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Minimal Brain Dysfunction in Children

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MINIMAL BRAIN DYSFUNCTION IN CHILDREN

Few clinical problems incite such disputation as the concept of minimal brain dysfunction (MBD). There are those who deny its existence and others who see the syndrome in the majority of troublesome children. The confusion stems from an interaction of the following factors: the differing viewpoints of the professionals who encounter its manifestations; the variability of its manifestations in different settings; the variability in the syndrome itself; and the variable meanings inferred from the diagnosis by professionals and parents when it is encountered.

Children so labeled are seen by neurologists, psychiatrists, pediatricians, psychologists, and schoolteachers. To some neurologists a diagnosis of brain damage cannot be made unless the classical neurological signs associated with nervous system lesions (that is, sensory defects, reflex changes, motor abnormalities, and so on) can be positively identified. The limitation of this viewpoint is evident from the fact that the classical neurological signs are the result of injury to only certain fractions of the brain substance; most of its bulk is silent in this respect, though it is very noisy in relation to complex behavior. There may be a marked discrepancy between neurological impairment, on the one hand, and behavior disturbance, on the other, following brain pathology. A child whose motor function is severely crippled by cerebral palsy may nonetheless display superior intelligence.

Conversely, a child with severe intellectual impairment on the basis of brain disorder (as in Heller's disease) may have normal reflexes and gross motor behavior. Conceptually, it is essential at the outset to differentiate the child with evidence of identifiable other neurological disease from the category of children considered here. The term "minimal" in minimal brain dysfunction is meant to indicate that the syndrome does not fit an otherwise recognized pattern and is associated with soft signs and presumptive evidence of brain disorder in the regulation of complex behavior.

The psychiatrist often fails to make the diagnosis, but for quite different reasons. The problems he is accustomed to dealing with are so often psychogenic or sociogenic that he may fail to consider that a behavior disorder may be secondary to brain dysfunction. His set is reinforced by the fact that disturbed family relations often accompany the syndrome. The difficult child may engender difficult behavior in his parents; organic lesions in a child do not preclude the simultaneous existence of psychogenic problems in his family.

The problem for the pediatrician is again different. The variability and unpredictability of development make the distinction between a transient behavioral aberration and one that is enduring difficult to discern except over time. If he has reassured a parent that the child will grow out of his problem and the problem persists, he may find it hard to extricate himself from his

earlier commitment. Under such circumstances, he will continue to provide ineffectual reassurance while morbidity continues.

The psychologist is likely to base his diagnostic judgment on test results. The correlation between minimal brain dysfunction and defective cognitive and perceptual performance is significant but not one to one. That is, a normal child may show quite uneven developmental attainments, whereas one with this syndrome may score in the average range. Except at the extremes, psychological test performance and neurological status may fail to correspond. The psychologist is in the difficult dilemma of making an inference about brain function from the test results. If he turns to the neurologist for confirmation, he may find the neurologist in turn relying upon him. This is no indictment of either profession but a simple consequence of the lack of pathognomonic criteria.

The educator observes the child in the classroom. He infers the diagnosis from overt behavior without necessarily having the skill to discriminate between the causal factors underlying common behavioral patterns. Moreover, he sees the child in a group setting, whereas the other specialists observe him alone in examining rooms.

This last feature brings us to a second major characteristic of the brain dysfunction syndrome: the variability of its manifestations in different

settings. The symptoms are most evident in an environment that provides a maximum of stimulation. The child who is a “whirling dervish” in a classroom or on a playground may be able to sit quietly and pleasantly in a small room with a friendly examiner who can command his attention. Thus, professionals may engage in fruitless arguments about the description of the child because they fail to understand the significance of the settings in which each observes him.

Finally, the very broadness of the category minimal brain dysfunction should prepare us for the fact that children so affected differ markedly from one another, presumably in relationship to the presence or absence of an anatomical lesion, size of the lesion, site of the lesion, number of lesions, the age of acquisition, the total amount of brain tissue involved, and perhaps even the cause of the lesions. Since present techniques do not enable us to determine the state of tissue function except indirectly, we do not have the anatomical information to correlate structure and function. Without the ability to do this, we use a common label for children suffering from what we can assume to be quite different anatomical or physiological defects. And yet there is sufficient commonality to the behavioral syndromes and sufficient responsiveness to similar treatment regimens to warrant the continued clinical use of the diagnostic term.

Finally, the connotations of the term can lead to unanticipated

consequences. To some parents (and some professionals) it connotes irreversibility and poor prognosis. But biochemical or even structural defects need not have such consequences in a growing organism if the extent is limited and if rehabilitation is provided. Indeed, clinical experience suggests that the outcome can be quite favorable if gross disability is not present.

For the present, it would be useful if the diagnosis of minimal brain dysfunction is always followed by a brief list of its major clinical manifestations as well as by a statement of cause, if cause can be established. When the behavioral syndrome is seen in a child whose basic disorder fits a better-defined category (postencephalitic syndrome, cerebral palsy, and so on), that diagnosis should take precedence over this behavioral term.

Characteristics of the Minimal Brain Dysfunction Syndrome

There is disagreement as to the boundaries of the MBD syndrome. We will discuss those signs and symptoms found in classical instances.

Motor Behavior

The major abnormalities of motor function are high activity level and impaired coordination (dyspraxia). When these symptoms are present, the history is surprisingly stereotyped. As an infant, the child is reported to have been active, colicky, and a poor sleeper. As soon as he entered the toddler

stage, he was into everything, constantly touching and/or mouthing and having to be watched at all times for his own protection as well as that of his household. As an older child he is described as having been driven like a motor, constantly fidgeting, unable to keep still at the dinner table and even *(mirabile dictu*) in front of the television set. At school, his teacher reports that he is unable to sit still, gets up and walks around, whistles, drums, and annoys her as well as his fellows. As he enters adolescence, gross hyperactivity is apt to disappear, but other characteristics of the syndrome may not. Hyperactivity is not a necessary sign for the diagnosis of the MBD syndrome. There are children with other characteristics of the syndrome who are normally active or even hypoactive.

