel in the field of autism because it is the first time children with autism were studied at such a young age. The researchers used a recently developed prospective screening instrument for autism in infancy called the CHAT (Baron-Cohen, Allen, & Gillberg, 1996). The empathy test used in this investigation was based on the study by Sigman et al. (1992). This test measures affective and attention responding to displays of distress by adults. The researchers found that the infants with autism showed lower production of behaviours than infants with pervasive developmental disorder and infants with developmental delay.

However, half of the infants with autism did look at the researcher during the distress situation and one infant showed facial concern. These data begin to suggest that a deficit in empathy, if it exists in individuals with autism, is not a universal phenomenon. Therefore, labeling a deficit in empathy as a primary deficit of the syndrome of autism becomes less appropriate. These studies along with the current study suggest that at least some aspects of empathy are intact in some children with autism.

The findings of the current study suggest that at least some of the physiological mechanisms responsible for general social interaction in children with autism are different from those of typically developing children. There is a significant difference in the heart rate response between the groups to the cry stimulus. Additionally, there is a difference in the direction of heart rate change to the laugh stimulus. There is no statistically significant difference in the pattern of heart rate response to the tone stimulus between the two groups of children. That the autistic syndrome may be due to a disturbance in social interaction processes is supported in a recent study (Bacon, Fein, Morris, Waterhouse, & Allen, 1998). In this study, both high and low functioning children with autism were compared with developmental language disordered children, mentally retarded children and normally developing children. The behaviours of these children were coded in three situations: a nonsocial orienting stimulus, and two social situations of simulated distress. There are two features from this study, which are similar to the current study. First, the study by Bacon et al., (1998) provides evidence that there are fundamental differences between low functioning and high functioning children with autism. That is, the low functioning children with autism showed pronounced deficits in awareness of the situations whereas the high functioning children with autism showed good awareness of all

the situations. Several investigators have suggested that high and low functioning children with autism may represent subtypes of the disorder (Cohen, Paul, & Volkmar, 1987; Rapin, 1996). In the current investigation there was no relationship between developmental age (as obtained from a parent report measure) and heart rate reactions. This may be due to the fact that the children with autism in this study represent a sample of higher functioning children with autism. This lack of correlation also may partly explain why the children with autism did at least attend to the stimuli. In future research, addition of both high and low functioning groups of children with autism would be necessary to discern this further.

A second common outcome of the Bacon et al., (1998) study and the current study involves the pattern of deficits found common to both the groups of children with autism. In the Bacon et al., (1998) study, both groups of children had difficulties with social referencing skills. In the current study, the children with autism differed from the typically developing children on the two social stimuli. Bacon et al., (1998) interpreted this phenomenon as being evidence of a common neurological basis of the disorder of autism that is displayed as a core social deficit. The neurological basis of this dysfunction is consistent with early limbic – hypothalamic dysfunction (Bachevalier, 1994; Bauman & Kemper, 1994).

Conclusions

In this study, the children with autism were differentiated from the typically developing children on their responses to both the cry and laugh stimulus. This evidence corresponds with the notion that an underlying social deficit accounts for the autistic symptoms in social characteristics, cognitive and linguistic impairments (Bailey, Phillips &

Rutter, 1996; Fein et al., 1980; Mundy & Sigman, 1989). It is now necessary to discern what processes are disordered within the social domain. Two theoretical frameworks are provided that may account for the heart rate patterns seen in this investigation.

Autism: A Disorder of the Limbic System

The limbic system is a collection of nuclei and tracts that interact in the expression of emotion (Papez, 1937; as cited in Pinel, 1997). Many neurobiological studies in autism have implicated a deficit in the limbic system as responsible for several autistic behaviours, such as lack of eye contact, motor stereotypies and aberrant social behaviour (Bachevalier & Merjanian, 1994; Bauman & Kemper, 1994; Rapin, 1991). This theory is based on the neuropsychological similarities found between many autistic individuals and monkeys suffering from Kluver-Bucy syndrome.

Monkeys that have had their anterior temporal lobes removed suffer from a syndrome known as Kluver-Bucy syndrome. Specifically, damage to the hippocampus and the amygdala are implicated as causal to the syndrome. The behavioural manifestations of this disorder include: "consumption of almost anything that is edible, increased sexual activity directed at inappropriate objects, a tendency to repeatedly investigate familiar objects, a tendency to investigate objects with the mouth, and a lack of fear" (Pinel, 1997, p.440). In human patients, this syndrome is defined by flat affect, indifference to people and situations, inappropriate affect, oral exploration of objects, lack of eye contact and several motor, perseverative stereotypies.

