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MINIMAL BRAIN DAMAGE SYNDROME

BY

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A THESIS

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INTRODUCTION

In the past, most child guidance workers have tended to attribute behavorial and learning deviations seen in children almost entirely to rearing patterns and interpersonal relationships experienced by these children. Only relatively recently have workers begun to stress the importance of searching for organic causation before assuming a strictly psychogenic basis. Those proponents of an organic influence to behavorial disorders in children emphasize that there probably is a multitude of minimal organic abnormalities which are responsible for the abnormal overt behavior of these children. The difficulty, in the past and also in the present, in defining these abnormalities has been and is the lack of specific, accurate, and reproducible methods of detecting such "minute" central nervous system alterations. Therefore, it has been difficult to determine which behavior formerly attributed to sibling rivalry, rejecting parents, repressed hostility, oedipal conflict, repressed sexuality, etc. has a primary psychogenic basis and which is secondary to organic changes. It is believed by many that the organic abnormalities are probably sustained during early years of development and maturation of the central nervous system and especially those areas concerned with perception, language, inhibition of impulses, and motor control.

The current emphasis has primarily been aimed at developing a diagnostic evaluation plan. The complexity

of this project is emphasized in part by the multitude of labels which have been assigned to the symptom picture, i.e. brain-damage behavior syndrome, hyperkinetic syndrome, organic brain syndrome, hyperkinetic impulse disorder, post-encephalitic behavior disorder, minimal brain damage syndrome, minimal brain dysfunction, minimal chronic brain syndrome, and others.

It must be recognized that there probably is considerable overlapping of symptomatology between the organic behavior and learning syndrome group and the various childhood psychoses.

It is the purpose of this paper to summarize the various diagnostic methods which have been devised with some reference to underlying pathology and physiology and current methods of therapy.

The following terms will be used more or less interchangeably depending upon the context: minimal brain dysfunction, organic learning and behavior disorders, minimal brain damage, and central nervous system deviation. The only significant difference is that when the word damage is not included, it is to emphasize that the basic abnormality may be on a genetic basis or central nervous system "maturation lag."

SYMPTOMS

There have been a number of articles in which the

basic symptoms of the minimal brain damage syndrome have been listed and elaborated upon.[1,2,3,4,5,6,7,8,9,10] The classic clinical spectrum includes:

1. Disordered behavior--Hyperactive with no clear direct focus or object.

2. Short attention span and distractibility in performance of tasks alternating with marked perseveration.

3. Perceptual-motor deficits--Printing, writing, and drawing poor.

4. Emotional liability--Child is usually described as being impulsive, unable to delay gratification, irritable, and easily frustrated.

5. Short attention span and/or distractability-- The child is unable to concentrate on one subject for very long, especially if abstract material is involved.

6. Social incompetence--The child functions below age level and often far lower than estimated intelligence.

7. Specific learning disorders--Child frequently has difficulty with arithmetic and other areas of study involving abstractions, spatial relationships, and pattern perception.

8. General coordination deficits--May appear in either fine muscle performance or in over-all coordination or both.

9. Neurological signs most commonly seen are: transient strabismus, poor finger coordination, dysdiadochokinesia, mixed laterality, and non- specific speech defects.

10. Many authors emphasize that despite the presence of many or all of the above symptoms, the child not infrequently has a normal or near-normal I.Q.

As is readily apparent, the symptoms are not very specific and most do not apply to the pre-school child. Early diagnosis is extremely important in this condition because correct management can prevent a great deal of frustration which would otherwise result from constant attempts to push the child beyond the extent of his capacity.

Denhoff[10] described symptoms of cerebral dysfunction in the younger child (including refusal to nurse, difficulty sucking, excessive crying, startles easily, listlessness, inequality of limb function, strabismus, delayed speech, and convulsions). Again, these symptoms are not specific for diagnosing which of this young group of children should be classified in the minimal cerebral dysfunction group. Other authors argue that since the basic central nervous system lesion in this condition may be the result of a "maturation lag", the child would not be symptomatic during the first years of life.

It is important to realize that the degree to which a child with minimal brain dysfunction manifests the above symptoms depends on many variables (i.e. home and school environments, degree of CNS involvement, level of intelligence, underlying temperament, etc.). Also, a given child may not have symptoms in all or even many of the above areas.

