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ABSTRACT

This review of the literature provides summaries of the genetic, neurophysiological, and biochemical approaches to understanding autism, with special reference to neuroanatomic, cognitive, and neuropsychological studies of this disorder. Available instruments for the assessment of autism and various treatment alternatives including drug therapy, behavior modification, ethological approaches, and facilitated communication are briefly described. It is concluded that, although there is a lack of congruent data in the research on autism, evidence does suggest that autism is a neurologic syndrome. (Contains 87 references.) (DB)

Current Approaches to the Understanding of Early Infantile Autism

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Running Head: INFANTILE AUTISM

Introduction

Early infantile autism is a behaviorally defined syndrome, fast becoming a neurologic one, that is manifested before the age of 30 months. This syndrome is characterized by "impairments in reciprocal social interaction, verbal and nonverbal communication, imaginative activity, and a markedly restricted repertoire of activities and interests" (American Psychiatric Association, 1987). More specifically, autistic individuals usually present with abnormal responses to sensory stimuli, people, events, and objects; disordered language and cognitive skills; repetitive and stereotypic motoric behavior; poor eye contact; an insistence on sameness; and a normal physical appearance. The incidence of this disorder is estimated to be approximately 4 to 5 in 10,000 births, boys being more commonly affected than girls - 3:1 or 4:1 in most studies (Rutter, 1978). Since Kanner's original description of autism in 1943, in which he studied 11 children who presented with a profound isolation from other people (Kanner, 1943), a proliferation of research into the underlying cause(s) of this disorder has ensued.

Several researchers (for example, Kanner, 1943; Bettelheim, 1967) have proposed psychogenic causation of infantile autism. Kanner attributed this disorder to an "inborn autistic disturbance of affective contact", perhaps the result of cold and distant parenting, yet noted that his subjects were alone from the beginning of life, thereby making it difficult to attribute the whole picture of autism exclusively to the type of parental

relations (Kanner, 1943).

Bettelheim (1967) also argued that parental influence plays a role in the development of autism, stating that "an unrealistic ideal - that of the perfect infant-mother symbiosis" - is possessed by the mother, and that an infant's rejection of the mother "can develop into chronic autistic disease if the mother, in response, counterrejects the child" (p. 70).

With the advent of non-invasive techniques, and quite possibly due in part to a reaction to the psychogenic school-of-thought, a large body of literature concerning biological causation of autism has been generated. Researchers in the fields of biochemistry, genetics, neurophysiology, and neuropsychology (to name just a few) have provided much data concerning the development of autism and associated neurologic abnormalities. As with many other behaviorally defined syndromes, this literature is often conflicting; yet the bulk of this data seem to suggest that, as stated earlier, autism is fast becoming a neurologic syndrome. This paper will provide brief synopses of the genetic, neurophysiological, and biochemical approaches to the understanding of autism, with special reference granted to neuroanatomic, cognitive, and neuropsychological studies of this disorder.

Genetic Approach

In an effort to elucidate to the reader the extent to which genetics research has investigated the possible etiological agents contributing to autistic disorder, let us now briefly

examine some relevant studies. Folstein and Rutter (1977) suggested that autism may be inherited as a predisposition to a variety of cognitive abnormalities generally involving language difficulties of some kind and not just autism itself. Studies have suggested that some cases of autism are associated with the fragile X syndrome, which is a sex chromosome anomaly reported to occur in approximately 0.9 per 1,000 live male births (Brown et al., 1982). This condition is referred to a "fragile X syndrome" simply because genotypically, it appears as a fragile site on the X chromosome. Phenotypically, fragile X syndrome has manifested in physical anomalies such as large ears (macroorchidism), yet many fragile X patients do not have any distinguishing features except for their behavioral dysfunction (Reiss et al., 1986). Investigations of abnormal behavior patterns in patients with fragile X syndrome have described from 4 to 60 percent of affected males as autistic (Turner et al., 1980; Brown et al., 1982; Levitas et al., 1983). One study (Watson et al., 1984) reported the presence of the fragile X syndrome in four (5.4 percent) out of 76 autistic males. The significance of increased chromosome breakage in autistic children is unknown, however, this anomaly is seen in several viral infections and is secondary to ionizing radiation and certain drugs (Jackson and Schimke, 1979), thus supporting an environmental-determinant view of etiology.

Autism has also been associated with phenylketonuria (PKU), an inherited recessive disorder caused by a lack of phenylalanine

hydroxylase, which is an enzyme that converts phenylalanine to tyrosine. This condition is more prevalent in those of Scotch-Irish descent (1 in 5,000) and rare in blacks (1 in 300,000). The disease is present at birth, with complications (e.g., demyelination of neurons, mental retardation, seizures) developing when the infant begins living on a normal diet, due to high levels of accumulated phenylalanine in the blood stream (Ferguson, 1984). Decreased amounts of lipid components of myelin in the brains of patients with PKU have also been reported (Prensky et al., 1968). Studies examining animal models have suggested that actual formation of the myelin membrane may not be abnormal in PKU. Instead, damage to the developing brain may occur during the latter stages of neuronal differentiation. In a post-mortem examination of an autistic patient with PKU (Williams et al., 1980), changes in pyramidal cell dendritic spine density were identified. This same type of tissue damage was also identified in the examination of an autistic patient without an identifiable organic condition (Reiss et al., 1980).