The second abnormality seen in perhaps three-quarters of MBD children is incoordination. The distribution of MBD children may be bimodal in this regard. Some are reported as having passed developmental landmarks at an early age and of always having been agile. More common is the clumsy, inept child. The child is frequently reported as always having had two left feet, constantly tripping over himself or any object in his path. Fine motor coordination problems may have been reflected in the slowness in learning to button buttons, tie shoelaces, color, cut with scissors, or write with legibility. Balance difficulties impair riding a two-wheel bicycle or roller skating. Many will have difficulty in throwing, catching, or hitting a ball. This difficulty is "diagnosed" by the child's peers, who select him last when choosing up sides

for baseball.

Attentional Difficulties

The most striking abnormality of the MBD child is his short attention span and poor ability to concentrate. His parents report that he has never remained with one activity for a reasonable period of time. At school age, his teacher comments that "he has a short attention span. He is distractible. You can't get him to pay attention for long. He doesn't listen." These difficulties, like all the others, occur on a continuum. Some MBD children are able to persist in a few activities that they like. In others, attentional problems may be masked by perseverative behavior. This may be labeled "compulsive."

As with hyperactivity, distractibility and inattentiveness tend to diminish with age, but the problems may remain in a muted form.

Cognitive Difficulties

Cognitive disabilities are variable. There are three groups of children: those with perceptual-cognitive problems and no behavioral difficulties; those with behavioral difficulties and no perceptual-cognitive problems; and last, and most common, children with difficulties in both spheres.

Among the difficulties are problems with orientation in space

(manifested by right-left confusion, by reversals in reading and writing, and poor performance on the Bender Gestalt Test); difficulties in auditory discrimination (confusing similar sounds); difficulties in auditory synthesis (so that phonemes cannot be combined to sound out a word); difficulties in transferring information from one sensory modality to another (e.g., recognizing equivalence between a printed Morse code and its sounding out) and from a static to a temporal sequence (e.g., recognizing equivalence between flashing lights and a printed pattern).

Learning Difficulties

The area in which the MBD child's difficulties combine to produce maximum dysfunction is in school performance. Capacity, motivation, previous preparation, and adequacy of teaching contribute to how well a child performs. There are many reasons for inadequate school performance besides MBD. But a substantial fraction of MBD children (perhaps one-half) manifest learning difficulties. Among children with normal intelligence, normal environment and preparation, and reasonable school experience MBD would appear to be a frequent source of academic difficulty. The most common difficulty is in learning to read, though problems in writing and in arithmetic may be present as well. This group of children overlaps the ill-defined syndrome of dyslexia.

Attentional and perceptual-cognitive difficulties impede academic progress. When untreated, the MBD child falls further and further behind academically. Since his IQ is apt to be normal, he will be labeled an underachiever. Falling cumulatively further behind, the MBD child is probably at greater risk to drop out than his peers. One study of non-selected adolescent underachievers found that two-thirds of the non-retarded underachievers were MBD children grown up.

Difficulty in Impulse Control

A common characteristic of the MBD child is poor impulse control as manifested by low frustration tolerance, inability to delay gratification, impaired sphincter control in the young (enuresis, encopresis), and antisocial behavior in the older child (destructiveness, stealing, lying, fire-setting, sexual acting out). Impaired impulse control is also manifested in poor planning and judgment. The ability to think ahead develops with age; the MBD child is behind in accomplishment for his age.

The overlap between MBD and acting-out behavior is important. That MBD children contribute to social deviance in adolescence is suggested by retrospective cross-sectional studies of delinquents. These findings suggest that effective treatment of the younger MBD child might be useful in minimizing adolescent problems.

Interpersonal Relations

The MBD child is apt to be extroverted, resistant to social demands, controlling, and independent. In extreme instances, he is stubborn, negativistic, and impervious to ordinary disciplinary measures. “He always wants things his own way. Punishment doesn’t faze him. You can’t reach him.” In relation to his peers, “he is bossy. He wants to play the game his way or not at all. He’s too aggressive.”

Emotional Abnormalities

The child with minimal brain dysfunction exhibits increased lability, altered reactivity, increased aggressiveness, and dysphoria. His response to pain is often diminished: He seems indifferent to the bumps, falls, and scrapes that are the common lot of childhood. On the other hand, he overreacts to frustration and excitement. Temper tantrums are frequent.

Although these children are often described as angry, the behavior is usually irritability and lack of consideration. The child is often described as having a low boiling point and a short fuse.

The major dysphoric characteristics are anhedonia, depression, low self-esteem, and anxiety. Anhedonia (reduced ability to experience pleasure) is evident from such parental comments as “He never gets a real kick out of

anything. It seems impossible to satisfy him. He wants something for a long time, and then when he gets it he's tired with it right away." Insatiability is often interpreted as the result of spoiling; in the MBD child, such parental behavior may be a response to the child's non-gratifiability. MBD children are sometimes said to have a masked depression or to have depressive equivalents. The behavior that suggests this interpretation includes concern about injury or death for parents or selves, low self-esteem, and lack of zest and initiative. Self-evaluation may be hidden by bravado or assumed indifference, but parents and teachers will report that the child has described himself as stupid, worthless, or bad.