Many workers[9,11] now believe the symptoms to be the

result of some CNS abnormality which interferes with the
ability of the child to perceive his environment and to
recognize its demands. They stress these factors of
perception and recognition and emphasize how frustrating
it would be to a child in whom these abilities were
limited in some way.

DIAGNOSIS

The procedures most helpful in assessing the possibili-
ty of organic brain damage are a careful and complete history
and physical exam. Then, if indicated, additional informa-
tion may be obtained via special neurological exam, evalua-
tion of emotional status, sensory evaluation, sensorium exam,
and intellect and perception through psychological testing.
These will be further elaborated upon in the following
discussion.

A careful gestation and developmental history is
invaluable and should include[1,14] virus illnesses during
pregnancy, bleeding, premature contractions, rupture of
membranes, birth weight, etc. The occurrence of prenatal
hemorrhage, toxemia, and prematurity have been reported to
be significant factors in the etiology of brain damage.[2,12]
Wiener,[30] et al have emphasized that an association
exists between low birth weights and brain damage. Neonatal
anoxia is often considered a likely cause of subsequent
behavioral abnormalities.[2,31] Other historical factors

which may be of significance include:[3] poor nutrition of mother during pregnancy, history of miscarriages, polyhydramnios, placental abnormalities, low Apgar, neonatal infections, abnormal head circumference, toxic and allergic reactions to immunizations, poor sucking ability, failure to gain weight, excessive crying that has no pattern or persists after 3-4 months of age, and excessive startle reaction. Pincus and Glaser[2] believe the presence of an active siezure disorder to be strong evidence of an "organic" background in behavioral disturbances. It must be remembered that a typical grand mal seizure is usually easily recognized but psychomotor seizures may present in many subtle ways.[2]

The importance of many of the above entities and their contribution to the eitology of this syndrome has not been well documented but, since it is believed to be a diffuse and variable process, multiple etiologic entities are probably usually involved.

The importance of a thorough history cannot be stressed too much since it is still one of the most accurate guides to the diagnosis. Many new diagnostic aids are being developed as will be discussed below but as yet, not are as standardized and as well documented as the clinical course.

A careful standard pediatric physical exam should be given all children suspected of belonging in the minimal brain damage group. In the "typical" case of minimal brain

damage, the ordinary physical exam is totally unrevealing.
However, a careful physical exam may give clues to the
diagnosis of other specific acquired or congenital disorders
i.e. the presence of cafe-au-lait spots will lead to a
(search for CNS tumors and retinal abnormalities, cataracts,
hepatosplenomegaly, etc. may lead to the diagnosis of
particular diseases for which specific therapy may be given).
Of particular importance in the examination of children with
apparent behavioral disorders is careful evaluation of
auditory and visual acuity. It has long been recognized
that poor auditory and/or visual acuity is difficult to
diagnose in the early years and may be the source of a good
deal of frustration for the child. New audiometric methods
and new possibilities for testing infants' visual
perception (i.e. Electro-oculography[11]) are being developed
which will greatly enhance early diagnosis of auditory and
visual abnormalities.

The routine physical exam should be supplemented with
a careful neurological exam. Anderson[11] and Boelsche[3]
recommend close observation of the child at play as an
excellent method of detecting such abnormalities as poor
coordination, clumsiness, mild choreoathetosis, and hand
tremors. Other neurological signs to be looked for include
ocular muscle palsy, impaired succession movements, and
hyper-reflexia. Extensor plantar responses have been

noted in a large number of these cases.[2,6,32]

Other items which may be of value in the "special" neurological exam include:[1]

1. Extension of arms, eyes closed: Abnormal--wide divergence of arms, convergence of arms, difference in arm levels, choreiform movements.

2. Coordination: Heal walk, toe walk, walk a line, hop on one foot, skip, stand on one foot, catch an object, observe gait, watch for over-shooting.

