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THE ABILITY OF AUTISTIC CHILDREN TO ORIENT THENSELVES AND RESPOND TO FAMILIAR AND NOVEL AUDITORY STIMULI: ENVIRONMENTAL, VOCAL, AND MUSICAL SOUNDS.

presented by

Dimitra Akogiounoglou

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Roger Smeltekop
Major professor

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THE ABILITY OF AUTISTIC CHILDREN TO ORIENT THEMSELVES AND RESPOND TO FAMILIAR AND NOVEL AUDITORY STIMULI: ENVIRONMENTAL, VOCAL, AND MUSICAL SOUNDS.

By

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ABSTRACT

THE ABILITY OF AUTISTIC CHILDREN TO ORIENT THEMSELVES AND RESPOND TO FAMILIAR AND NOVEL AUDITORY STIMULI: ENVIRONMENTAL, VOCAL, AND MUSICAL SOUNDS.

By

Dimitra Akogiounoglou

A frequent observation that educators, clinicians, and researchers make about autistic children is their unusual responsiveness to music and rhythm. The present study is designed to explore the ability of school-age autistic children to respond overtly to familiar and novel auditory stimuli: environmental, vocal, and musical sounds.

A literature review is given on areas related to the experiment, such as the diagnostic concepts and the possible causes of autism, stimulus overselectivity, auditory perception and auditory evoked responses of autistic children, as well as autism and music therapy. A typical, detailed behavioral profile of an autistic child is outlined.

Results of the study showed a strong preference of autistic children to respond with movement. There was an indication of weak preference toward musical excerpts rather than toward environmental and vocal sounds. There was a significant difference between the responses of younger and older autistic children, the younger showing a greater number. No differences were found among male and female, or higher- and lower-functioning children.

Dedicated to the memory of my father,

George Akoyunoglou

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CHAPTER I

AN EXPERIMENTAL STUDY

INTRODUCTION

Though autistic children seem to see and hear adequately, their behavior often resembles that of children whose vision or hearing is severely impaired. This has been a prominent research problem that many investigators are trying to solve. How much can they hear? Condon (1975) suggested that a delayed echo of an auditory stimulus prevents the autistic child from responding to auditory stimuli in normal synchrony. Tanguay and Edwards (1982) suggested that brainstem transmission time is longer in autistic children than in normals. No one answer has yet been found.

Parental reports indicate that an absence of response to sounds occurs in 70% of autistic children, and the occurrence correlates strongly with disturbances of social relating (Ornitz, Guthrie, & Farley, 1978). How could the relative lack of responsiveness to speech and the often reported strong responsiveness to music be reconciled with a general auditory imperception? When presented with different auditory stimuli, to which ones do autistic children attend, and which ones do they ignore? This is the basic question asked in this study, and since the capacity to orient to novel auditory information in the environment is very critical to language and knowledge acquisition, it appears to be a very important question to be answered about autistic children. Evidence suggests that autism cannot be regarded as being based on a multiple impairment, but rather on a selective perceptual impairment, in which the children do not respond to some sensory stimulus modalities while preferring others (Schopler, 1965; Hermelin & O'Connor, 1971).

PURPOSE OF THE STUDY

The purpose of the present study is twofold:

(a) To explore the ability of autistic children to respond overtly to novel auditory stimuli--environmental, vocal, and musical sounds;

(b) To investigate whether there are differences in overt behavioral responses of autistic children among each one of the three categories of auditory stimuli: environmental, vocal, and musical sounds.

THE PROBLEM AND SUBPROBLEMS

This study is based on a non-directional null hypothesis, stating: There are no differences in the overt behavioral responses of autistic children to environmental, vocal, and musical auditory stimuli.

The main research question which is asked throughout this study is: Does the autistic child respond overtly and within a 10 second latency period to environmental, vocal, and musical auditory stimuli?

Several other questions are asked as well:
Does the autistic child emit a greater number of behaviorally observed responses to musical than non-musical auditory stimuli? Does the autistic child emit a greater number of responses on the biochemical, motor development, or verbal aspects of his or her behaviorally observed responses?

In this study the above questions were explored, possible answers were offered, and further questions were generated.

DEFINITIONS

Auditory Perception: Auditory perception is the act of recognizing sensation through the medium of the ear, retaining the image and relating it to previous experiences. It does not include auditory acuity, association with activity symbols, or formation of concepts (Reagan, 1973).

Speech Perception: Speech perception refers to the act of differentiating among speech sounds.

Musical Perception: Musical perception refers to the act of differentiating among musical sounds.

Behavioral Observation Audiometry: Behavioral Observation Audiometry or BOA is a testing method based on observations of overt behavioral responses to controlled auditory signals (stimuli). In other words, the examiner observes changes in behavior (responses) which are time-locked to auditory signals (Lloyd, 1975).

Latency Period: Latency period is the time lapse between the end of acoustic stimulation and the moment at which a behavioral response is emitted by the subject. Based on studies (Engeland, 1984; Stevens & Gruzelier, 1984), the latency period which will be used in this study has been defined as a 10 second period of silence between auditory stimuli.

Familiar and Novel Auditory Stimuli: Familiar auditory stimuli are the auditory stimuli that are familiar or known to the subject, i.e. everyday sounds like a doorbell. Novel auditory stimuli are the auditory stimuli that are new or unfamiliar to the subject, i.e. unexpected or rare sounds such as plates breaking.

LIMITATIONS

The testing took place in the Genessee Intermediate School District, at the Center for Autism, in Flint, Michigan. The researcher attempted to control for factors such as age, sex, and IQ, yet various problems did arise.

Due to the limited population of autistic subjects, difficulties were encountered in forming balanced samples. The male:female ratio in the majority of studies (Gillberg, 1984) has fallen between 1.4:1 and 3.4:1. Investigators like Wing (1981) have observed that the male:female ratio increases with IQ. There are significantly more autistic boys than girls with an IQ greater than 50 compared to children with a lower IQ, but even among children with IQs less than 50, the male:female ratio fails to achieve unity. In the present study, the male:female ratio was 1.7:1 (five boys and three girls) which falls within the ranges in the majority of studies.

Since the testing took place at the Genesee Intermediate School District, at the Center for Autism, in Flint, the best room that was available for the testing was used. This room was the physical education therapist's office and had various equipment stored on shelves. This presented a problem during the testing since it was not possible to eliminate all of the distracting material from the room, and some had to be covered with pieces of cloth. The experiment was affected to some degree by the visual distractions offered in the room for the subjects, but the investigator eliminated most distractions by placing the child on a chair facing a clear wall with the speakers on the left and on the right in such a way to block most of the visual distractions of the room.

This investigation involved the study of eight subjects. Although this may be regarded as a limitation, consideration must be given to the rarity of this syndrome. Many research studies on various aspects of autism have used a small number of subjects (Naramsihackari & Himwich, 1975; Wetherby & Prutting, 1984; Abrahamsen & Mitchell, 1990). Thus, for the present experiment eight subjects can be considered an adequate number.

ASSUMPTIONS

Although most researchers investigating auditory perception and discrimination of autistic people have been using physiological measurements for collecting data, it seems very appropriate for this study to use behavioral observation testing with the autistic subjects. The overt behaviors of autistic children when occuring in close proximity to a stimulus, are considered as a direct reflection of their ability to orient themselves and respond to familiar and novel auditory stimuli. This method detects the presence of a response, and is independent of the constancy of the response pattern or duration. It has been largely used by audiologists, and although it has not been used with autistic people, it suits best the purposes of the present study.

Subjects were exposed to various auditory stimuli, where an equal number of environmental and musical sounds were presented, as well as two vocal/speech sounds. The sounds chosen are considered to be representatives of all other sounds, and examples of good sound quality were used. The environmental sounds included everyday sounds: doorbell, telephone ring, plates breaking, and a baby crying. The musical sounds included both vocal and instrumental excerpts and both classical and American popular music. The vocal sounds -- spoken material -- included phrases spoken by both a male and a female voice.

ETHICAL CONSIDERATIONS:

A form of the proposal of this study was submitted for approval to the Michigan State University Human Subject's Committee. After approval was granted, the Center for Autism at Flint was contacted. A copy of the proposal was given to the principal of the school, Mrs. M. E. Hicks, and permission was asked to obtain information from the files of children to identify the ones that could fit in to the requirements of the study. Consent forms were sent to parents, short letters briefly stating the purpose of the study and asking for permission (signed) for their child to participate in the experiment (see Appendix A). If the child was verbal or high-functioning, the child was asked as well. Children were known to the experimenter by their first names only. No documented connections were made between files, names, and faces. Children were tested individually and no two children were in the testing room at the same time. Parents had the right to withdraw from the study whenever they so decided. Parents were assured that no names would be used in the actual report of the study, since no names were attached to the data.

The three judges were given no names but merely numbers. All observations were treated as data and numbers and were not connected to a child. Each child, when coming for a testing session, was assigned a sequence number and the observation sheets were coded with that same number. This assured both anonymity and confidentiality of the test- results. All videotapes were kept in the Michigan State University Music Therapy Clinic under the responsibility of the experimenter and all tapes were erased as soon as the study had taken its final form and all data had been coded, counted and analyzed. No other person viewed the videotapes apart from the experimenter, her advisor, and the three observers.

CHAPTER II

A REVIEW OF LITERATURE RELATED TO AUTISM

INTRODUCTION

Numerous researchers have attempted to investigate specific areas of basic perceptual abnormalities in autistic children. Among the perceptual dysfunctions proposed as central to autism are the following: a basic defect in sensorimotor integration (Ornitz, 1983), an inability to relate present to past experiences (Rimland, 1964), a pervasive language disorder (Churchill, 1978), and an inability to interpret social and emotional cues (Rutter, 1983). On the basis of clinical and research observations, the most pronounced information processing defects in early infantile autism appear to be with auditory and verbal stimuli.

One of the characteristics frequently associated with autism is an inconsistent response to sound. Several researchers have proposed theories of auditory processing disorders. Evidence from brainstem-evoked auditory responses has generally indicated that brainstem transmission time is longer in autistic children than in normals (Rosenblum et al., 1980; Tanguay & Edwards, 1982). Since detecting, paying attention to, and learning about new and significant information is an essential requirement for normal development, a defect in attentional orientation to new and significant information could have devastating consequences. Researchers consistently observe that people with autism do not seem to pay attention to their environment in a normal fashion. They sometimes seem oblivious to even novel, unexpected sounds and may not give any overt indication that they were surprised or curious about the source. Their attentional orientation to the world clearly differs from normal, but at present there exists no adequate framework for predicting their attentional orientations (Courchesne, 1987). Although it is still not possible to know how auditory functioning relates to various perceptual deficits in autism, it has provided investigators a fertile area for research.

In the following pages, a review of literature on autism and auditory awareness will be given, to provide the reader with the essential background knowledge needed to understand the basic deficits and the nature of the disorder of autistic children.

DIAGNOSIS OF AUTISM

Kanner (1943) was the first to name and describe the syndrome of early infantile autism and to delineate the behavioral abnormalities, which he considered to be of basic importance in making a diagnosis. The points that Kanner listed were:

1. A profound lack of affective contact with other people,
2. An anxiously obsessive desire for the preservation of sameness,
3. A fascination for objects, which are handled with skill in fine motor movements,
4. Mutism, or a kind of language that does not seem to be intended to serve interpersonal communication,
5. Good cognitive potential.

Although Kanner considered that the above points summarized the essential features of the condition, during the course of his writings on the subject he described in great detail the full range of behavior seen in autistic children (Kanner, 1973). Since Kanner's original description of the diagnostic criteria, many researchers have struggled to identify the criteria which are necessary to make the diagnosis of early infantile autism.