Another disorder which results in deficits in myelination is Cornelia de Lange syndrome (CDLS). This disorder is of unknown etiology, has been associated with excess material from chromosome number 3 (Wilson et al., 1978), and manifests in a wide range of physical anomalies. Moderate to severe developmental delays also are characteristic of this disorder (Smith, 1982). In attempting to describe the behavioral phenotype of CDLS, Johnson et al. (1976), found that 10 out of 12

CDLS patients studied clearly met behavioral criteria for autism on all parameters except for age of onset of symptoms, which was not reported.

As in PKU, a common neuropathological abnormality in CDLS is deficient myelination. Ptacek et al. (1963) demonstrated diffuse deficiency in brain myelination in their study of a 17 month-old infant with CDLS. In a post-mortem examination of a 5-month-old infant at the Kennedy Institute for Handicapped Children, deficient and delayed myelination was seen in the basal ganglia (Reiss et al., 1988). Neuropathological reports have described severe developmental damage in CDLS patients including abnormalities of gyral and sulcal size and microcephaly (Ptacek et al., 1963), cytoarchitectural abnormalities of the cerebral cortex (Schlesinger et al., 1963), and pituitary abnormalities (Ptacek et al., 1963).

The above studies suggest that particular genetic disorders are especially likely to cause a pattern of CNS damage that results in the manifestations of the autistic phenotype. While no genetic etiologic agent common to all cases of autism has been identified, most genetic studies suggest that the autistic phenotype is the result of damage to one or more specific functional systems of the brain.

Neurophysiological Approach

The neurophysiological approach to autism has been represented by studies utilizing brain-wave patterns in attempting to determine whether abnormal brain electrical

activity exists. Some investigators in the field of autism research have reported significant asscciations between electroencephalogram (EEG) abnormality and parental complications, impaired speech development, mental retardation, and delayed developmental milestones (Gubbay et al., 1970; Ritvo et al., 1970; Small, 1975).

In an effort to determine the relationship between genetic factors and autism, Tsai et al. (1985) examined 100 EEG patterns of 132 autistic children and adolescents who were admitted to the Iowa Autistic Program over a period of seven years. These investigators attempted to 1) assess the incidence of abnormal EEG diagnosis in this autistic population; 2) identify background factors that may help to distinguish autistic children with a normal EEG from those with an abnormal EEG; and 3) investigate the relationship between genetic factors and EEG diagnoses of autism. Findings from this study suggest that overall, there is no EEG pattern unique to autism: The EEG abnormalities reported were characterized by a variety of abnormal EEG forms, involving bilateral brain hemispheres, with focal abnormalities nonspecific to any region of the brain. Moreover, selected background factors did not predict EEG outcome. One significant finding, however, was that the variable of sex ratio differentiated between two groups of autistics. The group with a normal EEG had a significantly higher boy to girl ratio than that of the group with an abnormal EEG. Tsai et al. speculated that since it has been observed that autistic males appear to have better outcomes

than autistic females (Lotter, 1974), autistic children with normal EEG's would tend to have better outcomes than those whose EEG's are abnormal. This speculation is supported by Small's (1975) study, which found that 42% of the autistics with normal EEG's were within the educable, borderline, or average ranges of intelligence, whereas more that 75% of those with EEG abnormalities on admission were either trainable or of lower ability. Thus, Tsai et al. conclude that EEG diagnoses may be useful criteria in determining individual outcome.

Evoked potential research has been useful in the study of autism, as it appears that different auditory evoked response patterns are being found in children who meet various criteria for the diagnosis of autism as compared to patterns seen in age-matched normal controls. Lelord et al. (1973) presented autistics with light and sound stimuli and found that their auditory evoked responses (AER's) were irregular and variable, whereas the AER's of the age-matched controls were stable and regular. Small (1971) found less complex AER's and visual-evoked responses (VER's) that were of low amplitude, had shorter peak latencies, and were more stable in autistics than in the normal controls. When auditory and visual stimuli were presented together, however, the VER's of the autistic children were more variable than those of the normal children.

In a study of 10 autistic and 12 normal children, Student and Sohmer (1978) found longer auditory nerve transmission latency and longer brainstem transmission time for the auditory

evoked responses of the autistics. Also, 5 of their autistic subjects showed definite peripheral cochlear hearing loss when their AER's were measured. Piggott (1979) speculates that physiologic maturation plays a role in the development of autism, since auditory evoked response patterns in autistics appear to be similar to those seen in much younger control subjects.