Familial Problems

Problems between the child and his parents, between the child and his siblings, and between parents themselves occur with sufficient frequency to be listed among the key characteristics of the syndrome. Although these problems are frequently interpreted as though they reflected familial pathology, it is probably more accurate to view them as a reaction to the child's difference. Most parents of MBD children feel guilty. Everyone "knows" that a child's behavior is the product of his upbringing, particularly his mothering. If the parents do not reach this conclusion independently, they are often helped to do so by mental health professionals. The guilt may produce depression or be projected onto the spouse. The difficulty in socializing the

child is a major source of arguments between parents: Each views the other's attempts as ineffectual. Since neither succeeds, the possibilities for mutual recrimination are endless. The MBD child demands more attention than his peers; they in turn react with jealousy and amplify the problem. The possibilities for disruptive family alliances, triangles, and the like are numerous.

Neurological Concomitants

There is an increased prevalence of minor, or soft, neurological signs in children with minimal brain dysfunction (as high as 50-60 percent in some series). The neurological findings labeled "soft" are so called because of their variability and lack of correlation with anatomical lesions. They include difficulties in fine motor coordination, visual-motor coordination and balance, choreiform movements, clumsiness, and poor speech.

The prevalence of abnormal EEGs among MBD children varies greatly, as a function of the population surveyed and the criteria employed. There is considerable overlap with the EEG records of other psychiatrically disturbed children. Except when epilepsy is suspected, the EEG is not particularly helpful. The one specific abnormality that has been reported but not yet replicated is that described by Laufer et al. These investigators demonstrated decreased photo-metrazol thresholds in hyperkinetic children.

It should be emphasized that many children with minimal brain dysfunction have no detectable neurological abnormalities. Neurological findings may support the diagnosis, but the absence of neurological abnormalities does not rule out the diagnosis.

Physical Stigmata

A number of workers have reported an increased prevalence of minor anatomic abnormalities in MBD children. In general, the stigmata are similar to those seen in schizophrenic children and overlap those seen in mongolism: anomalies of the epicanthus and ears, high arched palates, short incurving fifth finger, single palmar crease, abnormally long and webbed third toe, strabismus, and, perhaps, unusually large, small, or abnormally shaped skulls.

Psychological Test Performance

There are no pathognomonic psychological test findings; but the absence of abnormalities does not rule out the presence of the syndrome. As with the neurological examination, the psychological report may suggest the diagnosis but is not definitive. Children with minimal brain dysfunction display a varying degree of perceptual and cognitive dysfunction. Many of the abnormalities are not revealed on the standard psychological test batteries but may be revealed by educational testing techniques. Variability of WISC

subtest scores is often regarded as criterional; no evidence clearly supports this view. Abnormalities on the Bender Gestalt test (particularly reversals) are common. Difficulties in sorting tests, tests of figure-ground discrimination, and tests requiring cross-modal transfer of information are frequent. The difficulty is, as Conners concluded, that evaluations of children with documented cerebral lesions have failed to show a single pattern of dysfunction on intelligence tests; the same may be expected to be true of children without documented lesions.

Clinical Subsyndromes and Changing Manifestations with Age

Minimal brain dysfunction is generally associated with the picture of the hyperactive child: the driven, impulsive, distractible hellion. Many of the same psychological deficiencies seen in the hyperactive child are seen in children who are assigned to other diagnostic categories. We include these children within the boundaries of the syndrome. That is, we employ a Bleulerian rather than a Kraeplinian model. Minimal brain dysfunction would seem to be involved in the following subsyndromes: (1) the classic hyperactive syndrome; (2) the neurotic; (3) the psychopathic; and (4) the special learning disorder. In each of these variants, one or another aspect of the syndrome's varying manifestations are salient. In the "neurotic" it may be the rigidity and the "fixed" fear pattern; in the psychopathic, it is the recalcitrance to social expectations and impulsivity; in the special learning disorder, it is the

inattentiveness and/or perceptual-cognitive problems.

Together with the variable clustering of attributes, the changing behavioral manifestations of the syndrome with age tends to mask its diagnosis. The reasons for age changes include physiological alterations with maturation; learned consequences of continuing deviant behavior (a child is more hostile toward school after repeated failure); and most important, changing social expectations of the norms. In schematic form, the career of the MBD child might be summarized as follows: As an infant he is irritable, over-alert, colicky, and difficult to soothe. As a toddler, he is always on the go, threatening imminently to injure himself or family possessions. As he enters kindergarten and elementary school, his attentional and social problems become salient. His distractibility, low frustration tolerance, aggressiveness, and domineeringness win him the favor of neither his teacher nor his peers. Academic problems, though often present, tend to be ignored at first; by the time he reaches the third grade he is discovered to have a learning problem. Concomitant with the increased academic demands, the child's school behavior turns from inattentiveness to directed hostility. Associated with increased academic and peer problems, acting-out problems now appear. When antisocial behavior is present, it frequently claims the limelight, obscuring the existence and contributions of academic and learning problems. During preadolescence and early adolescence antisocial behavior constitutes the reason for referral. The academic problems persist but are

accepted; the school generally attempts to promote a delinquent out of its confines. The post-adolescent development of the MBD child is not fully known; the available information will be reviewed in the section on prognosis. It should be emphasized that the developmental changes discussed should not be construed as a fatalistic timetable of developmental difficulty; fortunately many children, either because of therapeutic intervention or maturation, return to a normal developmental sequence.

Diagnosis

The major tools for diagnosing the minimally brain dysfunctioned child are the history and current naturalistic observations of the child's behavior. The history can most rapidly be obtained by employing a structured format. Open-ended questions, successively becoming more specific, should be directed at the areas described under "characteristics." Multiple informants are useful. Teacher observations are of particularly great importance. The teacher, to a greater degree than the parents, has the opportunity of comparing the child with thirty or more of his peers in his daily activities. Discrepancy between home and teacher reports should not be discounted as documenting poor interrater reliability; it may provide useful information. If the child is reported to be normal at home and a dervish at school, one should determine whether the parents have aberrant norms of child behavior, whether the parents have devised effective techniques of control, or whether

the disturbed school behavior is the product of learning difficulties or school management. Similarly, a history of good adjustment at school and disturbed behavior at home suggests that the home situation be explored more fully.