In 1964, Rimland listed six criteria which he considered of importance when making the diagnosis of autism. These were:

1. Presence of the syndrome from early childhood,

2. Lack of physical responsiveness,

3. Preservation of sameness,

4. Autistic aloneness and isolation,

5. Unusual performance in memory, music, and mechanical skills,

6. Good physical health and motor development.

Rutter and Schopler (1986) identified three clinical features as essential for diagnosis of early infantile autism. These are:

1. Deficits in the capacity to form relationships, associated with a poor appreciation of socioemotional cues, a lack of modulation of behavior according to social context, and a weak integration of social, emotional, and communicative behaviors;

2. Deficits in the use of language for social communication, associated with poor synchrony and reciprocity in conversational interchange, impaired use of variations in cadence to reflect communicative modulation, together with abnormalities of language including stereotyped usages and delayed echolalia; and

3. Restricted, repetitive, and stereotyped patterns of behavior, associated with abnormal preoccupations with parts of

objects or play materials, and distress over changes in small details in the environment.

Although many researchers have proposed and argued as to what the criteria for diagnosis of autism should be, the American Psychiatric Association has offered a systematic approach of explicit diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders - III, Revised. The symptoms delineated in DSM-III,R are:

1. Onset of the disorder before 30 months of age,

2. Deviance in the development of social relationships and pervasive lack of responsiveness to other people,

3. Gross deficits in language development. If speech is present, peculiar speech patterns such as immediate and delayed echolalia, metaphorical language, and pronoun reversal,

4. Restricted, repetitive, and stereotyped patterns of behavior, and bizarre responses to various aspects of the environment, e.g. resistance to change, peculiar interest in or attachment to animate or inanimate objects.

It is clear from this account of the diagnostic criteria that the definition of autism is based upon behavioral symptoms in early childhood. The literature on autism is still expanding to include more research on the domains of behavior that Kanner first suggested as central to the syndrome.

CAUSES OF AUTISM

The behaviors characterizing early infantile autism strongly suggest that this disorder relates to some form of neurological dysfunction. Current research is focused on two aspects of this problem: first, the identification of the neurological correlates of autism, and second, attempts at identifying the cause of this handicapping condition. Mesibov and Dawson (1986) note a few identified neurological correlates, such as soft neurological signs (e.g. hypotonic or flaccid muscle tone, poor coordination), seizure disorders, abnormal electroencephalograms (EEGs), unusual sleep patterns, and several conditions known to be related to brain damage. This large number of neurological correlates has suggested an underlying neurological dysfunction in the brain of the autistic individual. However, this emphasis on a neurological explanation is relatively recent.

Historically, particularly following Kanner's original description, all research was focused on psychogenic factors (i.e., not due to an organic illness but to unidentified psychological causes) in order to understand this syndrome. Attention to the parental role was initiated by Kanner's (1954) description of the parental characteristics of his first 100 autistic children. Although he noted that there was very little mental illness in the families of the autistic children, the parents were described as obsessive, unemotional, and cold. Bettelheim (1967) took a more extreme position, arguing that autism was the child's defense against the hostility of parents who had emotionally rejected the child. After a long period of assuming that parents had a strong role in causing their children's autism, a number of studies showed evidence that the parents of autistic children have problems no different than the parents of children with other types of handicaps, such as mental retardation, brain damage, and dysphasia (DeMyer, Alpern, Barton, DeMyer, Churchill, Hingtgen, Bryson, Pointius, & Kimberlin, 1972).

In general, the research investigating the psychogenic hypothesis has failed to support it (Ornitz & Ritvo, 1976). This led to the promotion of several neurological theories. In 1964, Rimland presented in his twin study the first neurobiological explanation of autism. Since then, several investigators have proposed neurological hypotheses on the causes of this syndrome. Thus, most research is focused on four distinct neurological and pathological areas: (a) genetic factors, (b) neurochemical studies, (c) neurophysiological studies, and (d) neuropathological examinations. A representative number of studies from each of these four areas of research will be reviewed in the following pages.

(a) Genetic Factors

Because of the rarity of the syndrome of early infantile autism, genetic studies are quite scarce. However, there is accumulating evidence which can suggest that genetic factors are responsible for autism, a disorder of unknown etiology. The evidence for a genetic contribution to the syndrome of autism comes from two types of studies: twin studies and family studies.

Folstein and Rutter (1977) studied 21 pairs of twins and found that none of the 10 fraternal (dizygotic) pairs was concordant for autism, but four pairs of the 11 identical (monozygotic) pairs were concordant. Concordance was determined through behavioral observation of the twins, and the degree of concordance was estimated by examining whether autism, diagnosed according to strict criteria, was present in both twins. This monozygotic-dizygotic difference in concordance pointed to an important genetic factor in the etiology of autism. In all, the 21 twin pairs gave rise to 25 autistic children. Thus, Folstein and Rutter (1977) developed a hypothesis and proposed that the co-twins (the twins who did not meet the criteria of the autistic syndrome) might exhibit some cognitive impairment without necessarily manifesting the full autistic syndrome. From their further examination of the twins, they found that in addition to the four identical co-twins, five other identical co-twins showed some cognitive impairment. Therefore, nine of the 11 monozygotic twin pairs were concordant for a cognitive deficit. August, Stewart, and Tsai (1981) attempted to test the hypothesis proposed by Folstein and Rutter (1977) by looking at the siblings of autistic children. The experimental group consisted of the siblings of 41 autistic individuals, which summed to the total of 71 siblings. The control group consisted of 38 siblings of 15 Down's syndrome individuals. Their findings suggested that some 15% of the siblings of autistic children, compared with only 3% of the siblings of Down's syndrome individuals, had language disorders, learning disabilities, or mental retardation. This showed the likely role of an inherited predisposition to cognitive abnormalities.

Recently, the results of another twin study were reported by Ritvo, Freeman, Mason-Brothers, Mo, and Ritvo (1985). Their sample consisted of 40 twin pairs. The authors found a concordance for autism of 95.7% in the identical twins (22 of 23) and 23.5% in the fraternal twins (four of 17). The authors also studied the non-twin siblings of these 40 autistic subjects. From their data, the authors yielded a 10.3% incidence of possible cognitive processing pathology among all nonautistic siblings (78 nonautistic siblings, of which eight were possibly pathologic).

Unfortunately, the data do not allow a test of any specific hypothesis. Pauls (1987) suggests that in order to adequately test any genetic hypothesis, the phenotypes of the parents need to be known. Thus, further research is required to support the possibility of a genetic basis for autism.

(b) Neurochemical Studies

The normal development of the central nervous system (CNS) involves chemical processes which are the topic of various studies of neuronal maturation. There are a number of chemical compounds in the human brain which are called neurotransmitters. Nerve cells communicate information received from the environment to the brain through the chemical actions of neurotransmitters at the synapses between the cells. A certain group of neurotransmitters, called monoamines, consists of dopamine, norepinephrine, and serotonin. Anatomical studies indicate that monoamines are found in areas of the brain which control emotions and behaviors. The behavioral, emotional, and cognitive symptoms presented by autistic individuals strongly suggest that CNS functioning is altered in autism. Neurochemical studies of autistic individuals have been undertaken to examine processes related to neural transmission in the central and peripheral nervous system (Anderson & Hoshino, 1987). A rather small, yet representative number of studies will be reviewed in the following paragraphs on the neurobiochemical causes of autism.

Serotonin is a monoamine neurotransmitter found in the areas of the brain that control emotions and behaviors. Serotonin travels around the human body through the peripheral bloodstream, where it is carried in platelets. Yuwiler, Geller, and Ritvo (1976) gathered data that suggest that some autistic children have above-normal blood serotonin concentrations in their blood. Takahashi, Kanai, and Miyamoto (1976) found that the autistic group in their study had a mean platelet serotonin level significantly higher than the mean of the normal group.

Tryptophan, an essential aminoacid, is the dietary precursor of serotonin and of the vitamin nicotin acid. Hoshino, Yamamoto, Kaneko, Tachibana. Watanabe, Ono, & Kumashiro (1984) reported that both plasma free tryptophan and blood serotonin levels were significantly higher in autistic subjects than in normal controls. Thus, the well-established elevation of blood serotonin seen in autistic individuals has prompted speculation that central serotonin systems are dysfunctional in autism (Anderson & Hoshino, 1987).

Dopamine, a monoamine neurotransmitter, appears to be especially important in the control of motor function, in cognition, and in regulating hormone release (Moore & Bloom, 1978). Lake, Ziegler, and Murphy (1977) found decreased dopamine serum levels in 11 autistic children and their families. Once dopamine is released from the neuron, it is enzymatically degraded to homovalillic acid and dihydroxyphenylacetic acid (HVA and DOPAC respectively) (Anderson & Hoshino, 1987). Martineau, Garreau, Barthelemy, Callaway, and LeLord (1981) studied the biochemical and electrophysiological effects of Vitamin B6 and magnesium in 12 autistic children and 11 normal children. Before treatment, the autistic children showed a higher level of homovalillic acid (HVA), whereas after the treatment they exhibited a decrease in urinary HVA. This possibility of increased central dopamine function, which is supported by pharmacological observations, deserves further careful study.

Norepinephrine is an important neurotransmitter in both the central nervous system and in the peripheral sympathetic nervous system. Lake, Ziegler, and Murphy (1977) found, along with decreased dopamine-b-hydroxylase (the enzyme that helps produce norepinephrine from dopamine), an elevated norepinephrine level in 11 autistic children as compared to normals. In a preliminary study of five autistic boys and nine normal boys, urine level of norepinephrine was reported to be lower in the autistic subjects (Young, Cohen, Brown, and Caparulo, 1978).

These areas of neurochemical research in autism appear to hold special promise. As Anderson and Hoshino (1987) suggest, additional studies will help reach a greater consensus as to which aspects of neurochemical functioning are abnormal, and which are normal, in autism.

(c) Neurophysiological Studies

The neurophysiological approach is another major area of study on the causes of autism. In the last decade, there is a strong suggestion of the possibility that numerous systems within the brainstem do not function properly in early infantile autism. Neurophysiologic studies of cortical and subcortical events have focused on the autistic disturbances of language, communication, sensory modulation, and motility. These investigations have included electroencephalogram (EEG), radiologic, event-related-potential, autonomic, brainstem auditory evoked response, and vestibular studies.

EEG studies have suggested a deficiency in hemispheric lateralization. Small (1975) showed that in autistic children, their mean integrated EEG voltage over the left hemisphere did not show the normal increment over the right hemisphere. In addition, in the forementioned study the abnormal EEG findings were significantly related to other indications of impaired CNS functioning, such as lower intelligence, positive neurological signs, and poorer follow-up status. Ornitz (1987), in a review of literature on neurophysiologic studies, concluded that although there is evidence from EEG studies for unfavorable cerebral lateralization in autism, dichotic listening studies or CT scan studies do not support that concept. A recent study by Balottin, Bejor, Cecchini, Martelli, Palazzi, and Lanzi (1989) tested the hypothesis that specific computerized tomography brainscan (or CAT scan) findings are associated with infantile autism, but their results did not show any significant differences between the autistic and the normal groups. Thus, the authors concluded that "autism is nonspecifically associated with brain-scan abnormalities, and that other nonorganic and/or organic factors should be taken into account" (p. 109).

Sleep studies have shown some differences between autistic and normal children. Tanguay, Ornitz, Forsythe, and Ritvo (1976) compared a group of autistic children (ages 36-62 months) to an age-matched group of normals and to a group of normal infants (ages below 18 months). They found that the rapid eye-movement (REM) activity of REM sleep in autistic children is reduced and is similar to that found in normal infants. They suggested that this indicates brain mechanism immaturity in the autistic individuals.

Maturational deviation has also been reported in event-related-potential studies in the awake autistic child. One early study of evoked responses to flashes and clicks in waking autistic children found that the visually evoked response (VER) of the autistic children was more variable than the VER of the normal children (Small, 1971). Yet, the evidence was inconclusive, since no statistical analysis of the data was presented. In 1978, Student and Sohmer found longer auditory nerve transmission latency and longer brainstem transmission time for the auditory evoked response (AER) in a group of 10 autistic children compared to 12 normal children. Courchesne, Kilman, Galambos, and Lincoln (1984) compared nonretarded autistic adolescents with normal controls. They found that the late AERs waves (wave P300) of the autistics were significantly smaller in response to target stimuli requiring an active response and in response to novel stimuli presented during the same testing trials.