Recent studies of event-related brain potentials (ERP's) support the idea that autism involves deficits in information processing. One of the component peaks of the ERP, the P3b, occurs approximately 300 milliseconds after the onset of a stimulus and has been associated with the detection of biologically significant, striking acoustic stimulation, or the speed of stimulus classification (Courchesne et al., 1985). In a study of nonretarded autistic individuals aged 13-25 years, Courchesne et al. (1985) had their subjects press buttons at the occurrence of target stimuli intermixed with unexpected, novel stimuli in addition to expected, nonnovel stimuli. One of their predictions was that unexpected, novel information would evoke greater amplitudes in the P3b component than highly probable "background" stimuli. Findings indicate that auditory stimuli evoked smaller P3b components in the autistic subjects as compared to those of controls, suggesting that nonretarded autistic individuals may have a limited capacity to process novel information. Moreover, N1 components, which are believed to be affected by auditory sensory processing and selective attention (Hillyard & Picton, 1979; Hanson & Hillyard, 1980), were smaller

in the autistic individuals when evoked by auditory stimuli, thereby further substantiating studies implicating information processing deficits in autism.

Neurochemical Research

Perhaps the oldest and best replicated biological finding in the research of autism is that of hyperserotonemia. Hyperserotonemia refers to higher than normal platelet serotonin (5-HT) levels in the bloodstream. Serotonin is a neurotransmitter which acts as an inhibitor of pain pathways in the spinal chord and is believed to help control mood and cause sleep (Guyton, 1987). It is secreted by nuclei that originate in the brain stem and project to many areas of the brain, especially to the dorsal horns of the spinal chord and to the hypothalamus. Ritvo et al. (1970) found an inverse relationship between age and blood serotonin levels in normal children but not in autistic children, who had significantly higher levels. Takahashi et al. (1976) also found a higher mean level of 5-HT in 30 autistics compared to 30 normal children. However, when they made comparisons of individual levels, they found that 1/3 of the autistic children had platelet serotonin levels below the mean of the normal children. Furthermore, in comparing the mean serotonin level of the autistic children with that of a group of nonautistic children with various neurological and psychiatric disorders, they found no significant difference. When ratings of hyperactivity were attributed to the autistic children, Takahashi et al. found higher platelet 5-HT levels in the hyperactive

children as compared to those who were nonhyperactive. This would seem to suggest that serotonin is also associated with hyperactivity. Takahashi et al. concluded that elevated platelet serotonin levels do occur in infantile autism - about 30% of the autistic children in their sample - yet this finding is not specific to infantile autism.

In a recent study of 23 autistic and 10 control subjects aged 6-89 years, Piven et al. (1991) investigated platelet serotonin levels to investigate the genetic implications of elevated 5-HT in autism. They found significantly higher serotonin levels in the five autistic individuals who had a sibling with autism or pervasive developmental disorder as compared to the rest of their sample - those who did not have an affected sibling. This finding led Piven et al. to conclude that while elevated serotonin levels are not necessarily specific to autism, their study offers additional support for a causal relationship between 5-HT and genetic liability to this disorder. These results are consistent with those of the aforementioned genetic studies associating recessive chromosomal abnormalities.

Dopamine, an inhibitory neurotransmitter secreted by neurons that originate in the substantia nigra, has been implicated in schizophrenia primarily due to the clinical efficacy of dopamine receptor blockers as antipsychotics. Dopamine blocking agents have not been found to affect the core symptoms of autism, rather, they only appear to affect hyperactivity, stereotypic behaviors, self-mutilation, and aggressive outbursts (Elliot et

al., 1983). Consequently, research of the dopamine hypothesis as it relates to infantile autism has not proliferated in recent years. One study which is noteworthy, however, is that of Elliot et al. (1986), who found a high correlation between HVA (homovanillic acid, a major dopamine metabolite) and 5-HIAA (5-hydroxindoleacetic acid, the major serotonin metabolite) in the CSF of autistic individuals. As a result of these findings, Elliot et al. have raised the question about whether serotonergic and dopaminergic systems are in opposition of one another.

As a primer to the section of this paper regarding neuroanatomic abnormalities in autism, we will now briefly discuss cellular anomalies found in this disorder. It is arguable that disruption of CNS development during one or more critical stages involved in the establishment of perceptual, motoric, language, and related systems could produce autistic symptoms, if not autistic disorder itself. Abnormalities in brain myelination have been found in the CNS of patients with congenital rubella, a disorder in which up to 12 percent of affected children manifest the autistic syndrome (Reiss et al., 1986). This finding is especially important, since brain myelination occurs at a rapid rate from the last trimester of gestation through the first 2-3 years of life. Reiss et al. (1986) suggest that a "hypothesis of dysfunctional myelination is therefore consistent with the suggestion that CNS damage in autism occurs in the latter stages of brain development, and [the fact that] autistic behavior is usually first noted before 30

months of age.

The few existing studies of neuronal development seem to suggest that abnormalities of this sort do exist in autism. In an autopsy study of 4 autistic subjects, Ritvo et al. (1986) found significantly lower cerebellar Purkinje cell counts as compared to those found in the control subjects. Purkinje cells comprise one of three layers of the cerebellum, functioning primarily in the inhibition of motor impulses arising from the deeper cell layer. This finding led Ritvo et al. to question whether lower numbers of Purkinje cells could exist in all or in a subgroup of autistic individuals, noting, however, that their findings could prove to be artifacts created by methodological limitations of their small data base. Ornitz (1983) argues that brainstem dysfunction is the basis for the constellation of autistic symptoms, in particular, vestibular nuclei and thalamic centers. Dysfunction in these areas is proposed to cause abnormalities in the processing of basic sensory input and motor output, consequently making crucial information unavailable to higher centers, such as cortical areas. Hence, the finding of lower cerebellar Purkinje cell counts in autistic subjects would support Ornitz's theory. Another neuroanatomical model of autism supported by experimental and clinical data which implicates dysfunction of higher cortical centers, such as the temporal and frontal lobes, will be discussed in the sections which follow.