Bachevalier (1995; as cited in Waterhouse & Fein, 1997) and other proponents of this theory (Bachevalier & Merjanian, 1994; Bauman & Kemper, 1994) propose that

"because all autistic persons share the same behavioural impairments, they, like the monkeys and like Kluver-Bucy syndrome cases, all suffer from limbic system deficit" (Waterhouse & Fein, 1997, p.910). These studies are supported by autopsy and imaging studies that show a medial temporal lobe deficit in individuals with autism (see Bauman & Kemper, 1994).

Tying this theory with the current study, deficient mechanisms within the limbic system would be consistent with the unusual response to the laugh stimulus in children with autism. That is, where the response to this pleasure stimulus is one of heart rate acceleration, the children with autism showed heart rate deceleration. To re-iterate, this type of responding is typical of orienting responses aimed at obtaining information. It would be interesting to see whether individuals with Kluver-Bucy syndrome react similarly to individuals with autism with respect to heart rate in response to stimuli varying in empathic content. This may aid attempts to define the role of temporal lobe dysfunction as one causal factor of the social impairments found in autism.

An immature limbic system is also implicated in sensory oversensitivity (Grandin, 1995). In this investigation and consistent with past research, the children with autism were in a constant state of hyperarousal compared with the typically developing children (see Table 3) (for review, see Minshew, 1991). This oversensitivity may partly account for the response to the laugh stimulus. However, the same type of response did not occur to the tone and cry stimuli and the stimuli in this investigation were controlled for pitch and frequency. However, in the case of autism, "a child is usually sensitive only to certain pitches or types of sounds" (Grandin, 1995, p.39). Further investigation is necessary to

delineate what aspects of the laugh stimulus are associated with an increase in heart rate in children with autism.

Applied Implications

This study supports the premise that individuals with autism process social information differently and that this difference is not due to an anxiety response to empathic situations nor to general attention or perceptual constraints. Further investigation is required to determine what accounts for impaired social processing. However, combining the results of this study with previous studies on the social profile of individuals with autism (for review see Travis & Sigman, 1998), more support is given to interventions that aim to enhance socialization through cognitive compensatory mechanisms, play, social stories, and a range of environmental supports (Quill, 1995).

Several different approaches exist with respect to early intervention approaches for children with autism (Rogers, 1998a,b). Rogers has reviewed the early intervention literature in autism and has found that the programs that are most successful are those that focus intervention on the core neuropsychological difficulties of children with autism. As stated by Rogers (1998b), "these core difficulties affect development of intersubjectivity, imitation/praxis, possible deficits in executive functioning, emotional functioning, and sensory/arousal functioning" (p.104). The Lovaas model is one of the interventions that she has reviewed for its efficacy (Lovaas, 1987). It is interesting to note that the children with autism in this investigation also had received intervention from the Lovaas method. This intervention may have helped these children react in the way that they did to the stimuli.

For intervention purposes, results such as those obtained in this investigation and from other research (Bacon et al., 1998; Charman et al., 1998) lend support to the argument for the "teaching and shaping of behavioural responses to the emotional displays of others" (Charman et al., 1998, p. 272). That is, by systematically teaching and promoting social communication skills from an early age, children with autism can show positive gains in several social domains such as empathy, joint attention and play (see Rogers, 1996, for a review).

General Limitations of Study

Design and Internal Validity. This study has a small sample size that decreases the power of the statistical analysis and hence may account for some of the non-significant findings. More power would have been given to this study if there were 20 participants in each group (Sawilowski & Blair, 1992).

The children with autism in this study have received up to at least one year of behavioural intervention. The history effects of behavioural intervention may be accounting for their responses to the stimuli. Due to this, the results of this investigation, pending replication, apply only to children of similar backgrounds as the children with autism in this investigation.

Control of several extraneous variables was established by matching of the two groups. Matching increases the sensitivity of an experiment and the variables on which subjects are matched are controlled in the sense that constancy of influence in attained (Christensen, 1991). Due to the exploratory and innovative nature of this investigation, the disadvantage with respect to matching was that it was difficult to know what were the most important variables to match. As well, as more variables required matching, the

more difficult it was to find appropriate matched participants. In this way, matching also limits the generality of the results of the study. Furthermore, some variables are difficult to match. As mentioned, in this study a possible confound exists due to the autistic groups' involvement in behavioural intervention.