Autonomic response studies have focused on the regulation of cardiovascular and respiratory responses. Disturbances in autonomic function have been found in a number of children diagnosed as autistic or psychotic. In a review of literature of autonomic studies by Piggot (1979), the author cites a study by Hutt, Forrest, and Richer (1975). As the reviewer states, "they found significantly more arrhythmia in autistic children than in normal children when they recorded their heart rates in situations varying from an external stimulation to an adult actively attempting to involve the child in a task" (p. 525).

Other reports of elevated peripheral blood flow (Cohen & Johnson, 1977) and heart rate (Kootz & Cohen, 1981) in autistic individuals provide further evidence of abnormal autonomic responsivity.

The brainstem auditory evoked responses (BAER) seem to be the most direct measure of brainstem funtioning, yet results from BAER studies on autistic children are not in agreement. Rosenblum, Arick, Krug, Stubbs, Young, & Pelson (1980) reported significantly prolonged Brainstem transmission time (BSTT) in autistics, yet Gillberg, Rosenhall, & Johansson (1983) did not find consistent group differences between autistics and controls. However, they did identify a subgroup of the autistic individuals with prolonged BSTT.

Vestibular reflexes also provide a measure of brainstem function, and a number of vestibular studies in autistics have been reported. Ornitz, Brown, Mason, and Putnam (1974) found significantly decreased duration of nystagmus and total number of nystagmic beats in the autistic as compared to normal children in conditions in which the children had minimal light input and eye fixation, and with light input and no eye fixation. Ornitz and Ritvo (1976) suggested that since autistic children show pronounced peculiarities of behavior (e.g. staring both at fixed and spinning objects) this could reflect disturbances in visual-vestibular interactions. Ornitz, Atwell, Kaplan, and Weatlake

(1985) found that the time constants of decay of the nystagmus response were prolonged in autistic children compared to those of age-matched normal children and a group of normal young infants.

The neurophysiologic studies reviewed in the previous paragraphs provide some evidence for distortion at the cortical and subcortical level of functioning of autistic children. Future studies should further examine these hypotheses in order to provide more conclusive evidence of the neurophysiologic factors involved in the etiology of autism.

(d) Neuropathological Examinations

Disturbances in neurological functions are consistently found in children with autism. Researchers have suggested central nervous system dysfunction in infantile autism, yet conflicting results have been produced from post-mortem examinations and in vivo brain imaging studies.

Williams, Hauser, Purpura, DeLong, and Swisher (1980) examined four autistic subjects who died at ages 4, 14, 27, and 33. Neuropathological examinations on brain weight and Golgi Stains were normal. Ritvo, Freeman, Scheibel, and others (1986) in an autopsy research report found abnormalities in the cerebellum of four autistic subjects. In fact, they found lower purkinje cell counts in the cerebella of the autistic subjects.

As Courchesne (1989) suggests, partial loss of certain cell types of brain cells, called purkinje cells, can result in abnormal neurophysiological activity. This was evidenced in his study done with autistic subjects. Courchesne (1989) used magnetic resonance imaging (MRI), a new modality of in vivo brain imaging, to investigate the neocerebellar vermis (i.e. a narrow structure in the midline of the left and right hemisphere) of the autistic group. His findings showed anatomical abnormalities in the neocerebellar vermis. Specifically, neocerebellar vermal lobules VI and VII were significanlty diminished in size in the autistic group, but the paleocerebellar vermal lobules I-V and VIII were normal in size. The vermal lobules VI and VII have usually been viewed as principally involved in motor control. Autistic individuals, however, exhibit impaired social, communication, and cognitive functioning, and show abnormalities in attention, sensory modulation, serotonin and dopamine activity (as mentioned in previous paragraphs), memory, and complex motivated behaviors. Because there is no significant deficit in motor control, per se, there is a strong need for more research in this area for uncovering the functional significance of vermal lobules VI and VII, and their relationship to the specific patterns of behaviors exhibited by autistics.

Remarks

Although there is a strong conviction that childhood autism is a biologically based disorder, researchers have not been able to find organic causes. The search for specific etiologies seems to have made little progress in the past 40 years. Since Kanner's original description of infantile autism, a variety of neurological conditions have been defined, but not linked to the various behavioral symptoms that these children exhibit. A few reasons for this significant lack of knowledge may be:

(a) our limited knowledge of brain physiology and of functional relationships between brain and behavior;

(b) the heterogeneity of autistic children who exhibit behaviors in a wide range of frequency, intensity, and severity;

(c) the need to control a variety of factors (i.e. age, diet, and other) in an already small group of children;

(d) the need to find autistic children who are high functioning to allow for research to be free of the influence of mental retardation; and

(e) the difficulty in connecting the various neurobiological results from the various studies in all the different fields of investigation.

THE BEHAVIORAL PROFILE OF AN AUTISTIC CHILD

Wing and Wing (1965) have offered a brief but systematic description of the behavioral abnormalities of autistic children. These are classified and listed under various headings in order to clarify the relationship between the basic disabilities and the social difficulties to which they lead. The same headings will be used in the following description of the behavioral profile of an autistic child. Many observations that this author made while working at a school for autistic children will be added to the observations and remarks of Wing and Wing (1965). One should always keep in mind that no child ever has all of these disabilities at any age.

(a) Disorders of the Special Senses.

Vision: Autistic children have an inability to recognize things seen. Their ability to separate figure from ground tends to develop very slowly. For example, a child may not recognize his/her own house from a distance. They use mostly peripheral vision , which can be considered as their main characteristic. Many times they look at people or objects as if they are invisible, looking past them but through them. Various times they cover their eyes with their hands in order to avoid something visual, and they avoid direct eye-contact with other people. Although they tend to ignore strong lights, they like to look at shiny surfaces, certain colors, and the reflections of light. There are other visual disorders that autistic children might have, such as difficulty in seeing moving things (i.e. airplanes).

Hearing: There is an apparent non-reaction to noise often seen in autistic children. An autistic child may not react to a loud noise behind him/her, but might be fascinated with whispers in a room. They have special interest in certain sounds, and music is particularly enjoyed. A usual reaction to sounds they want to avoid is to cover their ears with their hands.

Other senses: Autistic children like to explore their environment through touch, smell, and taste. They often prefer soft objects, and they identify new objects in peculiar ways (i.e., by licking). They are not sensitive to temperature changes, so they often are indifferent to cold or hot objects, and they don't seem to feel pain. They lack the ability to localize a sensation. They like unusual tastes and smells, not necessarily pleasant ones.

(b) Disorders of speech.

Communication through speech presents great difficulties for autistic children. Speech may not develop at all, or may begin and then be lost. If any speech develops at all, various abnormal characteristics are present: echolalia, frequent repetition of phrases, inability to answer questions due to echolalia, mix-ups over words with two meanings, use of fragments of speech to convey meanings, use of words that are not understood by the child, incorrect word order, use of second or third person when talking about self, no use of abstract or subtle meanings, marked difficulty in understanding speech, frequent use of a 'special voice' different from the normal voice, and use of speech in an arrhythmic and monotone voice.

Autistic children are quite sensitive to the way people address them. Oftentimes they avoid someone who is talking to them in a loud manner, whereas other times they are able to follow a low tone conversation, even when no one is talking to them. Sometimes it is easier for them to follow a story or a conversation that is recorded instead of live. Because they have a strong interest in music and rhythm, they frequently pay close attention to the words of songs.

(c) <u>Motor Behavior.</u>

One main feature that characterizes autistic behavior is rocking behavior. Sitting or standing, they like to move their body rhythmically either left to right, or back to front. Some autistic children are characterized by clumsiness, while others are very graceful. They often exhibit special movements, such as finger flicking, or hand flapping. In some, their walking manner presents a peculiar appearance. Some walk on their toes, others walk with no synchrony, and some walk with a slight bend forward. They are often characterized by hyperactivity, and they often exhibit secondary self-stimulatory behaviors, such as head banging and rocking. Usually they lean on a surface and hit their head repeatedly, which frequently results in some injury, yet the autistic child does not seem to be in pain. They find great pleasure in certain movements, such as swinging and spinning. Although some of their movements are stereotypical and done in a repetitive manner, they are not the same for all autistic children, and they change as the child grows older.

(d) Odd Behaviors, Including Resistance to Change.

Objects seem to be of great importance for autistic children, as they like collections of specific objects, and they are in great distress if an object is lost or misplaced. They usually have one particular object that they hold and carry, and if someone tries to take it away, they react with great resistance. They make lines and patterns with all sorts of objects, regardless of their proper use. The autistic child does not play as normal children do, but exhibits odd routines of behavior instead of play, and does not seem particularly interested in joining in games with other children. Once a routine is established, the autistic child has great difficulty in changing and following an altered routine. He/she also resists learning new things and establishing new routines.

(e) Abnormalities of Mood.

The autistic child acts in a remote, aloof, and distant manner. He/she looks cold and moodless when others show their love, may lack outward signs of warmth, and might not be 'cuddly'. Often outbursts of rage and anger are present due to frustration or even for no apparent reason. When frustrated, the autistic child bursts into tears, stamping, kicking, and yelling. Occasionally, he/she may start laughing for no apparent reason. The autistic child can not share the feelings of other people. When presented with real danger, the child might not show fear at all, but might exhibit fear for harmless things, e.g., taking a bath.

(f) Other Agnosias.

The autistic child often has difficulty in achieving or reflecting knowledge in the following areas:

1. Failure to distinguish left from right
2. Difficulty in wrapping objects in paper
3. Little use of gesturing
4. Writing letters in reverse

5. Delayed and inefficient drawing

6. Peculiarities in dress habits, e.g. putting clothes on back to front, reacting with anxiety if part of their clothing, such as a button, is missing, or reacting to a new piece of clothing

7. Peculiarities in eating habits, e.g., either eating extremely fast or having great difficulties in eating, wanting only creamy foods.

8. Watching oneself with great curiosity in a mirror, or in contrast, showing discomfort or avoidance with one's own reflection.

(g) Uneven Development.

Some of the above listed disabilities occur in every autistic child, but each has a particular pattern of abnormal development and his/her own set of handicaps. Autistic children present peculiarities in their development. They do not follow the slow and steady developmental process of the retarded child. Sometimes they make leaps in their development, and other times they take steps backwards. One must not forget that each child is an individual and might exhibit all or just some of the above characteristics, in varying degrees of severity.

OVERSELECTIVITY OF SENSORY STIMULI IN AUTISM

Experimenters and theorists working from a variety of frameworks have considered the role of attentional disturbances in the lack of responsivity to environmental stimuli of autistic children. An even more common manifestation of these disturbances in autistic children involves a lack of consistency with which the children respond to a majority of stimuli. In particular, a growing body of research has delineated a learning characteristic known as stimulus overselectivity or overselective responding in autistic children. Stimulus overselectivity refers to a tendency of autistic children to respond to extremely restricted portions of complex stimuli (Dunlap, Koegel, & Burke, 1981). The research on overselective responding is distinguished from other similar work in that it has attempted to explicitly and empirically define the observable nature of the phenomenon.

Lovaas, Schreibman, Koegel, and Rehm (1971) speculated that the primary cognitive deficit in autism might be stimulus overselectivity, a tendency of autistic children to selectively respond to only one component of a complex cue. To validate their hypothesis, Lovaas and his colleagues conducted a series of six experiments to observe and delineate the exact nature of this deficit. They found that the autistics responded primarily to only one of the cues of a complex stimulus, involving simultaneous presentation of auditory, visual, and tactile cues. The control group (normal children) responded uniformly to all three cues while the other control group (retarded children) functioned at a level in between these two extremes. Based on these results, Lovaas and Schreibman (1971) decided to investigate the same problem using only two stimuli, auditory and visual. They used two groups of children, autistic and normal, who were rewarded for responding to a complex stimulus: the simultaneous presentation of a 150W red floodlight and white noise. Their findings included: (a) the autistic children showed stimulus overselectivity as demonstrated by their differential response to one of the two stimulus components, whereas the normal children responded equally to both cues; (b) there was no evidence that any one sense modality is impaired or preferred in autistic children. In 1973, Koegel and Wilhelm reported that of the 15 autistic children they studied, 12 were overselective, while three of the 15 normal children showed similar overselectivity.