Cognitive Approach

Now let us turn to the research of cognitive scientists,

who, over the last 20 years, have accumulated a large body of evidence suggesting that autism involves perceptual and cognitive impairments. In a review of studies examining the learning and performance in autistic children, Prior (1979) argues that there are three issues central to further the investigation of infantile autism: 1) that there are two subgroups of autistics - those individuals who are mentally retarded and those of borderline or normal tested intelligence - who present with similar behaviors yet differ in their prognosis due to differing levels of language acquisition and verbal expressive skills; 2) that experimental studies of autism contain serious methodological flaws, thereby providing little insight into the specific nature of the disorder; and 3) that the existing data provide support for an hypothesis of abnormal left (language) hemisphere functions in autistic children. In her review, Prior considers several components of cognitive research as they relate to infantile autism, which will be discussed below.

In the area of perception, Prior (1979) notes that "under- or oversensitivity to visual and auditory stimulation is commonly reported [in the literature] suggesting problems of sensory reception" (p. 358). While the theory of perceptual inconstancy in autism (Ornitz, 1969; Ornitz & Ritvo, 1976) has met with little corroborative evidence, research into other information processing difficulties has been fruitful. Frith (1970) found that selective perception in autistic individuals may be impaired, thus leading to idiosyncratic selection and processing

of specific features of material presented for perception and analysis. In support of this finding are studies suggesting hat autistic children are more successful on perceptual tasks such as the Sequin Formboard and the Decroly Matching Game - tasks which require little in terms of stimulus analysis and initiation. Prior interprets this as normal perceptual activity with impaired perceptual analysis, yet cautions that this is also characteristic of young normal children. She states, therefore, that "recourse to developmental explanations is ... indicated" (p 359).

The second area of research into the cognitive abilities of autistics reviewed by Prior (1979) is that of memory. Researchers (Hermelin and O'Connor, 1967) have claimed disabilities in coding based upon equal recall of random material as compared to sentence material among autistics, and greater recall of sentence material over random material in normal subjects. In a replication of this experiment, however, Fyffe and Prior (1978) found that autistic children utilized meaning to facilitate recall, and concluded that autistic children have the ability to use syntax to aid recall. In summarizing her section on memory studies in autism, Prior (1979) states the following:

> ....it may be said that autistic children vary considerably in memory ability even among diagnostically homogeneous groups. Acoustic memory is apparently relatively good. As with other aspects of learning, performance is apparently task-specific and

> very much dependent on developmental and intellectual level since high- and low- functioning children often behave in quite different ways (p. 362).

In a study examining the pragmatic ability of autistics to encode new versus old information, McCaleb and Prizant (1985) videotaped four autistics during interactions with their teachers or speech-language pathologists. Their results suggest that the 4 subjects encoded new information through "lexicalization" in simple word utterances and through "constrantive stress" to highlight new information in multiword utterance. Lexicalization refers to the selection of lexical items to be produced in a referential context, whereas constrantive stress involves drawing the listener's attention to the most salient element in multiword utterances (Hornby & Hass, 1970). Results of this study also indicated that the subjects encoded old information almost as frequently as they encoded new information. According to Prizant (1983), in normal development a child should gradually shift to more frequent encoding of new information *vis-a-vis* a decrease in the use of repetitions that encode old information. Moreover, McCaleb et al. also found that their subjects did not extend topics by commenting about a previously encoded topic and that nontransient information (i.e., concrete objects or pictures of objects) was more frequently encoded. In summarizing their research, McCaleb et al. state the following:

> Autistic individuals to a large extent may process whole situations without distinguishing between

> relevant and irrelevant information. This may result in limited development of an appropriate conceptual base from which to identify what is shared background information and what information is new and needs to be stated or highlighted...however, normative data are needed in future research to determine how autistic children compare to other populations (e.g. unimpaired, language impaired) in terms of encoding new versus old information (p. 237).

There appears to be much agreement in the literature that autistic children are deficient in their ability to imitate others (Goldstein, 1959; Rimland, 1964; Wing, 1976; Levinson & Osterweil, 1984). Prior (1979) points out that it is likely that "this basic, probably innate learning mechanism is lacking from the beginning of life and is a major contributing factor to the deficit in social learning as well as in cognitive development." (p. 364). In training autistic children to imitate behavior, operant conditioning methods, (e.g. successive approximation) appear to be most successful (Loovas, 1966; Hemsley & Howlin, 1976). Imitative behavior and operant conditioning techniques will be further discussed in another section of this paper, however, it should be mentioned at this point that autistic children will rarely imitate others spontaneously, with exception to the repetition of television commercials and echolalic verbalizations.

Prior (1979), in providing a brief synopsis of research into

the coding processes of autistic individuals argues that in comparison to normal children, they are "particularly subject to idiosyncratic, limited, and often stereotyped strategies" (p.364).