3. Cranial nerves: Test for nystagmus, pupillary reflexes, equality of pupils.

4. Deep tendon reflexes: Note symmetry.

5. Others: Rhomberg, dysdiadochokinesia, finger-nose, finger-thumb opposition.

Clements and Peters[1] have found the most common neurological abnormalities in minimally brain damaged children to be perceptual-motor difficulties, defects in gross coordination, defects in fine coordination, strabismus, reading difficulties, mixed laterality, some degree of ambidexterity, and the presence of or history of a speech defect.

More gross abnormalities of neuromuscular function may be apparent (i.e. hemianopia or hemiplegia) but this does not necessarily mean that the damaged areas producing these signs are also causing the abnormal behavior. Also, one must not be mis-lead by terms such as dysphasia, dyslexia, and dysgraphia since these seldom imply the focal significance in such children as they do in adults. Slow speech development and reading and writing difficulties

may merely represent a low-normal developmental progression and a familial incidence should be determined.

As emphasized by Anderson,[13] the evaluation of the mental status of the child and his environment should be included in the diagnostic work-up of a child with cerebral dysfunction. The attitudes of the patient, family members, teachers, and friends toward each other should be determined. It is apparent that it is frequently difficult to decide which behavioral disturbances have a pure psychogenic basis and which have an organic etiology as the primary factor. The school-aged child with minimal cerebral dysfunction has usually experienced such a great deal of frustration that there is a large amount of psychological overlay involved by the time that he is brought to the attention of the physician thus making the assessment of the degree of organic involvement a difficult task.

The sensory exam consists mainly of evaluation of auditory and visual acuity. It should be remembered that sensory abnormalities if not recognized early may be the source of much frustration and discouragement with secondary behavioral abnormalities. Also, frequently, sensory abnormalities are easily correctable which is another reason why this portion of the exam of a patient with behavior abnormalities is of such importance.

The electroencephalogram has proved to be a valuable

tool in evaluating the likelihood of organic dysfunction,
especially the possibility of seizures. It frequently can
be used to determine whether an abnormality is focal,
diffuse, or paroxysmal. However, the value of the EEG in
contributing to the diagnosis of minimal cerebral dysfunction
is questioned by many authors.[2,13,15,16] These authors
emphasize many drawbacks of the EEG with some of the more
important ones including: no electroencephalographic
changes are pathognomonic of diffuse brain damage; there is
a variation in standards of normality in the pre-adolescent
age group that makes interpretation of certain phenomena
difficult; and epileptic activity of deep structures may
be undetected in scalp-surface recording. Many of them
believe that electroencephalographic testing of patients
with behavior disorders should be limited to those patients
with seizures or those in whom petit mal epilepsy is suspected.

Despite these shortcomings of the EEG, many workers
have attempted to demonstrate its usefulness even in those
patients without seizures. Jasper[17] et al studied a group
of 71 behavior problem children and demonstrated: 71% of
the group with abnormalities in brain potentials; 59% with
very marked abnormalities; and 39% with "epileptiform"
electrical activity. Klinkerfuss[16] et al demonstrated
definitely abnormal EEG exams in 30% of hyperkinetic child-
ren with the most consistent changes being abnormally slow

frequencies. Nelson[18] et al compared independent findings
of pediatric, EEG, and psychologic exams and found a
significant but not very high degree of correlation. Another
use for the EEG is the photo-metrazol test as employed by
Laufer et al.[19] This test involves giving Metrazol until
a specific spike wave burst is seen on the EEG in response
to light stimulation. They found the threshold to this test
to be decreased in their group of children with behavior
disorders but the threshold was consistently increased by
the administration of amphetamines to these children.

Despite the many shortcomings, the EEG apparently can
furnish useful diagnostic information in evaluating children
with behavior disorders. Hyperventiliation, photic stimula-
tion, sleep recordings, and repeated testing should probably
all be utilized in evaluating these patients.

Another point of interest is that the arithmetic ability
of brain damaged children is frequently disproportionately
low when compared to other verbal and performance abilities.
Many[4,7] have noted that these specific learning disorders
apparently are the result of difficulty with abstraction,
classification, spatial relationships, and pattern perception.
All these areas are very difficult, especially in the very
young patient, to evaluate accurately but much work is being
done attempting to devise psychological tests which are
applicable to this age group as is discussed below.