The first study to seriously question Lovaas's original hypothesis was by Kovattana and Kraemer (1974). They described a study of visual discrimination learning that compared 20 autistic children with 20 Down's syndrome and 20 normal controls. The subjects were all boys. Their findings showed that the two verbal autistic children performed as well as the normal children. Kovattana and Kraemer (1974) questioned whether overselective attention may be due to a language deficit, rather than to the syndrome of autism. Wilhelm and Lovaas (1976) provided further evidence on the matter. They compared samples of moderately retarded, severely retarded, and normal children on a visual overselectivity task. They found that both retarded samples demonstrated significantly more overselectivity than did the normal control sample, thus demonstrating that stimulus overselectivity is not limited to autism.

Schover and Newsom (1976) questioned whether overselectivity is just one of many developmental lags autistic children display, rather than a unique feature of early childhood autism. They matched a group of autistic children with a group of normal children by mental age, and they gave both samples a visual overselectivity task. They found no significant differences between autistic and mental-age-matched normal children on the overselective-attention task. Thus, they concluded that overselectivity is probably one developmental delay among many, and in no way central to understanding autism. Further experimentation attempted to clarify the nature of overselectivity in autistic children. In 1977, Koegel and

Schreibman suggested that autistic children experience extraordinary difficulty when responding to multiple-cue inputs. These authors first trained the children to respond to individual component cues. In the next phase they altered the contigency so that responses to individual presentations were no longer reinforced, but responses to both cues presented simultaneously were reinforced. The results suggested that possibly autistic children's attentional deficiencies might create problems in distinguishing the complex stimulus from its components.

Bickel, Stella, and Etzel (1984) examined stimulus overselectivity in preschool autistic children. After training 27 subjects to respond to only two-component auditory stimuli, the investigators tested the subjects to determine which stimulus elements of the complexes (i.e., multi-component auditory stimuli) exerted control; in other words, which stimulus controlled their responding. Their analysis of the results indicated that overselective responding may be described as the ordering of stimulus elements in a stimulus control hierarchy rather than limited stimulus control.

Burke and Cerniglia (1990), in an attempt to extend the previous studies, conducted a study to address questions such as: (a) Would autistic children's correct responses to stimuli decrease as the number of stimulus components is increased from one to four?

(b) Would teaching autistic children to respond to single-component stimuli influence their responses to multicomponent stimuli?

Findings of this study showed that as the number of stimuli increased from one to four, the children exhibited difficulties in responding. In summary, data collected in the above study suggest that autistic children's lack of responsivity may occur in part as a result of a problem in responding to complex multicomponent stimuli. Burke and Cerniglia (1990), at the end of their study, suggest that "...Instead of assuming that autistic children's limitations in responding to environmental stimuli is a generalized characteristic, it may prove more beneficial to determine under what circumstances their limitations are more pronounced and how these limitations can be remediated" (p.250). This should be the direction of future research on stimulus overselectivity of autistic children.

AUDITORY PERCEPTION

The term auditory perception refers to the process of receiving sound and interpreting the signal by relating it to previously stored experiences (Reagan, 1973). The sound is received by the auditory system, and it is interpreted in the brain. The auditory system consists of the outer ear, the middle ear, and the inner ear. In simple terms, the auditory system works as follows: The outer ear, which is the visible portion of the ear, serves as the path entrance for aerial waves. Beyond the eardrum is the middle ear cavity, an irregularly shaped, air-filled space in the temporal bone. The function of the middle ear is the efficient transmission of sound energy. The inner ear can be described as a bony labyrinth which consists of three divisions: (a) the vestibule, (b) the semicircular canals, and (c) the cochlea. The first two divisions are concerned with bodily equilibrium, and the cochlea serves for hearing (Warren, 1982). As the aerial waves are converted into mechanical vibrations in the middle ear and brought inward to the inner ear, distortion of the auditory receptor cells evoke neural impulses. These hair cells are located on a membrane within the cochlea. The function of the hair cells is to convert the physical stimulus of the aerial waves to electrochemical changes in the neurons comprising the membrane. These electrochemical signals are sent to multi-layered areas of the brain in the central nervous system (Campbell, 1983). In other words, sound first travels as aerial waves, then as mechanical vibrations, through the ear to the receptor cells where it is translated into patterns of nerve impulses, which are sent to the brain centers and finally give rise to auditory perception.

Auditory perception is viewed as a primary factor in speech perception, language and cognitive development, and emotional growth of a child. There are many children that, due to an auditory perceptual dysfunction, are found to perform below the normal expectancy level in various areas (Reagan, 1973). All aspects of auditory perception, particularly discrimination and sequencing abilities, are fundamental to speech, reading, and the development of language. Consequently, impairment in auditory perceptual functioning constitutes in the young child a learning problem that could take the form of a learning disorder. Pediatric audiology has developed a number of tools to test the hearing sensitivity of young children (Gans & Flexer, 1983). The first step in an assessment procedure is often the initial identification of a problem through a screening test. The most common screening instrument is the sweep test, which uses a portable audiometer to present tones at about 20 to 25 dB (Kneedler, 1984). The next step in evaluating more accurately the extent and nature of the hearing loss can follow one of two general directions: pure-tone audiometry and speech audiometry. Pure-tone audiometry attempts to determine at what precise levels of frequency and loudness an individual can detect sound. Pure-tone testing is done with tones of various intensities (loudness) and frequencies (pitch). Speech audiometry, in contrast to pure-tone testing, measures the lowest levels of decibels at which a person can detect speech and the level at which he or she can understand speech (Kneedler, 1984). Some tests which are described by Reagen (1973) used in assessing auditory perceptual abilities are: a Screening Deep Test of Articulation, particularly useful in testing children of Kindergarten age; the Wepman Auditory Discrimination Test, designed to measure a child's ability to discriminate among phonemic differences; the Goldman-Fristoe-Woodcock Tests of Auditory Discrimination, purported to assess speech sound discriminatory ability in daily living; the Peabody Picture Vocabulary Test, which measures the vocabulary gained through listening; the Assessment of Children's language Comprehension, which examines the ability to understand language and does not require verbalization; and the Northwestern Syntax Screening Test, that measures a child's general use of grammar. All these tests are being used extensively by audiologists. However, they are of limited use when one tests infants or mentally or physically handicapped children whose young age or handicaps interfere with the assessment of their hearing? The responses of infants and many handicapped children are too limited for the usual requirement in the testing of hearing, that of speaking or signaling in some way when they hear a sound. When testing these children, audiologists look for a number of orienting responses or reflexive behaviors when a sound occurs as an indication that the child is hearing. In such cases the audiologist may get some index of sensitivity by using sound field behavior observation audiometry. As Fulton and Lloyd (1975) explain,

> "...Behavior observation audiometry (BOA) refers to the audiologist's attempt to elicit observable responses to sound. The responses may be respondents (or reflexive) and/or operants (or 'voluntary'), but they must be temporally and reliably related to the auditory stimulus. The auditory stimulus in BOA is usually speech or complex sounds produced by noisemakers." (p. 12)

One problem that arises when using any of the orienting responses as measures is that the child will not continue the behaviors indefinitely. One way of increasing the number of responses is to use visual reinforcements. Some tests developed by audiologists based on this principle are: Puppet in Window Illuminated, Visual Reinforcement Audiometry, and Peep Show (Gans & Flexer, 1983).

Hearing assessment of infants and those unable to make voluntary responses can also be done by using physiological measures that detect changes in skin resistance and brain wave activity. Impedance audiometry (Robertson, Peterson, & Lamb, 1968) and auditory brainstem response audiometry (Hecox & Galambos, 1974) have proven to be important in the hearing evaluation of young children. The field of evoked response audiometry is rapidly expanding and a variety of detection techniques are being developed (Reneau & Hnatiow, 1975). Although these methods are more difficult to administer and interpret, they can be very helpful in determining hearing disabilities in some cases.

Because autistic children frequently do not show response to sound in the usual manner, hearing impairment can be overlooked on the belief that this lack of response is part of their autism. An often used initial assessment procedure is the traditional office evaluation of the spoken voice. This requires close observation for response to a variety of sounds in the room or outside the building and it gives the examiner a rough estimation of hearing (Lacamera & Lacamera, 1987). More specific audiological testing may be required for accurate determination of hearing capabilities, and it may need to be repeated a number of times. If results still are uncertain, physiological testing can be attempted, such as testing for brainstem-evoked response or auditory-evoked potential.

AUDITORY EVOKED RESPONSES OF AUTISTIC CHILDREN

The word "autism" emphasizes the severely withdrawn, detached behavior that autistic children exhibit. Their unresponsiveness to external stimulation is one of the main characteristic features of autistic children. In many cases, this unresponsiveness is so severe that the child is suspected by his parents of being blind or deaf. As Rimland (1964) described, the suspicion of deafness is very often the earliest interpretation placed on the inaccessibility of the autistic child by his parents. Therefore, systematic measurements and neurophysiologic studies have attempted to investigate the nature of their auditory selectivity, and to assess the consistency of the autistic child's responding to auditory stimulation.

Koegel and Schreibman (1976) conducted an experiment on a child who was at various times reported to be deaf, hard of hearing, or functionally deaf, and at other times was reported to have normal hearing. In this experiment, Koegel and Schreibman (1976) measured his responses to systematically presented auditory stimuli in order to determine if there was any pattern in his responding. The auditory stimuli used were (a) white noise, consisting of most of the frequencies within the human range of hearing, and (b) the sound of a candy machine delivering candy. The results of this experiment showed the following:

(a) he had a definite pattern in his responding to auditory stimuli,

(b) his threshold for responding was consistent within any given session, yet his threshold varied from session to session, and,

(c) his threshold to the sound of the candy feeder was considerably lower than his threshold for the white noise.

The authors of this study, while discussing their results, suggested that the lack of speech development of autistic children might be a function of a problem in responding to auditory stimuli. They proposed that autistic children should be given thorough audiological examinations.

In 1981, Nober and Simmons conducted a study to investigate the possibility that autistic adolescents may avoid speech communication with the world around them by perceptually suppressing auditory speech stimuli. The auditory stimulus used was the subjects' own speech under three conditions: (a) with speech in a delayed auditory feedback mode, (b) with a white noise masking speech mode, and (c) with speech in a normal, quiet listening mode. The speaking responses of five autistic adolescents were compared with six normal controls on speech time duration and sound level. Results showed that delayed auditory feedback increased the speech sound pressure level (loudness) and increased speech time duration for both groups.

Gans and Flexer (1983) reported their attempt to define auditory response behavior in 31 severely and profoundly multiply handicapped children. They used behavioral observation audiometry, where five types of auditory stimuli were presented and one observer, seated in front of the child, scored response behaviors. They found that out of 9 possible response types, searching, quieting, and localization were the most predominant responses for all five stimuli. Additionally, the authors found that the higher-functioning children responded much differently to the sounds than did the lower-functioning children.

Apart from observational studies on the auditory responses of autistic children, neurophysiologic research has suggested that major abnormalities in their psychophysiological functioning result in their auditory attentional deficits.

In 1968, Ornitz, Ritvo, Panman, Lee, Carr, and Walter reported that autistic children below the age of five years did not show a decrease of auditory evoked responses (AER) during REM sleep as did a comparably age-matched group of normal children. Tanguay (1976) found significantly larger auditory evoked responses over the right hemisphere as compared to the left hemisphere in normal children but no consistent hemispheric differences for AER in autistic children. He suggested that this finding might indicate a definite disturbance in the development of functional lateralization in the autistic child. Student and Sohmer (1978) compared a group of 10 autistic children with 12 normal children. They found that the experimental group showed longer auditory nerve transmission latency and longer brainstem transmission time in their auditory evoked responses. In 1984, Stevens and Gruzelier compared the electrodermal activity elicited by auditory stimuli of 20 autistic subjects to their matched retarded and normal controls. Their results showed that the autistic group was virtually undifferentiated in isolated features of electrodermal activity from the other control groups. The only feature that reliably distinguished autistic children from the controls were longer response latencies and longer response rise times of their right compared to their left hand to the 70 dB tones presented.