Once an intensively pursued hypotheses, the notion of stimulus "overselectivity" in the response and learning behavior of autistic children has lost its popularity in recent years. While some studies have suggested that autistic children, like young normal or retarded children, are overselective within a single modality (Reynolds, et al., 1974; Wing, 1976), it has been found that the overselectivity hypothesis lacks generality (Prior, 1979), is represented by studies failing to control for mental age and intelligence (Kovattana & Kraemer, 1974), and is not believed to be a unique feature in autism (Koegel & Lovaas, 1978), since, as previously mentioned, young children tend also to respond to a restricted number of cues when placed in a learning situation.

Reports of autistic individuals performing particularly well on visuospatial and rote memory tasks (Wing, 1976; Hill, 1977; Goodman, 1972) have perhaps been exaggerated in the public sectors of society. Often referred to as "idiot-savant" characteristics of autistics, it is now known that special abilities are just as rare in the autistic population as in the normal population - the prevalence rate has been suggested to approximate .06% (Hill, 1977). Indeed, the vast majority of autistic children possess no specific, impressive abilities.

Prior (1979) prefers the term "circumscribed interest patterns" to describe "patches of behavior where the general retardation is a little less severe" (p. 369).

Neuroanatomic Studies

The hypothesis that there is abnormality of brain structure or function in autistic individuals has been approached by many researchers in recent years. Hauser et al. (1975) utilized pneumoencephalographic techniques and found a relationship between infantile autism and recognized patterns of temporal lobe disease. Results of their study of 18 children with a history of retarded language development and autistic behavior suggested pathological enlargement of the left temporal horn in 15 cases. Variable enlargement of the left lateral ventricles was also present. A comparison of this condition to Korsakoff's memory disorder was made, in which Hauser et al. suggested that autism may represent a variation of Korsakoff's syndrome that is either congenital or acquired early in life. In support of this, they noted that "Korsakoff's syndrome accompanies bilateral temporal lobe disease only; isolated left-sided lesions are known to produce only very mild disturbances of verbal memory, yet the consequences of such lesions become devastating when even seemingly minor disease coexists on the right" (p. 681). By analogy, Hauser et al. postulated that the children in their study also had a bilateral disease - an insult to the right temporal lobe in

addition to the severe disease on the left - thus suggesting that the gross anatomical deficits in Korsakoff's are similar to those in autistic individuals. Moreover, as Hauser et al. point out, primary deficits such as an incapacity for adaptive social behavior and a loss of recognition of the significance of persons, objects, or events have been described as effects of widespread damage to the temporal lobe (Kluver-Bucy syndrome) two of which are also present in autism. Involvement of the medial temporal lobes (amygdala and hippocampus) have been suggested from lesions in these areas (Kling, 1972), and Hauser et al. speculate that the surrounding structures may flavor all experience with a personal, appropriate, emotional meaning. In further elaborating the similarities between Kluver-Bucy syndrome and autistic disturbances, they state the following:

> ....social isolation; aimless hyperexploratory behavior ("hypermetamorphosis"); failure to recognize parents or to acknowledge people in general ("psychic blindness"); monotonal, perseverative, non-communicative language and frequent oral and hypersexual tendencies [autistic signs] are features analogous to those seen in the Kluver-Bucy syndrome in adult man....[therefore] medial temporal lobe dysfunction may be a major factor in the pathogenesis of the syndrome of infantile autism (pp. 682-683).

In a study of 17 patients with autistic behavior, Damasio et al. (1980) utilized computerized tomographic (CT) scanning procedures to determine whether a discernible pattern of neuroanatomic abnormality was present. Findings of this study suggested that while no such pattern was present, several abnormalities believed to be consequent to a variety of disease processes of the CNS were found. Mild abnormalities of the ventricular system (increased size, altered left/right relation of lateral ventricles) were noted, as well as three scans indicating major hydrocephalus. In perhaps the first CT study of autistics which attempts to control for primary neurologic abnormalities, Campbell et al. (1982) examined a group of 45 clinically homogeneous autistic children and found evidence of ventricular enlargement in a subgroup of their sample. Ventricular measurements in two groups of autistic children were significantly larger than those in both the normal ventricle size autistic group and the control group, thereby establishing an identifiable subgroup with enlarged ventricles.

Even though the Campbell et al. (1982) study utilized a homogeneous sample in the neurological sense, there were no data indicating the mental ability of their subjects (i.e., IQ scores). This failure to account for mental ability can be a complicating factor in CT studies, as abnormalities could just as well be related to mental retardation as they are to autism.

Prior et al. (1984) argue that it is necessary to study high-functioning cases of autism because those studies involving

mentally-retarded subjects do not lend themselves to conclusions specifically concerning autism. In a CT scan study of nine autistic males functioning in the borderline or average level of intelligence, Prior et al. found no sign of abnormality on the CT scans or any asymmetry that might be related to lateralized cognitive functions. This study was carried out as a follow-up to a neuropsychological assessment of a group of high functioning autistics (Hoffman et al., 1982), which demonstrated poor performance of autistics on tests purporting to measure left hemispheric functions, yet average performance on tasks believed to be dependent upon functions of the right hemisphere.