The Bender Visual Motor Gestalt Test is a measure of perception and visual-motor coordination.[1,22,23] This test basically requires patients to copy pictures and figures "as he sees them." It is believed by many workers that the difficulty behind behavioral disorders of brain damaged children is of a perceptual nature and in the hands of well-trained psychologists, this type of test is a good measure of perceptual deficits. The Bender-Gestalt Test should always be utilized when conducting a psychologic evaluation of a behavioral disorder.

The Rorshach Test is also believed by some[23] to be a valuable adjunct to the diagnosis of organic brain damage in children. This test involves a verbal response to ink-blot stimuli. It is another measure of perceptual and symbolic thinking and can be very revealing if interpreted by a well-trained clinician.

The other major psychological tests utilized in making the diagnosis of organic changes are the standard intelligence tests, Wechsler and Standford-Binet. The Wechsler Intelligence Scale for Children (WISC)[33] is one of the most important psychological tests in the evaluation of childhood behavior disorders. This test consists of a minimum of five verbal subtests and five performance subtests and requires that the child be able to comprehend questions, organize response, and give verbal or performance response.

The most common abnormality reported[1,20,23] using this test is that children with organic brain abnormalities tend to do more poorly on the performance and full scales than on the verbal scale. The brain damaged child experiences difficulty with most of the performance scale items, but particularly the pure visual-motor perceptual tasks (i.e. block design, object, assembly, coding, and mazes). He has less difficulty with such items as picture arrangement and picture completion. The end result is that the performance I.Q. often falls in the mentally retarded range while the Verbal I.Q. is in the normal range or above.

Clements and Peters[1] found another common abnormal pattern in the WISC tests taken by brain damaged children to be one of scatter in either or both verbal and performance scales. Relative to the other subtest results, the lowest scores most frequently occurred in Arithmetic and Digit Span in the verbal scale and block design, object assembly, coding, and mazes in the performance scale. Other authors[2,4,8,23] have pointed out that those findings which have a significant degree of correlation with other diagnostic results in evaluation questionably brain damaged children include: perseveration; sequential repitition of the same response regardless of stimulus type; limitation of the number of responses; automatic phrases; and "color naming" responses.

The Gesell Developmental Scales are of value because

they allow psychological evaluation of children below three
years of age. Boelsche[3] has noted that children with mini-
mal cerebral dysfunction frequently show discrepancies
between motor, adaptive, language, and personal social
abilities. Usually, the motor and adaptive abilities are
subnormal whereas the language and personal social abilities
are within the normal range. This is similar to the WISC
test as mentioned above.

Much work has been done in an attempt to productively
incorporate these tests into the diagnostic work-up of a
suspected minimally brain damaged child. The value of
these tests in children has been questioned[2] because of the
lack of correlation of test results with neurologic status
or personality difficulties. Also, because of insufficient
correlation of performance on psychologic exams with the
location and type of lesion in children, these tests cannot
be used to determine the site of, or etiologic agent
responsible for an abnormality. However, much has been
and is being done attempting to standardize and correlate
psychological test results with other diagnostic findings.
It is hoped that in the future these tests will be used to
quantitate behavioral dysfunction and intellectual deficits
and serve as guides to therapy as well as indicators of the
progress of the theraputic program.

PHYSIOLOGY--PATHOLOGY

The physiologic and/or pathologic alterations under-
lying a syndrome such as this are largely speculative in
content. These behavioral symptoms are often thought of
as the result of diffuse disturbances but it is known that
small, discrete CNS lesions may produce severe behavioral
distortions. Pincus and Glaser[2] point out the close relation
of this syndrome to disorders of the limbic system, particu-
larly the psychomotor-temporal lobe seizures and the interic-
tal state. It is known that many children with psychomotor
seizures have significant behavioral changes. Some behavioral
abnormalities have been found to be associated with other
subtle seizure manifestations such as lip smacking and
myoclonic jerks. In these cases the behavioral symptoms
are considered to be part of the seizure phenomena.

Similar behavioral alterations have been noted to
occur during the interictal periods in children with petit
mal[34] and overt psychomotor seizures.[35] The impulsive,
aggressive, and hyperactive interictal behavioral patterns
noted by these workers were apparently independent of the
seizures, indicating that the behavioral changes are not a
continuum of the seizures but that the basic pathophysiology
is probably similar in both entities.