Van Engeland (1984) studied the spontaneous electrodermal activity and the electrodermal orienting responses to auditory stimuli of moderate intensity in a group of 35 autistic children and in three control groups. He found that autistic children were significantly more often nonresponsive to the first trial and that when they responded, they showed electrodermal orienting responses characterized by large amplitudes and fast recovery. Van Engeland reached a hypothesis that "... when highly physiological aroused, autistic children are abnormally open to environmental stimuli and exposed to a stressing condition of information overload" (p.276). He concluded that nonresponsiveness of the autistic child can be explained as a defensive strategy to minimize the overload stress.

A different study by Courchesne, Lincoln, Kilman, and Galambos (1985) explored the possibility of a modality difference in information processing in ten nonretarded autistic adolescents. They compared visual and auditory event-related brain potentials (ERPs) to stimuli requiring simple classification decisions and to unexpected, novel information. Their results showed that the autistic group did not differ significantly from the control group in their accuracy in classifying targets. The authors discussed the possibility that although visual ERP differences do not seem to reflect maturational delay, the auditory ones may.

Martineau, Garreay, Roux, and LeLord (1987) recorded the auditory evoked responses (AERs) of 16 autistic children, ages 2 - 10 years, and age-matched normal and retarded controls. Several differences between the groups were found concerning the frequency and the amplitudes of present AERs. The authors suggest that the weak response amplitudes observed in autistic children can be related to abnormalities in selective attention and responsiveness.

In 1989, Courchesne, Lincoln, Yeung-Courchesne, Elmasian, and Grillon recorded two neurophysiological components of the event-related brain potential, Nc and P3b, in auditory and visual target detection tasks in groups of (a) nonretarded autistic, (b) receptive developmental language disordered, and (c) normal subjects. The nonretarded autistic subjects in this study performed the auditory target detection tasks as accurately and rapidly as normals. However, they had abnormally small auditory P3b responses, which is characteristic of autistic children. Since small auditory P3b responses are typically associated with poorer or slower task performance, the authors suggested that the autistic children may be using some unusual or alternate physiological processes in order to perform to auditory tasks as well as the normal subjects.

This possibility, as well as that of limited attentional resources, constitutes the topic of current event-related brain potential research in autism.

MUSIC THERAPY AND AUTISM

One of the most frequent observations that educators, clinicians, and researchers make about autistic children is that these children are unusually responsive to music. An increasing body of evidence is available on attempts to investigate the special interest and/or ability of autistic children in relation to music. Even though many of the reports are in the anecdotal form of case studies, the description of isolated examples of autistic children with musical abilities can assist in comprehending the relation between autism and music, as well as understanding this disorder.

In 1952, Mahler attempted to analyze the meaning of music to autistic children in terms of their psychological processes. He believed that the autistic child can break through the ego boundaries and reach out of his or her world with the help of the music. A year later, Sherwin (1953) reported a study of the musical responses of three autistic children. The common characteristics of these children were their profound interest in singing and listening to various selections of music, their selectivity and preference for familiar and rhythmic pieces, and their ability to remember and identify known melodies. Sherwin offers three possible explanations for the reasons behind this intriguing behavior: (a) the child is drawn by sound and vibrations instinctively, (b) the child's preference for objects rather than people favors his/her preoccupation with music, and (c) the child may use music as a more appealing way of communication because it is less specific than speech.

Various authors have observed that autistic children frequently show strong positive responses to particular types of musical stimuli. Pronovost (1961) reported a two-year study of 12 autistic children. During his observations, he found that all autistic children but one showed a greater interest toward musical sounds than environmental sounds. In 1964, Rimland stated that musical abilities and/or interests are almost universal in autistic children. Euper (1968) referred to this interest or ability in music as an outstanding characteristic and suggested the need for further research. Cain (1969) reported that severely psychotic children respond positively to music, it being one of their special isolated abilities. Viscott (1970) reported a case study of an autistic child with musical abilities, and referred to the child as a "musical idiot savant". In a follow-up study of 11 autistic children, Kanner (1971) mentioned great musical abilities noted in six of them. In 1972, Frith reported an experiment on color and tone sequence production in autistic children, and observed that they produced far better tone sequences than color sequences. In 1974, O'Connel described his study of an eight-year-old autistic boy with exceptional musical ability and absolute pitch.

In view of the apparent relation between autism and music, many authors have attempted to establish effective treatment methods using music as their primary therapeutic tool and have reported positive results in the autistic condition of the subjects.

In 1964, Goldstein reported a treatment plan for an autistic girl based on singing, dancing, and painting. The author concluded that after a six-month period, noticeable progress was made in motor skills, communication abilities, and social awareness. Stevens and Clark (1969) conducted a study that supported the use of music as an effective treatment for autistic children. They suggested that music can be beneficial in enhancing creativity, initiative, and social behavior skills. Another study on the implementation of a music therapy treatment program was done by Mahlberg (1973). A seven-year-old autistic boy was provided with a treatment program designed to increase attention span and enhance communication skills. Mahlberg concluded that observable progress was made on all goals. A similar study, by Saperston (1973) reported noticeable progress in communication skills of an eight-year-old profoundly retarded boy exhibiting autistic features, after attending a music therapy program. In 1974, Hollander and Juhrs developed a treatment method for autistic children based on the Orff-Schulwerk. The main focus of the Orff treatment program, as described by the authors, was language development. Schmidt, Franklin, and Edwards (1976) studied the use of music in a teaching program of three autistic children on individual and social behavior skills. Alvin (1978) suggested that in the early stages of therapy, music therapy treatment programs should be accepting and in a free form, since music is usually appreciated by autistic children at a concrete level. In 1984, Thaut developed a general music therapy treatment model for autistic children, directed to four prospective treatment areas: development of language, socioemotional, cognitive, and perceptual motor skills. The author attempted to tie aspects of the diagnostic characteristics of the autistic children to appropriate music therapy techniques in a systematic fashion.

Various researchers have been trying to find the relation between autism and music, and many experiments have been conducted in order to begin to comprehend the nature of this relationship. In 1978, Blackstock conducted two experiments investigating listening preferences of autistic and normal children, when given a choice between verbal and musical stimuli. Results showed that autistic children preferred musical stimuli, whereas normal children did not establish a preference. It was also noted that autistic children attended to both stimuli predominantly through the left ear, whereas normal children used the left ear to listen to music and the right ear to attend to spoken material. Another experimental study, done by Applebaum, Egel, Koegel, and Imhoff (1979) tested autistic children and normal children in their abilities to imitate individual tones and series of tones. The results showed that autistic children overall performed as well as or better than the age-matched controls.

Campbell (1980) suggested that autistic children attend to an auditory stimulus more often than a visual stimulus, particularly when the auditory stimulus is musical. Thaut (1980) found that in tone sequence production, autistic children scored significantly better than the mentally retarded control group in the areas of rhythm, originality, and total performance. In 1982, Soraci, Deckner, McDaniel, and Blanton found that when music of medium range rhythm was played, the self-stimulatory behaviors of autistic children were increased, rather than during slow- or fast-rhythm music. Frith and Snowling (1983) observed that hyperlexic autistic children perform well in phonetically accurate word decoding, as in reading for sound instead of meaning. Nelson, Anderson, and Gonzales (1984) suggested ways to synthesize music activities in accordance with the characteristics of children with pervasive developmental disorders. Thaut (1987), in a study similar to Campbell's (1980) found that autistic children attended longer to the musical rather than the visual stimulus. Stamatis (1987) suggested that music should be used in enhancing speech reality orientation and behavior management. Frith and Baron-Cohen (1987) refer to the musical skill of autistic children as an "islet of ability", and they state that this skill and especially their ability to imitate tone sequences and sounds might form the basis for their ability to very precisely initiate parts of speech (echolalia).

A variety of therapeutic methods have been used in treating autistic children. One common feature though, is their responsiveness to music. The causes are still unknown for this intriguing relationship between autism and music, yet one cannot overlook the power of music. Music is an experience that can affect a person's mind, body, and emotions. It may bring change in the behavior of the listener or the performer. Music can be enjoyed at a concrete level without an understanding of abstract processes. Music can simply be a pleasant or an unpleasant sensation. The inclination of the autistic child to become enamored of rhythm, order, and repetition, seems to indicate some likely directions for treatment with the use of music.

CHAPTER III

METHODOLOGY

A group of eight school-age autistic children were tested for their ability to respond overtly to various auditory stimuli: environmental, vocal, and musical sounds.

SUBJECTS: This study consisted of eight school-age autistic children. All of the subjects were enrolled in the Center for Autism in Flint, Michigan. The group consisted of five boys and three girls, ranging in age from 7 to 14 years, with a mean age of 11 years. All children were diagnosed as autistic by agencies not associated with the experiment, and for the purpose of inclusion in this study, satisfied the diagnostic criteria established in DSM-III-R (American Psychiatric Association, 1987 rev.). They all exhibited autistic behaviors, such as a lack of responsiveness to other people, gross impairment in communication skills, and bizarre responses to various aspects of the environment. The speech development of all but one had been delayed. At the time of testing, five were still nonverbal, making occasional noises, but with no communicative language. There were two who had minimal speech in the form of words, and only one of the younger boys had acquired fairly good speech. The IQ scores of this group ranged from 19 to 89 on the Leiter

International Performance Scale. An estimate of their developmental age was given by their individual teachers. Their D.A. ranged from 1 to 5 years, with a mean developmental age of 2.8 years.

Information about their hearing abilities was collected from the children's files from previous auditory screening tests, and none of the children were hearing impaired.

PILOT TESTING: The procedures were pilot tested first with three subjects who did not take part in the actual experiment. One subject was an autistic child, selected from the clients seen at the Music Therapy Clinic of the Music Therapy Department at Michigan State University. The other two subjects were severely mentally retarded children selected from the students at the Center for Autism in Flint, Michigan. All test trials were videotaped. These tapes were used for the training of the three observers who viewed and scored the tapes of the actual experiment. The three observers viewed and scored the test trial tapes a number of times until they reached a 95% agreement level as evaluated by Kendall's Coefficient of Concordance. The actual results of their last trial scores were $W = .9574$ and W corrected for ties $= .9681$. As soon as this agreement level was reached, the observers were judged as sufficiently reliable to proceed with the scoring of the experimental tapes.

PROCEDURE: The subjects were tested individually. They were tested in a room which was located on the first floor of the Center for Autism in Flint, mostly used as a store room for physical education equipment. This room was chosen because it was a room whith which the children were not familiar and yet was located on their school grounds.

Each child was assigned a number (from 1 to 8) and all records and observation forms had that number as the identification of each child. Only the principal of the school knew which number corresponded to each child, so that the primary investigator was not able to match records with names or faces.

Each child was seated in a chair in the middle of the room, with the experimenter seated in another chair across from and facing the child. Due to anticipated behavioral difficulties of three children, their teachers accompanied them and sat across from them during the experiment.

The stimuli were presented through a stereo system (the receiver was a KENWOOD KR 4070, and the tape deck was a SANKYO SKD 1000) with two speakers (ADVENT 3) placed on top of two tables, one on the right and one on the left side of the place where the subject was seated. The speakers were placed at approximately three feet above the floor, about the height of the ears of the child. A Sony CCD-V3 videocamera was stationed at an angle to be capturing all behavioral responses of the subject, facing the child from about five feet high. The stereo system was set up well in advance and was activated by the experimenter prior to sitting in the chair.