The clinical interview with the child has a limited role in diagnosis. It is common for teachers to report that the child will do well briefly in a one-to-one situation; the psychiatrist thus may be misled. The psychiatrist obtains the most unrepresentative sample of the child's behavior. (For example, Zrull et al. found that when mothers', teachers', and social workers' reports and psychiatrists' playroom evaluations were all intercorrelated, the evaluations that correlated least well with the others were those of the psychiatrists). The differential diagnostic consideration for which the psychiatrist's evaluation is most important is in determining whether the child is psychotic. Although parents and teachers are quick to spot the unruly, they frequently fail to notice the bizarre; the differential diagnosis between MBD and borderline schizophrenia has major therapeutic implications.

The physical and neurological examinations are contributory rather than diagnostic. It is important to screen for sensory defects. This is particularly important in lower-class populations in whom hearing or visual defects may have long remained undetected. A neurological exam may suggest the diagnosis; approximately one-half of MBD children have soft neurological signs. The presence or absence of these signs does not have any

implications for pharmacological management, but the boy who is reported to be poorly coordinated can frequently be helped by specific programs in physical education. When this results in improved sports performance, it may bolster the child's deflated self-esteem. The electroencephalogram is relevant neither diagnostically nor in planning management, except when historical information leads one to believe that a seizure disorder is present. There is no evidence indicating that epilepsy is more common in children with minimal brain dysfunction than in children without the syndrome.

While projective testing is of little, if any, value, diagnostic educational testing may be of the greatest practical importance. Those MBD children who have specific perceptual-cognitive difficulties may require remedial special education; those who do not have such difficulties are nonetheless frequently behind grade level and will continue to remain academic misfits unless they receive correct academic placement.

With the disturbed child diagnosis is not a sterile exercise but a determinant of action. A good general principle for any physician to remember is that since he cannot diagnose with perfect accuracy, he must decide whether to over-diagnose or underdiagnose. If a disorder is moderately serious and the treatment very safe, he should over-diagnose (e.g., if one suspects a strep throat and has no laboratory facilities, it is safer to treat with a non-allergenic antibiotic than risk the possibility of rheumatic

fever). If the disorder is not very serious or if the treatment is dangerous, one should diagnose with much greater caution. In the case of the MBD child, recognition of the classical hyperkinetic case imposes no diagnostic difficulty. The problem is in the borderline areas. There will be many children in whom the diagnosis is suspected but cannot be ascertained. A therapeutic trial of medication is easy, safe, and permits a rapid evaluation of a child's drug responsiveness.

Prevalence of the MBD Syndrome

There are two separate questions. (1) What is the prevalence of minimal brain dysfunction among children? (2) What is the prevalence of the syndrome among diagnosed disturbed children? Despite imprecision in diagnosis, a number of surveys of school-age children have produced prevalence figures that are in surprising agreement. Prechtl and Stemmer surveyed the prevalence in the Netherlands of the choreiform syndrome, which they defined as the presence of minimal choreiform movements together with behavioral problems. They found the syndrome present in 20 percent of elementary school boys and severe in 5 percent of them; its prevalence in girls was 10 percent with less than 1 percent having severe problems. Of children with this syndrome, 90 percent were reported as having appreciable reading difficulties. Stewart et al. reported the hyperactivity syndrome to be present in approximately 4 percent of a St.

Louis grade school population between the ages of five and eleven. Huessey found hyperkinesis in 10 percent of Vermont second grade children; he reported that 80 percent of the children whom teachers felt had serious behavioral difficulties fell into this category. Despite the different diagnostic criteria employed and the different areas surveyed, the reported figures fall into the same range: 5 to 10 percent. The prevalence of the disorder may be linked to social class, being more frequent among disadvantaged children. The syndrome, as reported in clinic populations, shows clear sex linkage: the male-to-female ratios ranging from three- or four-to-one to nine-to-one. Some of the manifestations of minimal brain dysfunction may be different in girls. (It is our impression that hyperactivity itself may be less prominent with undirectedness and resistance to socialization being more salient.)

The prevalence of the disorder in clinical populations is difficult to ascertain; until recently, the syndrome could not be coded except as chronic brain syndrome. Current American Psychiatric Association nomenclature permits the additional category of hyperkinetic reaction of childhood. Employing a broad definition of minimal brain dysfunction, one finds that half of the children referred to outpatient clinics can be encompassed within this category. The situation is analogous to that with schizophrenia. The clinics and practitioners who use a dementia praecox model report very few schizophrenics in ordinary outpatient populations, whereas clinicians employing a Bleulerian model may report as many as one-half of their

outpatients in this category. This issue clearly requires further study.

Etiology

It is probable that the MBD syndrome is a final common expression of distinct and separate causal factors. It may be produced by extrinsic brain insults, genetic transmission, intrauterine random variation in biological development, fetal maldevelopment, or psychosocial experience.

The earliest description of MBD behavior in children was in those who developed behavioral abnormalities following von Economo's encephalitis. Subsequently, similar behavioral abnormalities were associated with other forms of infection, poisoning, and trauma. These causal associations led to the first diagnostic labels for the syndrome: "postencephalitic behavior disorder," "organic drivenness," "minimal brain injury." Studies by Knobloch and Pasamanick demonstrated an association between prematurity, prenatal difficulties, and paranatal complications and a variety of psychological, behavioral, and neurological abnormalities in children (including cerebral palsy, epilepsy, mental deficiency, behavior disorders, and reading disabilities). The highest association between reproductive pathology and behavior abnormality was found for the group of children who were hyperactive, confused, and disorganized, a group obviously resembling and/or overlapping the MBD syndrome.