Lytton and Knobel[24] emphasize that the term organic
does not of necessity mean anatomical or structural lesions;

physiological encephalic dysfunction of unknown cause might be implicated, or dysfunction due to changes in encephalic enzyme systems may be present. These workers theorize that the lesion(s) is probably in the cerebral cortex and that the abnormal behavior is due to primitive diencephalic impulses not subject to the usual cortical control. They also point out that the Reticular Activating System and Thalamus both exert broad influence on the Cerebral Cortex and these areas should in included in further studies to locate the etiology of the abnormal behavior syndromes.

Other workers[5,19] attribute the etiology of behavior disturbances in children with minimal brain damage to alterations in the Diencephalon. They believe the disappearance of the behavioral abnormalities with age to be due to gradual cortical take-over of the functions previously controlled by the Diencephalon.

It is likely that the etiology of this kind of behavior is related to a combination of organic cerebral dysfunction and environmentally determined personality factors. The limbic system probably is vitally involved in the emotional life of a subject, and when it is disturbed by lesion and seizure, he is likely to experience periodic disturbing sensations not related to external reality. Penfield's work[36] seems to bear out this hypothesis. He found that the temporal lobe (in contrast to other areas of

the brain) is devoted, in large part, to the comparative interpretation of perceptions and to the conscious analysis of their significance. The resulting perceptual distortions and failure to evolve appropriate concepts from the formed stimuli of the environment is believed by many (as has previously been pointed out) to be the direct cause of the behavior abnormalities in the children with minimal cerebral dysfunction.

There is little histopathologic data to support any of the above hypotheses since very few children with this behavioral syndrome ever come to autopsy.

THERAPY

There are three general areas of therapy to be considered: pharmacologic; environmental; and psychotheraputic.

The use of anticonvulsant medication is always indicated in children with seizures of any variety. The prevention of seizures is important to prevent anoxic episodes and head trauma which may otherwise further enhance organic cerebral deterioration. It has been noted by several workers[35],[37] that the interictal behavior disorders may worsen, improve, or remain unchanged when the seizures are controlled with medication. The drugs which control seizures most effectively vary with each case and theraputic trials are often required to find the best one. In general, however,

diphenylhydantoin (Dilantin) and primidone (Mysoline) are
the drugs of choice in psychomotor seizures. Phenobarbital,
although a good anticonvulsant, often leads to an exascer-
bation of interictal behavioral symptoms.[2,5,6] The use of
anti-convulsants in the treatment of children with behavior
disorders and abnormal electroencephalograms who have no
seizures is usually unsuccessful but occasionally marked
improvement may result.

Probably the most widely used drugs in the treatment
of behavior disorders not associated with overt seizures
have been the amphetamines.[1,2,5,6,9,13,19,25] The para-
doxical action of amphetamines in modifying hyperactive
behavior and of phenobarbital and other barbiturates in
enhancing these abnormal behavioral symptoms has been noted
by many authors.[2,5,6] The most popular amphetamines are
dextro amphetamine sulfate (Dexedrine) and racemic
amphetamine sulfate (Benzedrene). The degree of effect-
iveness and the dosage required varies from case to case
and can best be determined through a carefully conducted
theraputic trial. The mechanism of action of the ampheta-
mines is largely speculative at present. Conners[25] has
hypothesized that these drugs may be operating more upon
the way behavior is perceived and organized relative to
environmental demands than merely in a sedating and
calming manner. Laufer[19] has shown that oral amphetamines

increase the CNS threshold of children with minimal cerebral dysfunction to the photo-Metrazol test. The mechanism and significance of this finding is not known at present.

Another popular drug has been methylphendate (Ritalin).[2,24,26,27] Again, the effectiveness and dosage can be determined in each individual case only through a theraputic trial program. Nichamin[26] believes Ritalin to be the drug of choice in school-aged children who have behavior disorders but no convulsions. He believes the degree of insomnia, anorexia, headache, tremors, etc. to be less than with the amphetamines. The mechanism of action of Ritalin, again, is unknown. Lytton and Knobel[24] have had good results with it and have shown that, in many cases, Ritalin improves reality testing, increases introspection, and increases mood stability. They believe the results to be due to a strong cortical component (both directly on cortex and indirectly through subcortical structures). They hypothesize that these patients are "cortically immature" and that Ritalin increases the degree of maturity resulting in "a decrease in absolute amount of motor activity but an increase in the amount of motor activity devoted to goal-directed behavior."