The test consisted of 12 different auditory stimuli, each one falling under one of the three larger categories of environmental, vocal, and musical sounds. All stimuli were presented on a monophonic basis, in a randomized alternating order, half appearing from the right speaker of the stereo system, and the other half appearing from the left speaker. The environmental sounds that were presented were: a doorbell, telephone ring, baby crying, and plates falling down. The musical sounds were short excerpts from the "Carnival of the Animals" by Saint-Saens, "Chim chim cheree" from Mary Poppins, "I will wait for you" by Vikki Carr, and "Sunfin' USA" by the Beach Boys. These excerpts cover a wide range of music styles, tempi, rhythms, and media performed. In addition to the above auditory stimuli, four vocal/speech excerpts were included, with a male and a female voice speaking various phrases (see Appendix C). All auditory stimuli ranged between 65 to 75 decibels on the A weighting scale. The experimenter used a portable REALISTIC decibel meter and before each testing reconfirmed that the intensity of the auditory stimuli ranged from 65 to 75 dBA.

It was considered important early in the test to show the subjects all the different stimulus conditions which were presented. As a result, the experimenter intentionally chose not to randomize the sounds presented, but to form a pseudorandom scale where all stimuli were presented in a prearranged formation (see Appendix C). However, the auditory stimuli did appear in a random order from either the left or the right speaker, having previously been determined by a flip of a coin. There was a brief training procedure in which the child was told explicitly what was expected of him/her during the actual testing. Once the testing had begun the child was given minimal additional verbal instruction.

All trials were videotaped in the order that the testing occurred. The children came in a different order for each testing session to help assure that any bias from the observers might be minimized. Each child was tested three times on an individual basis. Due to unforeseen illnesses and absences of the children from the school, two subjects were tested only twice while the other six participated in all three trials. The testing lasted about 8 minutes from the time the child entered the room until he/she left the room after the testing was over. The actual response time which was recorded was about 6.5 minutes, during which all auditory stimuli were presented. Verbal instructions were kept to a minimum.

RECORDING: A behavioral observation test was used to gather data. The data collected was all evoked responses to the auditory stimuli presented during the testing sessions. The observation scale which was used was constructed by Buehler and Richmond (1963) and was revised by the experimenter in order to suit the needs of this study as best as possible.

Nine possible behavioral responses were listed on the rating sheet in order to delimit the large array of possible behaviors to record and thereby reduce the anxiety of and increase the efficiency of the scorers (see Appendix B). The behavioral observation scoring sheet consisted of three main categories: biochemical responses, motor development responses, and speech. Each one had several subcategories. The biochemical responses referred to responses of affect (i.e. giggling, laughing) and body contact responses (i.e. extending arm to touch experimenter). The motor development responses referred to responses such as changes in posture (i.e., postural shifts within the limitations of the chair), movement (i.e. any limb movement within the limitations of the chair), eye-movement (i.e. any eye contact with the sources of the auditory stimuli), gesture (i.e. any gesture made in reaction to the stimulus presented), and locomotion (i.e. any movement away from the chair). The third category of behavioral observations was the speech responses, which included any sound responses (i.e.

vocalizations with no meaning), and verbal responses (i.e. any utterances or words with meaning) (see Appendix B).

The observers selected a response category when they believed that the child had emitted a behavioral change elicited by the sound. Each observation was locked in time units, each being 10 seconds long and with 3 time units for each auditory stimulus presented. Each stimulus was 20 seconds long and was followed by 10 seconds of silence that accounted for any latency period reactions in part of the child. Each behavioral change was checked on the rating sheet within the 10 second period during which it occurred, and within the particular auditory stimulus presented. The same three observers recorded responses on all three trials of the eight children. For each behavioral response, a check mark was given on the observation sheet. Each response was counted as 1, and no response as 0. When the data of the three observers were added, the responses that were marked by all three of them received a measurement score of 3, which suggested a strong behavioral response. The responses marked by two of the observers totalled 2, and were regarded as moderate behavioral responses. The reponses marked by only one of them received a 1, which suggested a weak behavioral response. Then, the data were added for all three trials for each of the eight autistic children. For example, if all three judges observed a specific behavior (e.g, eye-movement) during the first 10 seconds of a particular auditory stimulus in all three trials, the measurement score of the child in the eye-movement behavioral category for that particular stimulus would be 9.

Since two of the autistic children were tested only twice, the investigator calculated the average measurement per trial by dividing by two, whereas the total data collected from the testing of the other six subjects were divided by three.

CHAPTER IV

ANALYSIS OF DATA

BASIS FOR THE STATISTICAL ANALYSIS:

Various reasons justify for use of nonparametric statistical tests for the analysis of the data. One main reason was the small sample of autistic children that participated in the experiment. Another important reason was that the data gathered was of ordinal measurement level. The measurement scale used in each of the three trials was 0 - 3 points, depending on the degree of responsiveness of the subject for each auditory stimulus presented. Each subject collected:

0 points for no observed behavioral response

1 point for a weak behavioral response

2 points for a moderate behavioral response

3 points for a strong behavioral response.

The degreee of responsiveness of the subjects was categorized as weak, moderate, or strong, depending on how overt or obvious was the behavioral response to each of the three judges. The validity of this measurement scale is justified by the high level of agreement (95 %) of the three judges, reached during the pre-testing trials.

Once the three trials were added together, the measurement scores became larger, yet the scale remained the same: the larger the score, the stronger the response, the lower the score, the weaker the response.

A third reason that nonparametric statistical tests were used for the analysis of the data was that the subjects of this group could not be assumed to represent a normal population distribution.

RESULTS

General:

Table 1 lists the total number of responses of all subjects in each of the nine behavioral categories during all trials for each of the 12 auditory stimuli.

Table 1.

Distribution of Response Types Elicited by Each Sound Stimulus

	Behavioral Responses									
Stimulus	1	2	3	4	5	6	7	8	9	Total
A(m)	6	9	7	138	161	2	26	15	3	367
B(e)	10	16	12	138	148	4	30	40	14	412
C(s)	5	8	8	149	148	4	29	49	17	417
D(m)	8	13	9	139	137	7	32	29	5	379
E(e)	2	12	14	110	130	1	50	30	8	357
F(s)	6	2	15	132	135	3	44	45	16	398
G(e)	4	9	12	107	105	5	85	30	6	363
H(m)	10	0	10	103	104	13	72	27	7	346
I(s)	4	9	19	102	91	7	86	34	4	356
J(m)	12	0	7	106	98	9	84	22	3	341
K(e)	13	12	9	94	95	1	63	40	0	327
L(s)	11	6	17	91	92	8	75	30	0	330

Note. Response definition: 1=affect, 2=body contact, 3=posture, 4=movement, 5=eye movement, 6=gesture, 7=locomotion, 8=vocal, 9=verbal. Stimulus definition: A=Saint-Saens, B=Doorbell, C=Male voice, D=Chim-chim-cheree, E=Baby crying, F=Female voice, G=Plates falling, H=Vikki Carr, I=Male voice, J=Beach Boys, K=Telephone, L=Female voice. Stimulus types: (m)=music, (e)=environment, (s)=speech.

Movement, eye movement, locomotion, and vocal were the most predominant responses for all 12 auditory stimuli. Overall, there were slightly fewer responses towards the end of the testing, with the lowest total number of responses during the telephone ringing stimulus. Interestingly, the telephone ringing stimulus received the highest measurement score in the affect category and among the highest scores in the body-contact behavioral category. The stimulus with the highest total measurement score was the first spoken material stimulus by the male voice (see Appendix C).

Another interesting observation is the decreasing measurement scores in the movement and eye-movement categories and the increasing measurement scores in the locomotion category as the testing progressed. This observation can be easily seen in the second graph (figure 2). One can speculate that the decreasing behaviors of movement and eye-movement might imply the fatigue of the autistic subjects toward the last part of the testing session, and the increasing behaviors of locomotion might be a manifestation of their short attention span. Another observation one can make is that the total measurement scores decreased toward the last part of the testing, and the stimuli that appeared toward the end received the lowest scores of behavioral responses (see figure 4).

Another observation one can make by looking at Table 1, is that in the sixth behavioral response type, gestures of explicitly pointing toward the speakers, the largest number of responses fell under the musical auditory stimuli. The music stimulus that received the most responses was the song "Chim-chim-cheree", the only "children's" song on the tape.

The following graphs represent the total measurement scores of all subjects in the three main behavioral categories: figure 1 outlines the total measurement scores of the two biochemical behavioral categories, figure 2 outlines the total measurement scores in the five motor development categories, and figure 3 the measurement scores in the speech behavioral categories. Figure 4 respesents the total measurement scores in all nine behavioral categories of all subjects.

In addition, further observations can be made from Table 2, which lists the average per trial of the total number of responses of each subject to each one of the 12 auditory stimuli. Table 3 lists the means of the measurement scores of all subjects to each of the 12 auditory stimuli.

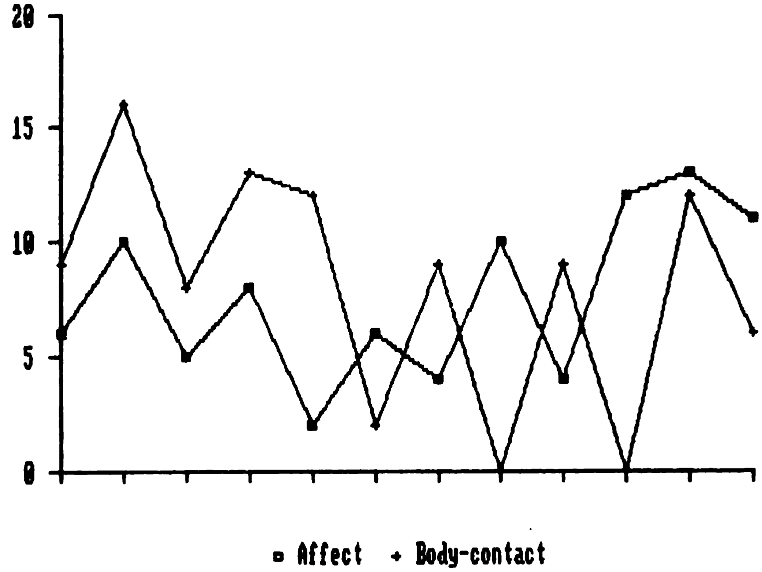

Figure 1. Total Measurement Scores of Biochemical Responses to Each of the 12 Stimuli in the actual order of Presentation during testing.

Figure 2. Total Measurement Scores of Motor Development Responses to Each of the 12 Stimuli in the actual order of Presentation during testing.

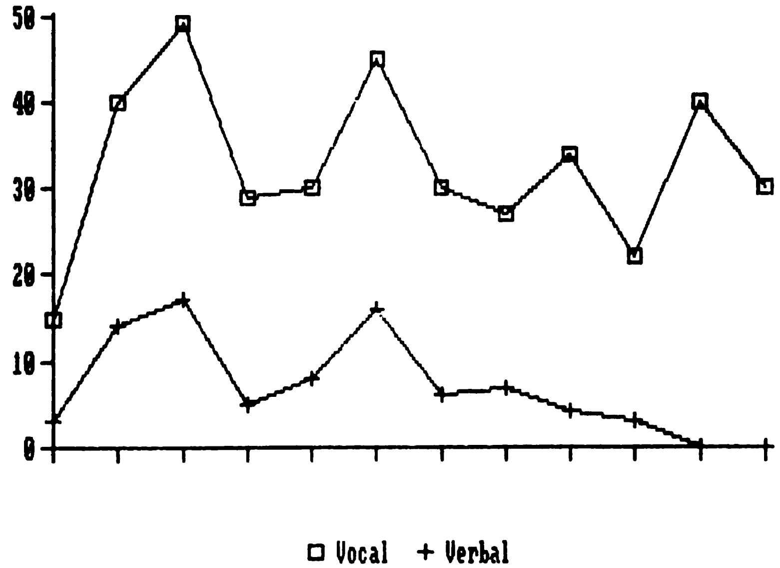

Figure 3. Total Measurement Scores of Speech Responses to Each of the 12 Stimuli in the actual order of Presentation during testing.