Courchesne et al. (1987) used magnetic resonance imaging (MRI) on one nonretarded male with autism (WISC-R Performance IQ=112; Verbal IQ=96) and found evidence of both cerebral and cerebellar abnormalities. Specifically, the right posterior cerebral hemisphere was larger than its corresponding area on the left hemisphere, with an abnormally large ventricle and a slight increase in sulcal width. Moreover, an unusual cerebellar pathologic condition was found in this patient. His cerebellum showed "decreased development of the declive, folium, and tuber in the superior posterior vermis, as well as the medial aspect of the cerebellar hemispheres" (p. 338). In elaborating upon these findings Courchesne et al. presented an analogy to previous animal studies, stating the following:

> Very nearly the same structures in the rat have only just recently been shown to be essential for one form

> of learning and memory - long-term habituation of the acoustic startle response. It is an important experimental question as to whether our patient will show analogous deficit in long-term habituation (p. 338).

In yet another study attempting to control for the factor of mental retardation, Gillberg and Svendsen (1983) compared CT scans of 21 autistic children with those of 23 mentally-retarded and 16 normal children. Their findings suggested that about a quarter of the children with typical infantile autism showed gross anatomical changes in the brain (e.g. internal hydrocephalus or atrophy with widening of the ventricular system), yet these gross changes were more common among those cases with mild to moderate mental retardation than in cases with severe mental retardation or average intelligence levels, thereby suggesting that these abnormalities are not unique to cases of classic autism.

In a review of the neuropsychological testing of autism, Maurer (1986) notes that "studies using standard neuropsychological cognitive and language batteries have revealed no clear, consistent relationship to patterns associated with other disorders" (p. 375). There is little evidence supporting a localization hypothesis of autism, as the aforementioned neuroanatomic research suggests that no abnormalities are specific to autism. The use of neuropsychological tests, often in conjunction with imaging techniques, however, have shed some

light upon specific functional deficits and those areas of the brain purported to be representative of those functions.

It is generally accepted that a severe and global language deficit underlies autistic disorders (Rutter, 1974; Hermelin and O'Conner, 1970; Prior and Bradshaw, 1979). Even before the period of normal language acquisition, autistic children have deficits in communication. Babbling is less frequent in autistics and conveys less information than does that of other infants (Davison and Neale, 1986), and about 50 percent of all autistic children never learn to speak (Rutter, 1966). As mentioned earlier, echolalia is often found in those who do learn to speak. A characteristic of many autistic children is that they tend to perform almost invariably lower on verbal measures of intelligence as opposed to performance measures, such as the block design and object assembly subtests of the WISC-R. Largely derived from lesion studies (Milner, 1963, 1974; Luria, 1964), performance abilities are believed to reflect right hemisphere functions, whereas language abilities are reputed to reflect functions of the left hemisphere. In autistic individuals, language performance is often characterized by concreteness, repetitiveness, and recognition without analysis - all considered right hemisphere functions (Prior and Bradshaw, 1979) - which has lead some investigators to hypothesize that left hemisphere functioning underlies autistic disturbance and that right-hemisphere functions serve as compensatory mechanisms (Hauser et al., 1975).

In an effort to determine whether abnormal hemispheric functioning exists in autism, Prior and Bradshaw (1979) examined 23 previously diagnosed autistic children, using measures of hand and foot preference and a dichotic listening task. Also, Prior and Bradshaw administered the Peabody Picture Vocabulary Test-Revised (PPVT-R) to each child to obtain measures of language ability. Results suggest a significant excess of right hemisphere dominance for verbal stimuli, determined by failure to show "right ear advantage characteristics of the normal children" on the dichotic listening tasks (p. 80). Prior and Bradshaw argue that these results suggest the development of language functions in the right hemispheres of the autistic subjects. They further this argument by stating the following:

> Lateralization was shown to be related to presence or absence of speech before the age of 5 years and to IQ level....for the theory of laterality and development this would be supported for the suggestion that laterality precedes language development and that language emerges consequent upon the 'fixing' of hemispheric specialization (pp. 79,80).

Another study investigating the possibility of hemispheric lateralization of language in autistic children was conducted by Arnold and Schwartz (1983). These investigators compared dichotic listening performance of autistic, language-impaired (aphasic), and non-language-impaired subjects and found that, contrary to the Prior and Bradshaw (1979) study, the autistic

subjects did not evidence left ear bias. In fact, just the opposite occurred; the autistic and normal subjects showed right ear bias whereas the aphasic subjects demonstrated left ear bias. This suggests that while aphasic subjects evidenced right hemisphere lateralization for language, the autistic subjects showed no such lateralization. In clarifying the 'dichotomy' between their results and those of Prior and Bradshaw, Arnold and Schwartz state that "previous studies based their conclusions (that autistic children are predominantly right hemisphere processors) on indirect measures ...[and] results that could have been obtained by chance" (p. 136). Other methodological flaws were mentioned as being present in Prior and Bradshaw's research, including the use of words as stimuli,the requirement that children make a verbal response, the use of a laterality index (hand and foot preference) that was not independent of accuracy, and the use of a nonretarded control group much younger than the experimental group. Based upon prior research, Arnold and Schwartz claim that 1) differential familiarity with words can effect dichotic listening; 2) requiring a verbal response confounds laterality with accuracy; and 3) using a non retarded, nonlanguage-impaired control group makes it difficult to rule out fatigue or boredom as affecting the results. In summary, Arnold and Schwartz noted that while their study did not provide evidence for compensatory right hemisphere function in autistics, it is nevertheless probable that left-hemisphere abnormalities exist.