Other drugs that have had some usefulness include: chlorpromazine (Thorazine), thioridazine (Mellaril), diphenhydramine (Benadryl), and captodiame (Suvren). Apparently, however, the beneficial effects of most of these

drugs are unsustained after several weeks of continued administration. The dosages may have to be progressively increased or combinations of drugs given a trial.

Even though drug therapy may not completely alleviate the symptoms, they may control behavior enough to allow easier control of the patient and allow the patient to be more attentive and more receptive of instructions.

Of major importance in successfully managing these children is reduction in the frustrations that they experience through environmental changes. As stated by Anderson,[13] "the combination of understanding and acceptance by the adults dealing with the child is still the keynote to therapy." An important step in this direction is, once the diagnosis has been made, to describe the condition as completely as possible to the parents. The parents frequently are very relieved to know that the condition is not inherited or that it is not because they were "bad parents". Once this is accomplished, it frequently removes a great barrier between the parents and the child allowing the parents to become more understanding and accepting. Proper school management is also very important and an individualized teaching program is probably most ideal[1] but not always practical. Both at home and in school, a regular, structured, well-ordered existence with consistent, firm, fair discipline is the ideal goal of management.[2] Sustained concentration should not be demanded for long periods and distractions

should be minimized. Special techniques should be utilized
to replace the abstract with more concrete material. Verbal
instructions and examinations probably are much more benefi-
cial than those requiring reading and writing. Other aids
include utilizing geometric designs, form boards, puzzles,
kinesthetic clues, rhythmic singing, etc. Patterson et al[28]
offer strong support for the efficacy of behavior modifica-
tion techniques for the control of the hyperactive child
in a classroom setting. They also make reference to methods
of behavior conditioning with more involvement of the peer
group and others in their social culture.

Formal psychotherapy is another tool which may be
utilized to modify the abnormal behavior of the child with
minimal cerebral dysfunction. This has not been widely used
in the past, partly because those cases which were diagnosed
were handled adequately with appropriate drugs and environ-
mental alterations. Even today, psychotherapy is believed
to be indicated only in those cases in which both primary
and reactive psychiatric maladjustments dominate the
clinical picture.[2]

PROGNOSIS

It is generally agreed that the abnormal behavior
pattern of a child with minimal cerebral dysfunction will
show a general declining at the age of eight or nine years

and disappearing at adolescence. This is why early diagnosis and treatment is of the utmost importance. Proper management throughout the early years can make it possible for the patient to experience an essentially normal childhood and enter adulthood on an intellectual level approximating his peers and without overlying emotional disturbances which will interfere with proper adjustment. However, as pointed out by Oberman,[4] Thelander,[15] and Anderson,[29] if the condition is not recognized and properly treated early, secondary emotional disturbances arising from altered interpersonal relationships and poor intellectual development will make it extremely difficult for the patient to adjust to the demands of adulthood.

Menkes et al[7] believe the major prognostic sign to be the I.Q. of the patient obtained at the initial examination. However, it probably is safer to judge prognosis on the basis of the severity of the involvement as judged by various clinical facets and more importantly, on the basis of the response to therapy. It is difficult to determine the prognosis of such an entity in which the etiology is not known and the response to therapy so variable. It would be wise for a physician discussing the patient's future with the parents to explain the entity and its variability leaving much room for hope but without making exact predictions.

SUMMARY

The behavioral syndrome associated with "minimal brain damage" in children is described and discussed. Emphasis is made to the difficulty but importance of early diagnosis via utilization of a multi-facetted approach involving complete and accurate history and physical, the EEG, and psychologic tests. The etiology and patho-physiology underlying the disorder are not definite but probably organic and environmental factors both are involved. Therapy consists of drugs, environmental alterations, and psychiatric consuling and must be administered largely on an empirical basis with individualization for each new case. The prognosis is generally good, especially if an early diagnosis is made and proper therapy is instituted.

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