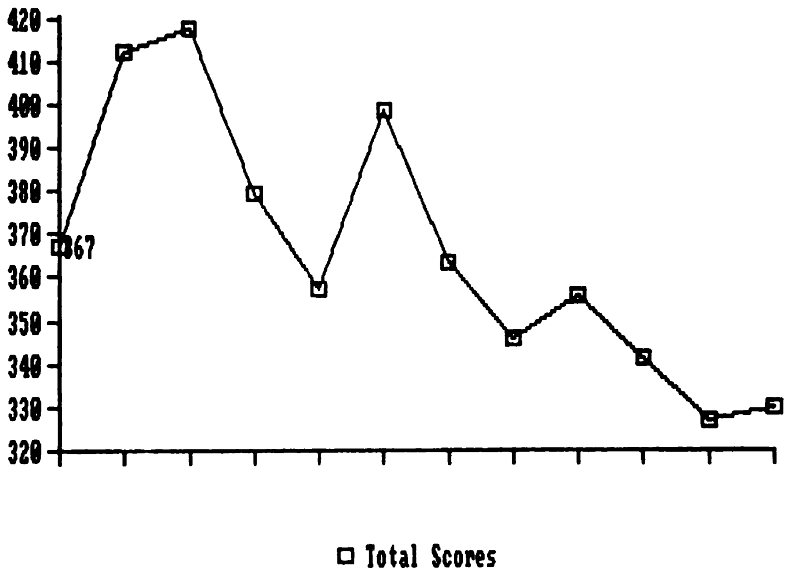

Figure 4. Total Measurement Scores of all Behavioral Responses to Each of the 12 Stimuli in the actual order of Presentation during testing.

Table 2.

<u>Distribution of Average per Trial Measurement Scores of Subjects to Each Auditory Stimulus.</u>

Stimulus	Subjects 1	2	3	4	5	6	7*	8*	Total
Music									
A	18.3	15	18	14.3	18.3	17	17	15.5	133.4
D	16	18.3	16.3	12.3	18.3	17	20.5	22.5	141.2
H	14.3	17.3	20	14	14	17	16.5	12	125.1
J	18	18.6	18.3	14	10.6	11	13	12.5	116
Environ.									
B	19	18.3	20.6	10.6	19	18	21	21.5	148
E	15	19	18	12.6	17.6	14	21	16	133.2
G	16.3	17.6	18.6	11.3	18	18	15	15	129.8
K	15.3	19	16.3	14.6	11.6	19	18.5	14	128.3
Speech									
C	21	20	21.3	14	14.3	19.6	20.5	24	154.7
F	17.3	20.3	19	13.6	17.3	19	16	22.5	145
I	14.3	17.6	17.3	15.3	11	19.6	21.5	9	125.6
L	18.6	19.3	16.6	10.6	10.6	23.5	15.5	13	127.7

<u>Note</u>. Stimulus definition: A=Saint-Saens, B=Chim-chim-cheree, C=Vikki Carr, D=Beach Boys, E=Doorbell, F=Baby crying, G=Plates falling, H=Telephone, I=Male voice, J=Female voice, K=Male voice, L=Female voice. *Subjects tested only twice.

Table 3.

Means of Measurement Scores of all Subjects to Each Auditory Stimulus.

	M	*SD*	MIN	MAX
Saint-Saens	16.7	1.6	14.3	18.3
Chim-chim-cheree	17.6	3.0	12.3	22.5
Vikki Carr	15.6	2.5	12.0	20.0
Beach Boys	14.5	3.3	10.6	18.6
Doorbell	18.5	3.4	10.6	21.5
Baby Crying	16.6	2.8	12.6	21.0
Plates Breaking	16.2	2.4	11.3	18.6
Telephone Rings	16.0	2.7	11.6	19.0
1st Male Voice	19.3	3.5	14.0	24.0
1st Female Voice	18.1	2.7	13.6	22.5
2nd Male Voice	15.7	4.2	9.0	21.5
2nd Female Voice	16.0	4.5	10.6	23.5

Note: MIN = Minimum measurement scores among all subjects.

MAX = Maximum measurement scores among all subjects.

From Table 2 one can make various observations. The four stimuli with the higher number of responses of all eight subjects added were: the first male voice, the doorbell, the first female voice, and the song "Chim-chim-cheree" (in numerical order). The stimulus with the least number of responses was the song by the Beach Boys, "Surfin' USA". Additionally, Table 3 shows that the auditory stimulus with the largest deviation from the mean was the second occurrence of the female voice, which also was the last stimulus presented during the testing. The excerpt from the 'Carnival of the animals' by Saint-Saens obtained scores that deviated the least from the mean. This was the first stimulus presented. The auditory stimulus with the highest mean score was the first occurrence of the male voice, and the stimulus with the lowest mean score was the excerpt from 'Surfin' USA' by the Beach Boys. An interesting observation is that the mean scores with the least variation were the ones pertaining to the environmental sounds. All maximum scores fell within two standard deviations above the mean. The minimum scores deviated more below the mean and some exceeded two standard deviations below the mean. The doorbell, the plates breaking, and the musical excerpt by Saint-Saens were the stimuli with minimum scores below two standard deviations from the mean. The following table, no. 4, lists the total number of responses in each behavioral category of each subject individually, and table 5 lists the means of the responses of the subjects in each behavioral category.

Table 4.

Distribution of Total Measurement Scores of the Subjects in Each Behavioral Category.

	Subjects								
Responses	1	2	3	4	5	6	7*	8*	Total
Affect	17	10	17	9	13	1	24	0	91
Body-cont.	25	2	0	0	33	0	33	3	96
Posture	12	4	18	1	20	67	5	12	139
Movement	99	156	246	292	128	219	147	104	1409
Eye-movt.	104	160	224	171	199	262	184	140	1444
Gesture	3	6	35	0	0	11	1	8	64
Locomotion	229	175	39	0	144	0	8	81	676
Vocal	115	144	5	0	10	37	33	47	391
Verbal	5	0	77	0	0	1	0	0	83

* Subjects tested only twice.

From table 4, one can easily see that the major number of responses fell under the movement and eye-movement behavioral categories. Even though most responses that occurred were movement or eye-movement reactions to the stimuli presented, each child had his/her unique ways of responding. Some did respond vocally, whereas others did not. Some showed affect changes during some stimuli, whereas others did not.

Table 5.

Means for Total Measurement Scores per Subject for all Three Trials in Each Behavioral Category.

	M	SD	MIN	MAX
Affect	11.37	8.19	0	24
Body Contact	12.00	15.42	0	33
Posture	17.37	21.14	1	67
Movement	173.90	70.50	99	292
Eye-movement	180.50	49.10	104	262
Gesture	8.00	11.61	0	35
Locomotion	84.50	88.50	0	229
Vocal	48.90	53.00	0	144
Verbal	10.38	26.98	0	77

Note: MIN = Minimum measurement scores among all subjects.

MAX = Maximum measurement scores among all subjects.

From table 5 one can make other observations as well. The behavioral category 'gesture' had the lowest mean and the 'eye-movement' had the highest. This could be expected since the autistic child often has difficulties in being direct, and the 'gesture' category referred to the specific gestures made by the child toward the speakers, either by pointing or going to the speakers in close relation to the sound stimulus presented at that time. The scores that deviated the most from the mean were in the 'locomotion' category. This seems rather natural since within a group of autistic children variation in movement activity and attentive behavior is expected. Some children prefer to sit still in their chairs, whereas others do not. The individual characteristics along with the severity of the autistic behaviors of each autistic child, could be the reasons why some children responded more overtly than others, some were more vocal than others, and some were more active than others.

Table 6 shows the total number of responses of all subjects in each of the main three behavioral categories during each of the three main auditory stimulus types.

Table 6.

Distribution of Total Measurement Scores on Each Main Behavioral Grouping to Each of the Main Auditory Stimulus Types.

	Behavioral Categories			
Stimulus	Biochemical	Motor-development	Speech	Total
Musical	58	1262	111	1431
Environmental	78	1218	168	1464
Spoken material	51	1252	195	1498

A rather interesting observation one can make by looking at Table 6 is threefold: (a) the highest total measurement score in the biochemical behavioral category was received during the environmental auditory stimuli, (b) the highest total measurement score in the motor development behavioral category was received during the musical auditory stimuli, and (c) the highest total measurement score in the speech behavioral category was received during the spoken auditory stimuli. In addition, the highest total measurement score of behavioral responses was received during the spoken auditory stimuli.

The last table, Table 7, lists the means of the total number of behavioral responses and the total number of scores in all auditory stimuli of all eight autistic children.

Table 7.

Means of Total Measurement Scores for Behavioral Response Categories and for Auditory Stimulus Types.

	N	*M*	*SD*	MIN	MAX
Behavioral Responses	9	488	568	64	1444
Auditory Stimuli	12	366.08	30.06	327	417

Overall, the subjects responded more frequently by either moving their body or turning their head or eyes toward the speakers, than by any other type of behavioral response. As shown in Table 6, the largest number of responses fell under the motor development category for all three sound stimulus types. Since the mean score of all auditory stimuli was $\underline{M}$ = 366.08 with a standard deviation $\underline{SD}$ = 30.06, one can see that the stimulus with the highest number of responses (first occurrence of the male voice = 417, Table 1) fell beyond one standard deviation from the mean. On the other hand, the telephone rings received the lowest number of responses and fell below one standard deviation from the mean. So, all scores ranged within two standard deviations from the mean at both ends. In addition, the total number of behavioral responses in the nine behavioral categories ranged within one standard deviation below the mean to two standard deviations above the mean, with the 'eye-movement' category being farthest from the mean. An interesting observation that one can make from Table 6 is the difference in responses in the speech category. During the environmental sounds and the spoken material, more vocal and verbal responses occurred, while during the musical stimuli fewer vocal and/or verbal responses were emitted by the subjects. One can speculate that this could be because the autistic child tended to listen to the musical stimuli more attentively than to the other two auditory stimuli.

<u>Results as a function of age, gender, and functioning level.</u>

Statistical analysis was applied to the scores of all subjects. The investigator selected the .10 level of significance as the criterion for this study. For comparison reasons several groupings and pairings were made. First, the group was divided into two subgroups based on the age of the autistic children. The younger group (YS) consisted of four children, ages 7 to 10 years old, and the older subgroup (OS) consisted of four children, ages 11 to 14 years old. A Mann-Whitney "U" statistic was calculated between the two groups for the total mean score on the combined three factors: music, environmental, and spoken stimuli. With regards to the overall frequency of responsivity to the three auditory stimuli, the differences between the groups were significant at the .10 level ($U = 2$, $n = 4$, $p = 0.057$). These results show that the two subgroups of children responded differently to the stimuli presented during the testings. To explain, the younger-aged group tended to respond more overtly to the auditory stimuli than the older-aged group. Thus, the differences seen in the performance of the groups can be attributed to the differences in their ages. The nonparametric Spearman Correlation Coefficient was used to correlate subjects' age with their fluency in making responses. The rho corrected for ties was -.518, and even though it did not obtain significance at the .10 level ($p = .524$), it

Table 8.

Average Scores - Work-up for the Mann-Whitney "U" Test.

ID	AGE	GENDER	IQ	Average Score
1	9	M	20	203
2	10	M	19	219
3	9	M	89	220.3
4	14	M	32	157.6
5	12	M	20	182.3
6	7	F	39	201.5
7	13	F	40	217.5
8	14	F	23	197.5

Note: M= Male, F= Female.

was rather close. These results showed that as age went up, the number of responses emitted by subjects went down.

The autistic group was also divided into two subgroups by their functioning level. The teachers of the children rated them as higher- or lower-functioning based on their everyday living skills, social skills, and communicative skills. One of the subgroups consisted of four lower-functioning autistic children (LF), and the other consisted of four higher-functioning autistic children (HF). The Mann-Whitney "U" test was computed, but no significant differences were found in the overall average number of behaviors emitted by the high- and the low- functioning autistic groups. Also, no significant difference was found in the average number of behaviors emitted by each group in the three auditory stimulus categories of music, environment, and spoken material ($U = 7$, $U = 6$, and $U = 5$, respectively). The Spearman correlation coefficient was also used to compare subjects' IQ score with their number of responses. The obtained correlation was low, and not significantly different from 0. The functioning level of an autistic child does not seem to play a primary role in the overall performance during the testing. Any differences that were observed might be due to other factors and not primarily to the subjects' functioning level.