It is these early studies that have willed the term “minimal brain damage” to child psychiatry. It is an unfortunate inheritance for both logical and empirical reasons. Logically, it is incorrect because one cannot argue that since some brain-injured children have the MBD syndrome, all children with MBD are brain injured. Empirically it is misleading because in a large fraction of children with MBD, one can neither obtain a history suggestive of neurological damage nor find signs of neurological impairment.

A second cause for minimal brain dysfunction is very probably genetic. Clinicians have long noted the familial clustering of the disorder, with an apparent increased prevalence among siblings and parents. Two studies documented the familial clustering of dyslexia. These studies reported MBD behavioral abnormalities associated with the dyslexia and an increased prevalence of MBD behavior among the non-dyslexic siblings. (In clinical experience, one sibling of a MBD child may have learning difficulties but no behavioral problems, a second may have behavioral problems but no learning difficulties, while a third may be clumsy but have no behavioral or learning difficulties.) Such observations are compatible not only with genetic transmission but with familial transmission of behavioral patterns. The only sound way to disentangle the effects of nature and nurture is to study the siblings of MBD children who have been reared separately. Safer was able to locate fourteen MBD children whose siblings or halfsiblings had been reared in foster homes. This study disclosed that approximately 50 percent of the full

siblings versus 14 percent of the half-siblings were characterized by short attention span, repeated behavior problems and a diagnosis (by an independent rater) of hyperactivity. This study must be viewed with caution because of the small sample size. Non-genetic, nontraumatic, prenatal variation may play a role in the development of behavioral pathology. This is suggested by the study of premature infants and monozygotic twins. In these groups increased MBD pathology is repeatedly seen in the lower birth-weight infants.

A fourth possible cause of MBD pathology is fetal maldevelopment. Several investigators have noticed an association between MBD behavior pathology and anatomical stigmata. There are no data indicating whether such anatomical abnormalities are familial. The pathology of mongolism (trisomy versus translocation) suggests the question of whether the minimal brain dysfunction disorder is associated with maternal pathology or genetic abnormalities. One must further inquire if there is an association between MBD and maternal exposure to toxins or infection during pregnancy.

Finally, there is reason to believe that minimal brain dysfunction behavior may be produced by psychosocial experience. For example, prolonged institutionalization during early childhood may produce a child who not only has difficulties in forming relationships but who also has certain temperamental and cognitive abnormalities, including hyperactivity, inability

to concentrate, and difficulties in abstraction. Some clinicians distinguish between organic and psychogenic subgroups of hyperactivity. The disorder can occur in the absence of organic signs, but there is no firm basis for supposing that these children manifest a different pattern nor that the syndrome has appeared in them solely as a response to stress. Psychosocial experience may interact with physiological predisposition to aggravate or minimize the manifestations of the syndrome.

Mechanism

The pathophysiology of the minimal brain dysfunction syndrome is unknown, but Wender proposed a model linking the observed behavior to a hypothesized physiological dysfunction. Briefly, it asserts that the primary psychological characteristics of the syndrome are directly produced by the physiological dysfunction. The primary characteristics generate, in the course of life experience, the psychological signs and symptoms seen in the clinical syndrome. There are three postulated primary abnormalities: (1) a difficulty in attention characterized by a high and poorly modulated level of activation; (2) a decreased ability to experience both pleasure and pain, manifested behaviorally by decreased sensitivity to reinforcement; and (3) extroversion.

The second hypothesis about mechanism is that some forms of the disorder are produced by a dysfunction in monoamine metabolism. The

reasons adduced are clinical and experimental. To begin with, von Economo's encephalitis, which produced Parkinsonism in adults, also produced minimal brain dysfunction in children. The inference is that the virus had a predilection for monoaminergic neurons (since postencephalitic Parkinsonism is known to be associated with dopaminergic lesions). A second naturalistic datum suggesting that decreased function of monoaminergic neurons lies at the basis of the syndrome is the dramatic response of MBD children to amphetamines and tricyclic antidepressants. It has been hypothesized that these drugs act by increasing the functional amounts of monoamines, most probably norepinephrine, which function as central nervous system neurotransmitters. They act, in effect, as stimulators or amplifiers of the monoaminergic systems. Animal experiments suggest that norepinephrine is probably the neuro-humor critically involved in mediating the effects of reinforcement; decreases in norepinephrine result in decreased responding to both positive and negative reward. Decreased norepinephrine is also thought, in the human, to be accompanied by depression. Decreased functioning of the noradrenergic system would be expected to produce an unhappy and socially unresponsive child. Similarly, although the mechanisms are not so well worked out, norepinephrine seems to be involved in arousal. It is unclear whether the inattentiveness seen in MBD children is a manifestation of over-arousal or of under-arousal (as suggested by Satterfield et al.). Though amphetamine is clearly arousing in adults, there is some

suggestion that noradrenergic neurons may be involved in diminishing attention and arousal.

The testable consequences of this theory are that at least one group of MBD children should be characterized by decreased synthesis, release, or sensitivity to norepinephrine. If the decreased synthesis is peripheral as well as central, it might be reflected in decreased excretion of monoamine metabolites in the urine. This hypothesis has been tested, but it was not supported. If the syndrome results from decreased sensitivity to normally produced norepinephrine, such children should manifest less autonomic responsiveness to exogenous norepinephrine. This test has not yet been conducted, but it too presumes that peripheral metabolism parallels central.

The monoamine theory, although plausible, suffers from lack of direct empirical verifiability; at present, we lack methods for direct measurement of the activity of central neurons in humans.