There are no other alternate hypotheses that could question the internal validity of this investigation. Counterbalancing the order of the stimuli controlled for sequencing effects. That is, four children in each group received order A (first cry, then laugh, then tone), four children received order B (first laugh, then tone, then cry) and three children received order C (first tone, then cry, last laugh). With these three orders, each stimulus has been in the first position, the second position, and the third position. However, due to the small sample size and the already mentioned strict matching criteria, it was not possible to match participants with respect to the order of stimuli with which they were presented.

External Validity and Generalizability. Already briefly mentioned earlier was the fact that in order to increase statistical confidence to which these results will generalize to the population of autistic children in general, groups should have been formed from randomly sampling from an autistic population. In addition to the fact that these children all had received behavioural intervention for at least one year, they were able to sit relatively still and were able to have the electrode stickers on their arms and ankle. Children not able to sit still and wear stickers were excluded from further participation in the study. Future investigations might provide additional practice in sitting still and in wearing the heart rate electrodes so that a more representative sample of children can be

utilized. With this regard, the results from this study have implications for a very specific type of autistic children.

The ecological validity of this investigation is also limited in that it was a highly controlled investigation, designed specifically to measure reactions to one variable, auditory sound. Although all the children were tested in a quiet environment within their own home, there did exist differential levels of background noise. This is more ecologically valid than testing in an isolated controlled laboratory environment, but in daily life, children are exposed to social situations that are a bombardment of interactions from various sources. This study could therefore be extended by adding visual displays, both with and without noise, comparing heart rate responses to behavioural reactions to these auditory and visual displays, comparing facial indices of emotional reactions and comparing to cognitive measurements, including but not limited to level of IQ.

Some attempt was made to increase the ecological validity of this investigation by testing the children in their own home environment. This decreased the anxiety produced by an unknown laboratory setting. A pilot study was attempted where one autistic child came to a lab setting for the experiment (Appendix D). This caused anxiety in the child due to the unfamiliarity of the setting and hence the experiment ended so that the anxiety was not prolonged.

Measurement. Some measurement error is inherent in investigations using the electrocardiograph because movement affects the heart rate reading. In this investigation, this was a factor, but it was constant for all of the participants in the study. The measurement error is due to the fact that at some points, the first three codeable beats after the stimulus were taken at different times for all of the subjects. This of course

decreases the accuracy of measurement of the initial reaction to the stimulus. Every attempt was made to keep the children as still as possible and participants who evidenced degrees of movement to the point that the heart rate printout was not codeable, were excluded from the study. However, for most children, there were no more than 10 heartbeats lost in all three baselines and all three conditions. This is the acceptable number for loss of heartbeats from past literature utilizing heart rate as a measure of empathic response (Eisenberg, Fabes, Miller, Fultz, Shell, Mathy, & Reno, 1989).

For future investigations, more modifications need to be made to ensure that movement is minimal in the research participants. A special chair could be arranged that is available to all the participants. This chair could be cushioned so that the children's range of motion is restricted somewhat. As well the chair should have a built-in footrest to minimize leg and foot movement.

To further control measurement error, each of the stimuli could be presented several times within one testing session. This would allow a comparison of the initial response to the stimulus with consequent stimuli and would also allow researchers to investigate habituation. An investigation which includes multiple trials may also aid in delineating the effects of arousal from overall responding to social stimuli.

Concluding Remarks

The findings of this investigation support the view that the use of physiological measures is useful as one method for investigating the nature of the social deficit in autism. In combination with facial indices, self-report measures, cognitive measures and different modes of stimuli (i.e. auditory and visual), physiological measures may make the

assessment of emotional responses more thorough. This type of triangulation of methods will help to increase our understanding of the nature of the autistic social dysfunction.

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Appendix A

Lovaas Behavioral Intervention

O. Ivar Lovaas (1987) developed a comprehensive behavioral intervention as a treatment of the various characteristics that make up the syndrome of autism. This program focuses on teaching children with autism language and communication, academic skills, how to play and appropriate in the place inappropriate, social skills. The second purpose of this behavioural intervention is to decrease inappropriate behaviours such as self-injury, self-aggression and tantrums.

The program begins by teaching the children with autism to sit quietly in response to a simple verbal statement, such as "sit down". When this is accomplished, the child is taught to imitate simple gross and fine motor gestures, and simple block designs. Then the child is taught to receptively respond to a variety of simple verbal statements. Lastly, the child is taught expressive language through newly acquired imitative and receptive language capabilities. Play is taught in a similar sequence.