The last grouping was done on the basis of gender, and so one group consisted of five autistic boys and the other of three autistic girls. The Mann-Whitney "U" was computed, but the results did not show a significant difference in the average number of behaviors emitted by the male and female autistic children. Also, no significant differences were found in the average number of behaviors emitted by the subjects of each group in the three auditory stimulus categories, music, environment, and spoken material ($U = 7$, $U = 4$, $U = 5$, respectively). Thus, any differences that were observed in the performance of the male and female autistic children during the testing, might not be attributed to their gender, but to other factors as well.

CHAPTER 5

DISCUSSION

Various researchers have investigated and established with their studies that autistic children show a strong interest in music and rhythm (Sherwin, 1953; Pronovost, 1961; Cain, 1969; Viscott, 1970; Kanner, 1971; Thaut, 1987). The initial purpose of this study was to explore the ability of school-age autistic children to respond overtly to familiar and novel auditory stimuli: musical, environmental, and spoken material. One main finding of this study was that autistic children favored the motor development responses. Thus, they responded to the sounds more overtly by the use of their body. They moved their heads, turned their bodies, or just shifted their eyes toward the speakers. Sometimes, they even left their chairs to move toward the speakers. The vocal and verbal responses were significantly more prevalent when the autistic child was young (ages 7 to 10), whereas the older children tended to respond verbally less often. The lower functioning children tended to touch the experimenter more frequently during the testing, but that behavior was not so frequent in the higher functioning group. No differences were seen between the responses of female and male autistic children. Gender does not seem to play a big role in the behavioral responses of autistic children to auditory stimuli. As seen from the statistical analysis of the data, significant differences were found only between the two age groups, older (11-14 years old) and younger (7 - 10 years old) autistic children. During the testing, the older children seemed more hesitant to react overtly, left their chairs fewer times to move toward a speaker, and tended to be quiet rather than verbal. On the other hand, the younger children moved more freely around the room, vocalized more often, touched the experimenter more frequently, and were more overt in their behavioral expressions in response to the auditory stimuli. A reason for these differences might be that older children have learned to be more attentive and to have more of a "classroom" attitude, whereas younger children are still in the process of learning to attend and focus on one task. Another reason might be that the nature of younger children in general is to be more overt and outgoing, and older children to be more in control of their behaviors.

From the three categories of auditory stimuli presented during the testing, no one category seemed to be favored. The greatest number of responses were exhibited in the first occurrence of the male voice, the doorbell ring, the first female voice, and the song "Chim-chim-cheree" from the movie Mary Poppins. The auditory stimulus that received the least number of responses was the telephone ringing, which apparently did not interest the autistic subjects as much as the other stimuli presented. Differences in behavioral responses were seen during the testing, such as moving the feet or tapping their knees during the musical examples. The difference between the behavioral reactions of the autistic children to the music as compared to environmental or verbal sounds can be seen in the scores received in the 'gesture' category, in which music received a total of 31, environmental sounds received a total of 11, and spoken material received a total of 22. These results coincide with the belief that autistic children show a strong interest in music and rhythm.

In the original design of this study, the investigator also wanted to see if autistic children favor the left or the right ear when attending to auditory stimuli. The stimuli presented during the testing were monophonic, and were presented either from the right or from the left speaker. Due to unanticipated difficulties, mainly during the rating of the videotaped testing sessions, data for this research question was not gathered. The experimenter had not foreseen the difficulty for the observers to observe behavioral responses within 10-second locked time-units, and at the same time observe whether the child was attending to the stimuli from the right or the left ear. A suggestion for future research on the issue would be to incorporate it in the observation sheet, so it would be easier for the observers to mark the responses. The videotaping equipment presented an additional difficulty. The stand on which the videocamera was set was about five feet high, and the lens was not a wide-angle lens. As a result, in the videotapes that the observers saw, the speakers were barely within the frame, and it was difficult to get a fuller view of the room. Thus, it is suggested for further research to use a videotaping procedure that will allow for a view of the whole room.

However, the investigator made a notable observation. One of the subjects, a 10-year-old, high-functioning, autistic boy insisted on moving his chair next to the right speaker, from the very outset of the testing. As soon as he heard the first stimulus, which appeared from the right speaker, he would stand up and move his chair next to the right speaker. During the stimuli that were presented through the left speaker, this boy turned his head or pointed to the speaker and asked the experimenter to tell him where the stimulus was coming from. He never moved to the left speaker, or acknowledged that some stimuli did appear through the left speaker. Nevertheless, during the stimuli that appeared through the right speaker, he leaned his body as close to the speaker as he could and placed his ear on the speaker, showing great interest and pleasure. This observation contradicts Blackstock's (1978) finding that autistic children attend to auditory stimuli mainly with their left ear, yet one can not reach a conclusion by the responses of only one autistic child. This issue requires further investigation in order to understand the tendency of autistic children to hear in a unilateral manner.

Overall, all autistic children who participated in this study were able to attend during the experiment without assistance and seemed to enjoy themselves. However, during the study several unforeseen problems were encountered, uncontrolled factors that might have affected the results. As mentioned earlier in the study, the room that was used for the testing was the physical education office and store room. Therefore, various instruments and equipment, which the investigator was not able to remove, were placed in this room during the testing. This presented a problem, since it provided additional distraction for the children. At the same time, this room was located close to the gymnasium, and as it was not sound proof, various extraneous sounds were able to penetrate and possibly affect the performance of the autistic subjects. Several other uncotrolled for factors, which were beyond the power of the investigator to control, were: the schedule of children's classes which sometimes conflicted with the testing, absences of children due to illnesses, late replies of parents to the request of the investigator for their child to participate in the experiment, and intervention by teachers and insistance on being present during the testing when they felt that the child might present behavioral problems.

The initial purpose of this study was to explore the ability of school-age autistic children to orient themselves and respond overtly to auditory stimuli: musical, environmental, and spoken material. Although the analysis did not show a significant difference in the total number of responses of the autistic children to the musical, environmental, and spoken material, the investigator made the various observations that were presented in the previous pages. These were felt to have supported the evidence of an interest by autistic children in music. Studies mentioned in previous chapters have found that autistic children exhibit a great interest in music and rhythm. However, most of these studies had focused on the actual interest and not the reasons for this peculiarity of autistic children. This study attempted to investigate whether this interest was a generalized auditory perceptual characteristic of autistic children or an exclusive interest in music. The results, however, were not conclusive enough to make any speculations with confidence.

If this study is replicated, several of the uncontrolled factors should be taken into consideration and controlled, and additionally, a larger number of subjects would make the study more valid. An additional category to the behavioral responses in the observation form that could prove beneficial, is the quieting response to auditory stimuli. During various testings, some of the autistic children did respond to auditory stimuli by quieting and becoming more attentive, but when the data was collected, this quieting response was not accounted for in the observation form that was used in the study. Thus, the investigator believes that in future research, the addition of a quieting behavioral category could be very beneficial. Another idea for future research would be to use longer auditory stimuli for each of the three auditory categories, in order to see during which stimuli the autistic child would remain attentive for a longer period of time. The observation form to be used for such an investigation would have to be different from the one used in the present study. Other possibilities that merit further consideration for future research are: the length of auditory stimuli presented, the length of the latency period following each stimulus, the order of stimuli appearances, and the number of repeated testings. Through changes in these areas, factors such as attention span, interest level, and level of expectation may be better controlled for.

Prior to the study, the investigator had various questions in mind, some of which still remain unanswered. Many more questions were raised during and even after the completion of the experiment. The unusual sensitivity and attention of autistic children toward music is an intriguing behavior that has captured the attention of many researchers (Cain, 1969; Hoolander & Juhrs, 1974; Thaut, 1987). Further investigation and experimentation is required in order to begin to understand the origins of this behavior and its importance to the syndrome of autism. This might eventually lead us a step closer to the inner life of the autistic child.

APPENDIX

APPENDIX A

PARENTAL CONSENT FORM

Dear Parent,

I am writing to ask your permission for your child to participate in my Auditory Awareness Testing Project. This is a research study within my thesis work for the Master's degree in Music Therapy. The study is supervised by R. Smeltekop, Chairperson of the Music Therapy Department at Michigan State University.

The objective of my study is to see how autistic children respond to various familiar and novel auditory stimuli and whether they respond more overtly to any of the three categories: environmental, vocal, and musical sounds. To accomplish this your child will be asked to participate in three individual sessions, each one a week apart, where the child will be asked to listen to 12 taped sounds. The sessions will be videotaped and will be viewed by three observers for purposes of data collection only.

This study has already been explained to the principal of your child's school and to his/her classroom teacher, and it has been approved by both. Your support would be most helpful for a deeper understanding of music in Special Education and Therapy.

Therefore, I would be very thankful if you would also approve, and indicate this by signing and returning the consent form below to your school.

Yours Sincerely,

Dimitra Akogiounoglou, RMT-BC
Graduate student in Music Therapy

Roger Smeltekop, RMT-BC
Chairperson, Dept. of Music Therapy

AUDITORY AWARENESS TESTING PROJECT CONSENT FORM

I have read the explanation above and hereby give my consent for my child to participate in your study. I understand that my child is free to withdraw from the study at any time. I understand that my child will remain anonymous and that his/her responses will remain confidential. I understand that the videotapes will be viewed only for purposes of data collection and that all will be erased at the end of the study. Within these restrictions, I understand that when the study is completed, the summary of the final results of it will be made available to me upon my written request to the school.

Signed____________________________________
Date______________________________________
Child's name______________________________
Teacher's name____________________________

APPENDIX B

ID ______________________________ DATE ________________________

Observer ________________________ Testing Trial ______________

OBSERVATION FORM FOR BEHAVIORAL RESPONSES OF AUTISTIC CHILDREN TO AUDITORY STIMULI

	#1			#2			#3			#4			#5			#6			
	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	
AFFECT																			AFFECT
BODY CONTACT																			BODY CONTACT
POSTURE																			POSTURE
MOVEMENT																			MOVEMENT
EYE-MOVEMENT																			EYE-MOVEMENT
GESTURE																			GESTURE
LOCOMOTION																			LOCOMOTION
VOCAL																			VOCAL
VERBAL																			VERBAL

	#7			#8			#9			#10			#11			#12			
	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	
AFFECT																			AFFECT
BODY CONTACT																			BODY CONTACT
POSTURE																			POSTURE
MOVEMENT																			MOVEMENT
EYE-MOVEMENT																			EYE-MOVEMENT
GESTURE																			GESTURE
LOCOMOTION																			LOCOMOTION
VOCAL																			VOCAL
VERBAL																			VERBAL

APPENDIX C

AUDITORY STIMULI LISTED IN THE ORDER OF PRESENTATION

STIMULUS

#1 Excerpt from "Carnival of the Animals" by Saint-Saens

#2 Doorbell Rings

#3 Male voice: "Hi, there! I'm really glad you're here. How are you today? I hope everything is going well with you. Thank you for participating and taking the time to listen to my tape. I really hope you enjoy yourself."

#4 Excerpt from "Chim-chim-cheree" from Mary Poppins

#5 Baby crying

#6 Female voice: "Did you have a fun day at school today? My day has been very nice. I came over to the school from Lansing early this morning. The weather outside is so warm. So much sunshine!"

#7 Plates falling and breaking

#8 Excerpt from "I will wait for you" by Vikki Carr

#9 Male voice: "Have you made plans for the summer? What will you do? I enjoy swimming a lot and I like sitting on the beach. Do you enjoy sitting in the sun? I also enjoy going on picnics and being out in the woods."

#10 Excerpt from "Surfin' USA" by the Beach Boys

#11 Telephone ringing

#12 Female voice: "I appreciate the time that you have given to help me with my project. I would like to thank you once again for participating, and I hope you have a nice day. I'm glad I got the opportunity to meet you. It's been really great!"

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