Prognosis

Pediatricians and child psychiatrists have tended to believe that the hyperactive child outgrows his difficulties with age. This belief was supported by the diminution of certain MBD signs with age: enuresis, fine motor difficulties, classroom disruptiveness, and immature behavior. Several studies disputed this assumption. The first group of studies were follow-up studies.

The most direct were those of Menkes et al. and Weiss et al. Menkes et al. studied the outcome of fourteen children who had been evaluated and labeled as MBD while outpatients at Johns Hopkins twenty-five years previously. The population consisted of children with probable organic brain injury and serious rather than mild brain dysfunction. At the time of reexamination, four of the original fourteen were institutionalized psychotics; only eight were self-supporting, and of these four had been institutionalized for some time. Weiss et al. followed their own sample for a mean of five years (to the age of thirteen). Their sample was composed of non-retarded, nonpsychotic hyperactive children who had shown no evidence of serious brain dysfunction. On follow up it was found that hyperactivity had diminished, but that disorders of attention remained and that a significant proportion of the children continued to show immature behavior, low self-esteem, and poor school performance. Compared to their peers, the children were more aggressive and inclined to antisocial behavior. A one- to nine-year follow up of postencephalitic children who had been institutionalized found that approximately two-thirds showed chronic and serious behavioral difficulties.

Another follow-up study of children who may have suffered from a severe form of the minimal brain dysfunction syndrome is that of Morris et al. who reported a follow up after more than twenty-one years, of ninety children who had been admitted to a psychiatric hospital for severe acting out in the presence of normal intelligence and in the absence of psychosis or

overt brain damage. The sample is described as disobedient and markedly restless and would seem to constitute a severely disturbed antisocial group of MBD children. Of sixty-eight children followed until age eighteen or older, twelve had become psychotic, ten were diagnosed as borderline, seven had acquired a criminal record, and only fourteen were described as doing well. Robins reported a thirty- to forty-year follow up of children seen in psychiatric outpatient clinics. The population consisted largely of children with acting-out problems; retrospectively, many of these children might be considered to have had minimal brain dysfunction. Robins' data documented the fact that acting out children are at greater risk not only for sociopathy but for psychosis as well. All these studies except that of Weiss et al. were skewed toward the more severely disturbed MBD child. There are no available follow-up studies describing the post-adolescent fate of moderately to mildly impaired MBD children.

The other group of studies that shed some light on the prognosis of the MBD child were retrospective studies. A number of these studies revealed an increased prevalence of histories reminiscent of minimal brain dysfunction among adult psychiatric patients with a variety of diagnoses. Healy and Bronner found that delinquents (as compared to sibling controls) demonstrated significantly more cross and fussy babyhood, enuresis, hyperactivity, restlessness, and impulsiveness. Studying a far less disturbed population, a group of adolescent underachievers, Hammar reported that

approximately one-half of these children (and two-thirds of the non-retarded subsample) constituted MBD children grown up. A number of studies of psychiatric inpatients revealed an increased prevalence of signs and/or histories of MBD problems in earlier life. Hertzig and Birch reported soft neurological signs in 30 percent of a heterogeneous group of hospitalized adolescents as compared to a 5 percent prevalence of such signs in a control population. Hartocollis examined the childhood characteristics of adult psychiatric inpatients whose psychological tests had suggested possible organic impairment. Of inpatients meeting these characteristics he found historical signs strongly suggestive of minimal brain dysfunction (clumsiness, hyperactivity, temper tantrums, aggressiveness, lability, reading difficulty, and the like). Of particular interest was the variety of adult diagnostic groupings into which these patients fell: Personality types were mainly infantile but included impulsive, schizoid, phobic, and hysteric; diagnoses included schizophrenia, depression, and infantile personality.

Another relevant study linking minimal brain dysfunction problems in childhood and psychiatric disorders of adulthood is that of Quitkin and Klein. Examining adult inpatients under the age of twenty-five, they found that 30 percent had definite histories of soft neurological signs and/or hyperkinesis, impulsivity, clumsiness, and other problems suggestive of minimal brain dysfunction. These adult inpatients fell into two major diagnostic groupings: the impulsive-destructive and the awkward-withdrawn. The former included

mainly emotionally unstable character disorders, while the awkward-withdrawn subgroup was constituted of process schizophrenics and schizoid and passive dependent characters.

A final source of information came from interviewing adults, including the parents of MBD children, who described themselves as MBD children grown up. Anderson and Plymate reported that even in the more benign instances the MBD child is prone to continuing attention problems, social imperceptiveness, and interpersonal difficulties.

Two points deserve particular emphasis. (1) The increased prevalence of neurological signs in psychiatrically disturbed populations does not document that neurological impairment causes psychiatric illness. It is entirely possible that both the neurological signs and the psychological problems are common manifestations of an underlying disease process (as is seen in Huntington's chorea). (2) The increased prevalence of MBD histories among psychiatric patients does not imply that most, or even many, minimally brain dysfunctioned children become psychiatrically disturbed adults. As may be easily shown, these figures imply that only a small fraction of MBD children subsequently develop the psychiatric syndrome studied. Nonetheless, these studies have several important implications. (1) The usual complacency regarding prognosis may not be justified; it appears that MBD children are at greater than average risk for subsequent psychiatric disorder.

(2) The studies implied that not only do the psychological abnormalities associated with minimal brain dysfunction persist, but these abnormalities may change their form. What we need to know is what types of MBD children develop in which ways. In particular the fate of the most common and least seriously afflicted, the hyperactive inattentive child who is amiable and has minor learning difficulties, is unknown.

Management

The care of the child with minimal brain dysfunction will obviously vary from case to case in relation to the predominant manifestations, the family setting, and community resources. Since cause is unknown and theories of pathophysiology are speculative, treatment is necessarily symptomatic. The four major therapeutic modalities are medication, family counseling, remedial education, and psychotherapy for the child.