These different dimensions are taught through the principles of positive reinforcement, where the child is reinforced for correct responses. The therapist breaks down each teaching task into a discrete trial. Using prompting, the therapist gradually shapes the child's response, offering guidance until the child can perform the desired response on his or her own. Gradually more difficult responses are required of the child.

Problem behaviours are dealt with through specific techniques in applied behavioural analysis. The children are not reinforced for problem behaviours; instead they are being reinforced for positive behaviours only. With time, the negative behaviours fade as the more appropriate behaviours are learned.

This intervention typically occurs within a child's home under the supervision of a behavioural consultant. The time commitment of this therapeutic intervention that is

theorized to provide the optimal benefit is 40 hours per week. Individuals trained in the Lovaas method deliver the therapy in an intensive one-to-one situation.

Appendix B

Description of Heart Rate Measurements

There were nine heart rate measures taken for each participant. Only the baselline before the onset of the stimulus and the first three codeable beats after the onset of the stimulus were used in analyses. The second three codeable beats after the onset of the stimulus did not result in any significant interactions. These will be reviewed in the following Table.

Name of Measurement	Description of Measurement
Baseline 1	Measured from the three codeable heartbeats prior to the onset of the first stimulus.
Cry 1	Measured from the first three codeable heartbeats immediately after the onset of the cry stimulus.
Cry 2	Measured from the second three codeable heart beats immediately after Cry 1.
Baseline 2	Measured from the three codeable heart beats prior to the onset of the second stimulus.
Tone 1	Measured from the first three codeable heartbeats immediately after the onset of the tone stimulus.
Tone 2	Measured from the second three codeable heart beats immediately after Tone 1.
Baseline 3	Measured from the three codeable heart beats prior to the onset of the third stimulus.
Laugh 1	Measured from the first three codeable heartbeats immediately after the onset of the laugh stimulus.
Laugh 2	Measured from the second three codeable heart beats immediately after Laugh 1.

Appendix C

Demographic Questionnaire

Participant #_____

BACKGROUND INFORMATION QUESTIONNAIRE

Please note that all information you provide is strictly confidential. No names (only a participant number) will appear on this form and therefore it will not be possible to identify you in any published report or account of this research.

Mother's Information

1) What is your marital status (please check one)?

_____Now married or living in common law
_____Single (never married)
_____Widowed
_____Separated or divorced

2) How do you describe yourself in terms of ethnic or cultural heritage (please check one)?

_____White (Anglo, Caucasian, etc.)
_____Black (African, Haitian, Jamaican, etc.)
_____Native Indian
_____Asian (Oriental, Chinese, Japanese, Korean, etc.)
_____Indo Canadian (East Indian, etc.)
_____Latin (Spanish, Mexican, South American, etc.)
_____Other (please describe in the space provided:_____)

3) How many years have you lived in Canada (please check one)?

_____less than 1 year
_____1 through 5 years
_____6 through 10 years
_____11 through 20 years
_____21 through 30 years
_____more than 30 years
_____all my life

4) What level of education have you completed (please check one)?

_____No schooling
_____Primary Education (grades kindergarten to 7)
_____Secondary Education (grades 8 to 12, with*out*) high school diploma
_____Secondary Education (grades 8 to 12,*with*) high school diploma
_____Post-Secondary Education:
  _____Took some post-secondary education (with*out* certificate, diploma, degree)
  _____Received a post-secondary certificate or diploma
  _____Received a university degree (B.Sc., B.A., etc.)
  _____Graduate School (Masters, Ph.D) or Professional Degree (Law, Medicine, etc.)

Participant #_____

5) What is your usual occupation?

_____

6) Are you currently working in this occupation (please check one)?

_____Yes
_____No

7) In your usual occupation, how many hours per week do you usually work?

_____

8) How would you describe your employment (please check one)?

_____casual
_____seasonal
_____part-time
_____full-time

Child's Information

1) What is your child's gender?

_____Male
_____Female

2) What is your child's age and birth date?

_____ _____/_____/_____
age (in years) month date year

Appendix D

Pilot Study

Pilot Study

The pilot study was instigated in order to determine the feasibility of conducting a physiological heart rate study in young children with autism in an unfamiliar setting. One young male child with autism (chronological age 71 mos.) was recruited having met the criteria for inclusion in the study. His mother accompanied the child to the University of British Columbia. The child's mother was previously instructed to bring along the child's favorite toys and favorite snacks.