In an effort to further determine whether selective left hemisphere dysfunction is a characteristic that is associated with autism, Dawson (1983) administered selected tests from the Halstead-Reitan neuropsychological battery to 10 males who were diagnosed as autistic in early childhood. Results were compared with those obtained by a group of retarded individuals matched for IQ and with a group of patients with diffuse brain damage. On the basis of sensory-motor, perceptual, and cognitive measures from the Halstead-Reitan, the autistic subjects showed significantly greater left than right hemisphere dysfunction; they performed at or near the normal level on the visual-spatial tasks, whereas their mean performance on the language tasks was severely impaired. Moreover, half of the autistic subjects performed within the high-average to gifted ranges on the right-hemisphere-mediated tasks, which was not evident in the other two groups. In summarizing these findings, Dawson notes that while her study provides further evidence for a link between early infantile autism and left hemisphere dysfunction, it "does not support the suggestion [of Prior and Bradshaw (1979)] that right hemisphere compensation may occur in cases of selective left hemisphere dysfunction" (p. 284). In turn, Dawson stresses that her sample was relatively small, and that direct measures or electroencephalographic activity during linguistic processing may be more appropriate measures of right and left hemisphere language processing.

A relatively recent study was conducted by Prior and Hoffman

(1990), in which selected neuropsychological tests (Milner Maze, Wisconsin Card Sorting Test, and Rey-Osterreith Complex Figure Design Copying Test) to 12 autistic children aged approximately 10 to 13 years. The purpose of this study was to determine whether deficits exist in frontal-lobe functioning. In short, results obtained on these tests suggest, in Prior and Hoffman's words, "some commonality of underlying processes which in the conventional neuropsychological literature might be termed frontal lobe functioning"(p. 588). In considering future theory and research, Prior and Hoffman stress that links should be drawn between neurological and neuropsychological functioning and cognitive disabilities common in autistic children.

Assessment of Autism

In an effort to familiarize the reader with available instruments used for the assessment of autism, we will now briefly discuss selected measures. It is important to note first, however, that neuropsychological testing is not usually indicated in the case of autism (Hynd, 1981), primarily due to inattention or apathy on the part of the child.

Comprised of 76 multiple-choice diagnostic questions directed to the parents of autistic children, the Rimland's Diagnostic Checklist for Behavior-Disturbed Children (Rimland, 1971), was normed on 2,218 children labeled as autistic. Originally, responses in the areas of birth history, symptoms, and speech patterns suggested that after the age of 5 1/2 years, behavior patterns were noted as more idiosyncratic and symptoms

of autism as defined by Kanner became more diffuse (Parks, 1983). Consequently, the checklist was revised to contain questions applying to children before the age of 5. No test of reliability has been reported on this measure. DeMyer et al. (1971) report a lack of discriminant validity and recommend that the Diagnostic Checklist be used only as a screening device.

The Behavior Rating Instrument for Autistic and Atypical Children, or BRIAAC, was developed from observations of autistic children involved in psychoanalytically oriented therapy (Parks, 1983). This instrument is divided into eight scales measuring relationship to an adult, communication, drive for mastery, vocalization and expressive speech, sound and speech reception, social responsiveness, body movement, and psychobiological development (Ruttenberg, 1966). Ratings of "typical" autistic behaviors compared to those behaviors of a normal 3 1/2 to 4 1/2-year-old are obtained. Reliability coefficients across the eight scales range from .85 to .93, and it is reported that the scales are useful in distinguishing between autistic and mentally retarded children (Ruttenberg, 1966).

A scale designed to rely on objective behavioral assessment was developed by Freeman et al. (1980), in which 67 objectively defined behaviors are provided in checklist form. This assessment involves observing the child through a one-way mirror, recording the occurrence of the 67 behaviors in eight 3-minute intervals while the child is exposed to standardized stimuli (e.g., a flashing light), and attempting to engage the child in

playing with a ball during another 3-minute trial. According to Parks (1983), no information concerning criterion validity of this Behavior Observation Scale for Autism (BOS), as it is called, is available, and the reported test of discriminant validity does not contain a nonautistic control group.

Another instrument which is based on direct behavioral observation is the Childhood Autism Rating Scale (CARS), developed by Schopler et al. (1980). This instrument is comprised of 15 subscales which are based primarily on the diagnostic criteria for autism as proposed by Kanner (1943). Ratings are made by observation through a one-way mirror, immediately after a structured session with the child (Parks, 1983). This scale was normed on a sample of 537 children, possesses good interrater reliability (correlation coefficients range from .55 to .93 depending upon the subscale), and extremely high internal consistency (coefficient alpha = .94). One advantage of this instrument is that it differentiates between severe and mild-moderate autism.