The responsiveness of the symptoms of hyperkinesis and distractibility to stimulant drug treatment is so remarkable as to have been suggested as a diagnostic test. In a number of well-controlled studies, it was established that two-thirds to four-fifths of children will show a favorable response if a stimulant drug is used properly. Contrariwise, sedative drugs often exacerbate the behavior disturbance. Methylphenidate in dosage level from 10 to 100 milligrams per day and dextroamphetamine from 5 to 50

milligrams per day are the drugs of choice. Side effects may be fewer with methylphenidate.

The drug should be begun at the lowest dose and the child's response observed. If little or no response is recorded, the dose should be doubled at two- to three-day intervals until a beneficial result is obtained, troublesome side effects intervene, or the maximum safe dose has been reached. All too often, treatment is abandoned after only minimal doses have been tried; some children may show little response until the maximum dose and then improve strikingly. Anorexia and insomnia are the most common side effects. Both symptoms may disappear even if dosage is maintained over a seven- to ten-day period. If they continue to be troublesome, the dose may have to be diminished and a compromise sought between effectiveness and unwanted side effects. One drug may succeed where another has failed. Since the symptoms tend to diminish with age, periodic discontinuation of medication is necessary in order to determine whether it is still necessary. We routinely suspend the drug during summer vacations except in severely troubled children. We then recommend a trial in school without medication in order to determine whether it must be restarted. Clinicians have maintained children on stimulant drugs for as long as five years with no evidence of tolerance or habituation. The drug can be discontinued from one day to the next with no need to taper off.

For children who fail to respond to stimulants, phenothiazines (Thioridazine) may prove useful, although there is reason for concern that learning may be adversely affected by the sedative effect of these drugs. More recently, there have been reports of good results from the use of tricyclic antidepressants. Preliminary trials have suggested that magnesium Pemoline may be an effective stimulant drug.

Family counseling is an essential ingredient of care. The parents are distraught and upset by behavior they cannot understand and for which they may blame themselves or have been blamed by others. It is essential that the physician attempt to clarify the nature of the syndrome, its cause, and its prognosis and provide guidelines for appropriate management. The child's over-responsiveness to stimulation indicates the usefulness of environmental restriction (parties, trips to department stores, and the like had best be postponed). The missing brake in the control of behavior by the child points to the need for the parents to intervene early when behavior begins to get out of control. They will need help in working with the teacher on such educational programs as are appropriate to the particular case. At the same time, attention must be paid to family problems that, though independent of the syndrome of brain dysfunction, nonetheless interact with it because of the greater vulnerability of the child to psychological stress. Psychiatric care for marital discord, parental disagreement about child care, anger toward the patient, or any of the manifestations of family psychopathology will be

essential if the program of management is to succeed.

There is no single educational prescription for this category of children but rather a need for an individual assessment of each in order to set out a sensible course of action. To the attentional defects that are so common there may be added in a particular case specific perceptual and cognitive defects that will further complicate learning. If the child cannot be helped to overcome his learning disability, the experience of school failure may lead to a train of psychological consequences which will further complicate the organic behavior disorder. What needs emphasis is the importance of a thorough psychoeducational work-up of each patient to provide the basis for a program of educational rehabilitation. In the absence of educational remediation for the child with a major learning disorder, medical efforts will be futile. In this sense, education is the single most important modality of treatment.

Psychotherapy is of limited value in treating the common symptoms in contrast to their good response to medication. On the other hand, psychotherapy may be essential if family pathology coexists with the minimal brain damage. Drug therapy may enable the child to make use of psychotherapy in instances in which he is unresponsive. A useful rule of thumb is to gauge the response to drug treatment alone. If the target symptoms improve, but other problems remain sharply evident,

psychotherapeutic intervention is not only indicated but can be more sharply focused.

Public Health Policy Questions

In 1970, a grossly inaccurate newspaper account, alleging that large numbers of elementary school children in a mid-Western city were being placed on stimulant drugs at the behest of teachers and without parental consent, touched off a storm of public protest, which culminated in congressional hearings and the appointment of a Department of Health, Education, and Welfare advisory panel. The two questions, on which lay and medical debates centered, were the following. (1) Are stimulant drugs mind-control agents to suppress rebellion against excessively rigid teachers and schools? (2) Does their use in children lead to drug abuse when these children become adolescents?

As to the first question, there is no reliable information about what stimulant drugs would do if administered to normal children. There are obvious ethical reasons why we cannot give stimulants to normal children to satisfy academic curiosity even on so important an issue. Since the phenomenon is age related, studies with adult volunteers do not help. But let us be clear: Over-activity and distractibility can occur under at least three sets of circumstances in which drug use would be grossly inappropriate and

medically reprehensible. The first is the child who exhibits intense anxiety in the midst of grossly disorganized family life. It is the physician's task in the diagnostic evaluation to explore this possibility; if it is identified, the therapeutic task is to restore family equilibrium before entertaining the use of medication. The second is the fidgetiness and inability to concentrate that can be produced by hypoglycemia in a child who is malnourished and regularly has no breakfast. Food is the appropriate pharmacological treatment for such problems. The third differential point to be considered in diagnosis is the character of the classroom; if it is overcrowded, if the teacher is incompetent (or simply overwhelmed), or if the classroom is above a busy fire station, what is needed is attention to the classroom setting and not to the chaotic activity that will characterize the majority of the children in such a classroom. Those who point out the danger of the indiscriminate use of stimulant drugs do so with justification. Any potent agent can be abused. But exclusive preoccupation with the possibility of misuse can lead to the abandonment of the hyperkinetic child along with the drug. Furthermore, it is a myth that stimulants make hyperkinetic children into conforming robots. Restlessness, distractibility, and impulsivity are constraints on freedom, not freedom; the child is not free to behave but is driven. Is a child whose attention is commanded by every passing sight and sound, meaningful and meaningless alike, to be considered independent? Is a child who is not learning to read, when most of his classmates are, in any sense expressing

creativity? Stimulant drugs reduce fidgeting not purposeful motor activity; they lessen distractibility so that the child can concentrate, but what he chooses to monitor is his decision; they diminish impulsivity so that his behavior is more reflective. There can be no argument that they should not be given except after a thorough diagnostic evaluation, under careful medical supervision and with informed parental consent.