Procedure

The child was escorted into the small, soundproof testing room located at the Psychoeducational Resource and Training Center at the University of British Columbia, along with his mother. In the testing room, the child's toys and snacks from home were given to the child. As well, there were more new toys for the child to look at (such as a toy train, several puzzles, and toy cars), and a variety of snacks (such as pretzels, Jujubes and licorice). The room housed the electrocardiograph and a small chair for the child to sit on.

I played with the child for approximately 15 minutes. The child then was given a choice of stickers. I first placed them on my wrists and ankle as I was explaining the procedure.

Results

During the play, the child made several attempts to leave the small testing room. At about five minutes from when we first entered the room, we did exit upon the mother's

suggestion that the child needed a break. When returning to the room, it was observable that the child did not enjoy this room. After I engaged the child in continuous play for ten minutes, I began trying to place the stickers on the child's wrists and ankle. The child refused me this action and the session was terminated.

Conclusion

The results of this pilot study indicate that there is some stress involved in being in a strange environment in the young child with autism. The child did allow others to place stickers on his wrists and ankles at home, but the same was not true of the experimental setting.

Implications

To increase the ecological validity of this investigation and to ensure there are no confounds in heart rate related to the stress of the testing environment, the location of the study has to be changed. The experiment proper will take place in each child's home to ensure the child is comfortable with the testing situation.

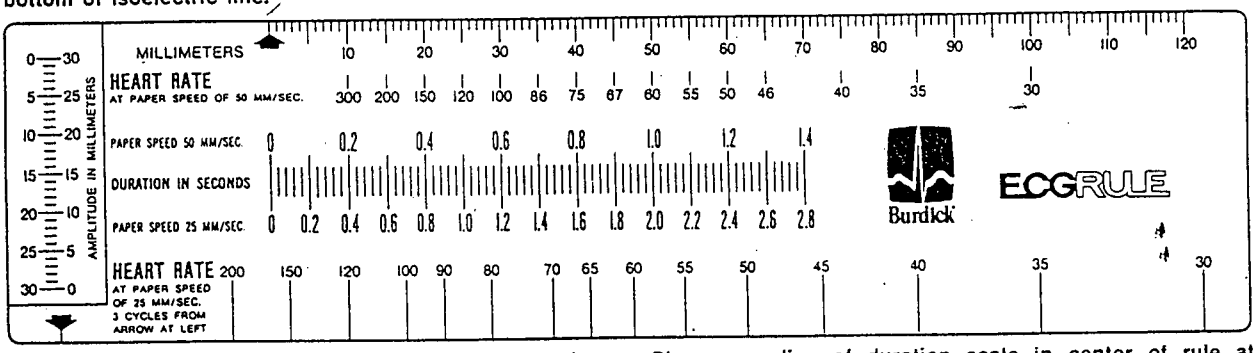
Appendix E

Heart Rate Measurement

Heart Rate Measurement

Use scale at left end of rule to measure amplitude of positive waves. Place lower zero line at top of isoelectric line. Negative waves are measured with upper zero line at bottom of isoelectric line.

To obtain heart rate from records made at 50 mm/sec. paper speed, measure one cardiac cycle from arrow at left end of millimeter scale.



To obtain heart rate from records made at 25 mm/sec. paper speed, measure three cardiac cycles from arrow at left end of lower edge of rule.

Place zero line of duration scale in center of rule at beginning of wave, interval or segment and read duration directly from appropriate side of scale.

Appendix F

Characteristics of Participants' Mothers

Background Information of Participants' Mothers

	Autism Group	Control Group
Marital Status		
• Married/Common Law	100%	100%
Ethnicity		
• White	90%	80%
• Asian	10%	20%
Years living in Canada		
• Whole life	70%	60%
• >30 years	10%	10%
• 21-30 years	10%	10%
• 11-20 years	10%	0%
• 6-10 years	0%	10%
• 1-5 years	0%	10%
Completed level of Education		
• Secondary School with Diploma	10%	0%
• Post-Secondary Certificate/Diploma	50%	20%
• University Degree (Bachelor's)	40%	40%
• Graduate School	0%	40%
Currently Working		
• Yes	50%	80%
• No	50%	20%
Hours working/week		
• Seasonal	20%	0%
• Part-time	60%	50%
• Full-time	20%	50%