One important, recently noted issue which must be addressed when making the diagnosis of autism is the influence of chronological age on autistic symptomatology. Wenar and Ruttenberg (1976), in a study of treatment effectiveness, found that younger children tended to be rated lower in autistic symptomatology than the older children in their sample. Parks (1983) maintains that this is the result of developmental processes and the fact that "there is no convenient way to

separate the influences of therapeutic intervention and natural, albeit delayed, maturation" (p. 263), and emphasizes the need to fully investigate the natural progression of autism.

Treatment of Autism

Since Kanner's (1943) original description of autism, approaches to treatment of this disorder have ranged from institutionalization to educational programs geared toward minimizing autistic behaviors and increasing daily living skills. Due to the lack of understanding of this disorder, treatment approaches have varied greatly, yet most clinicians and researchers alike generally agree that the goals of treatment for autistic children involve fostering normal development, the promotion of learning, and the reduction of stereotypic and self-injurious behavior. A multi-modal approach to treatment is necessary in order to reach these goals. The following synopsis should serve to provide the reader with a modest understanding of some current approaches to treating infantile autism.

There are no drugs which are known to specifically affect autism *per se*. Certain drugs have been effective in controlling specific behaviors such as overactivity and trichotillomania (pulling-out of one's own hair). Haloperidol, for example, is an antipsychotic agent which blocks dopamine receptor sites, often used for its sedating quality. It has been shown to reduce trichotillomania and other stereotypic behaviors (for example, Ghaziuddin et al., 1991), however, its extended use can result in the development of tardive dyskinesia (literally; "slow" and

"faulty" movement). Therefore, the need to control the behavior of an autistic child must be weighed against the risk of producing tardive dyskinesia whenever this type of medication is being considered.

Another form of medication which has been used in the treatment of autism is fenfluramine, an amphetamine, based on the hypothesis that underarousal of the reticular activating system causes the symptoms of this disorder. One study examining the effects of fenfluramine on the behavioral, cognitive, and affective symptoms in autism is that of August et al. (1985), who found that, in contrast to prior studies (Geller et al., 1982; Ritvo et al.,1983), fenfluramine had no effect on intellectual functioning. One positive effect of fenfluramine was noted in the August et al. study; a significant reduction in motor disturbances such as flapping, rocking, and whirling was observed. Affective behaviors improved, however, this improvement could not be attributed to the fenfluramine. In summary, August et al. stated the following:

> In light of these findings, it is best to interpret the effect of fenfluramine as symptomatic, ostensibly beneficial for those autistics who are excessively overactive and distractible, and who present peculiar motor symptoms. Ultimately, the reduction or elimination of these disruptive behaviors could make the child more accessible to other forms of intervention....which might, in turn, result in

significant improvements in socialization, communication, and learning (p. 106).

A more recent study examining the effects of fenfluramine on autistic behavior (Duker et al., 1991) found this drug to be effective in decreasing blood serotonin levels, yet ineffective in increasing communicative behaviors and in decreasing stereotypic and inappropriate behaviors. These investigators argue that the serotonergic effect of fenfluramine is not related to behavioral improvement reported in the aforementioned studies, primarily due to "lack of control for observational bias and other artifacts and that fenfluramine is differentially effective across individuals" (p. 361).

Research regarding the application of behavior modification principles to specific autistic behaviors are well-represented in the literature (Dorsey et al., 1980; Smith et al., 1985; Maag et al., 1986; Brady et al., 1987, to name just a few). Most of these studies focus on decreasing self-stimulatory or injurious behaviors such as trichotillomania, in addition to increasing social behavior and language skills. Perhaps the most popular approach is that of Lovass (1977), who, in addition to treating many negative behaviors of autistic persons, use modification techniques to facilitate the development of meaningful speech. Lovaas' program combines imitation training with reinforcement and aversive procedures and is reported to be successful in increasing language skills, in addition to social and self-help skills as the result of shaping (Morgan, 1981).

An ethological approach to the understanding and treatment of autism has been proposed by Tinbergen (1974), who argued that autism is basically an emotional disorder which requires treatment at an emotional level. Tinbergen believed that high stress levels are present in autistic children and their parents, and stressed that therapies be geared toward reducing anxiety and facilitating proper socialization in these individuals (Morgan, 1981).

Perhaps the most recent, innovative, and controversial approach to teaching autistic individuals methods of communication is that of "facilitated communication", in which electronic typing devices are utilized by autistic persons often aided by a trainer. Incredible results have been reported by Biklen (1990) in an article entitled "Communication Unbound: Autism and Praxis. Specifically, Biklen describes several autistic individuals who have learned to use dot matrix printers to demonstrate, in some cases, surprisingly advanced communicative skills in light of their assessed cognitive ability. While Biklen notes that occasionally a facilitator (trainer) may inadvertently cue their partners to letters and consequently words and statements, he argues that this technique is promising. In summary, it must be stated that given the lack of congruent data in the research of autism, the development of innovative techniques such as "facilitated communication" are perhaps not only desirable but necessary if this debilitating and disturbing phenomenon continues to occur in society.

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