What of the potential for adolescent drug abuse? One of the remarkable aspects of stimulant drug use with children in contrast to adolescents is its consistent failure to produce euphoria. If the child notes a change in feeling tone, he is apt to report sadness or drowsiness rather than feeling high. Most children have to be reminded to take their medicine; few ask for it. Those who feel positive about it do so because they are grateful for no longer being called stupid or bad. The point to be emphasized is that it is the high produced by these agents in the adolescent that leads to repeated usage. Since children do not become euphoric, there is no motivating force for drug abuse.

Taking a drug over a prolonged period of time under medical prescription and management is a very different matter from either being encouraged to experiment with drugs or watching one's parents employ cocktails, downers, and uppers at their own initiative in order to get through a stressful life. There are no data that suggest that epileptic children on anticonvulsants, diabetic children on insulin, children with rheumatic carditis

on prophylactic sulfonamides, or asthmatics on steroids are at any higher risk than the rest of the adolescent population for drug abuse. We anticipate that such youngsters may be less likely, rather than more likely, to become drug abusers because of having learned to take medicine for the proper business of suppressing illness.

Theoretical arguments are no substitute for empirical data. What are the facts? The only available data stem from a preliminary study by our clinic. Dr. Maurice Laufer of Providence, one of the pioneers in stimulant drug therapy, was good enough to give our staff permission to contact the parents of 110 children whom he had treated with dextroamphetamine for hyperkinetic impulse disorder some ten to fifteen years earlier. A letter was sent to each family, explaining the purpose of the study and asking them to cooperate. Eighty agreed to do so; of these, sixty-three completed the lengthy questionnaire sent to them. We hope to locate the missing respondents. Although a 60 percent response rate to a mailing is surprisingly good, and although the respondents did not differ in any significant way from the missing cases by history, the attrition in the sample limits the confidence to be placed in the data. To summarize the information we do have, the patients had now attained a mean age of twenty. As children, 40 percent had received medication for less than six months; only 30 percent, for more than three years. Of the sixty-three, only three were known by their parents to have tried marijuana, none as frequent users. Not a single one of these former patients

was reported to have experimented with other drugs, although four were described as drinking to excess. In the absence of a control sample, one can only compare these data to general experience: A contemporary college-aged population might include half who were experienced with marijuana and some 10 percent who had tried lysergic acid, mescaline, or psilocybin.

Despite the lack of evidence that hyperkinetic children treated with stimulant drugs become adolescent drug abusers, even the remote possibility of such an outcome justifies the call for more follow-up studies than are now at hand. Stimulant drugs are grossly abused in American society. The only medical conditions in which they have been demonstrated to be effective are the hyperkinetic syndrome and narcolepsy. Their temporary effects in obesity and depression are far outweighed by the risk they pose for habituation. Yet physicians continue to prescribe them almost indiscriminately; they are manufactured in entirely excessive amounts; they circulate through an extensive black market. They constitute a major public health hazard. Whatever faith we place in legal controls, an approach not conspicuously successful in containing the heroin pandemic, there is no excuse for poor medical practice and unethical pharmaceutical promotion. Recent efforts by medical societies to exhort their members to limit drug use to legitimate indications represent a much to be applauded, if somewhat belated, step in the right direction. It would indeed be regrettable if the patients for whom stimulants have been shown to be strikingly effective were to be denied

access to them by draconian legislation resulting from the failure of other measures of control. The hyperkinetic syndrome is no mere matter of a developmental phase to be endured until it is outgrown. The data from the longitudinal studies reviewed earlier provide evidence for persisting educational handicap and enduring behavior disorder. Stimulant drugs, though only one element in a program of treatment, can be key factors in enabling the child to benefit from remedial education and parent counseling. Continuing pediatric supervision is essential to success in rehabilitating what we are beginning to see as a chronic disorder and about which we have much yet to learn.

In January 1971, the Office of Child Development of the U.S. Department of Health, Education, and Welfare convened the "Conference on the Use of Stimulant Drugs in the Treatment of Behaviorally Disturbed Young School Children." We can think of no better way to conclude this chapter than by quoting the last three paragraphs of the conference report:

> Clinical pharmacologists have repeatedly found that drugs may act differently in children than in adults. To use medicines of all kinds effectively in children, more specialists must be trained in drug investigation—pharmacologists who can develop basic knowledge about the action of drugs in the developing organism. There is the obvious need for better and more precisely target drugs for the whole range of severe childhood behavior disorders. This requires intense research and training efforts. Such efforts provide the means for developing, testing and delivering better treatment programs. There is a similar need for research in the techniques of special education and also a need to make these

techniques available to children who can benefit. It would appear to be a sound Federal investment to conduct such research and training.

In summary, there is a place for stimulant medications in the treatment of the hyperkinetic behavioral disturbance, but these medications are not the only form of effective treatment. We recommend a code of ethical practices in the promotion of medicines, and candor, meticulous care and restraint on the part of the media, professionals and the public. Expanded programs of continuing education for those concerned with the health care of the young, and also sustained research into their problems, are urgently needed.

Our society is facing a crisis in its competence and willingness to develop and deliver authentic knowledge about complex problems. Without such knowledge, the public cannot be protected against half-truths and sensationalism, nor can the public advance its concern for the health of children.

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