Cognitive Style and Motor Activity Levels in Spastic Cerebral Palsied Children

Suzanne E. Siróta

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Abstract

Suzanne E. Sirota

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The relationship between activity level and cognitive style was investigated in 15 spastic cerebral palsied (CP) and 15 nonbrain-injured school-aged children matched for age, sex and intelligence. No significant difference was found between the two groups on either the stabilimetric cushion or the Werry-Weiss-Peters Activity Scale. Contrary to expectation, latencies for the two groups did not differ on the Matching Familiar Figures Test (MFF) a finding which suggested that the CP children were not cognitively more impulsive. The significantly larger number of errors by the CP group points toward an impairment in dealing with visual information. An analysis of the response patterns which indicated the presence of a significant position effect in the CP group further supported this hypothesis. Implications for the educational development of these children were discussed.

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The classification of various forms of neurological impairment under the general and equivocal heading of brain injury has caused a good deal of harm and confusion in the area of psychological research. Thus, although vague, the definition of the brain-injured child by Strauss & Lehtinen (1947) and Strauss & Kephart (1955) has formed the basis for many hypotheses and theories. A brain-damaged child, according to these investigators, is one who suffered an infection of the brain or who incurred an injury to the brain either before, during, or after birth. Such an injury may or may not result in neuromotor dysfunctions. These authors have also been responsible for the widely held view that hyper-responsiveness to external stimuli is a significant behavioral feature of brain damage in children. They describe such children as being hyperactive, distractible, impulsive, and as having short attention spans and perceptual-motor problems.

Further support for this concept has come from various other sources such as Clements, Lehtinen & Lukens (1963) and McCarthy & McCarthy (1969) who included hyperactivity and impulsivity as cardinal features in their lists of characteristics of the brain-injured child. Though these authors were mainly concerned with minimal cerebral dysfunction, their description was used to characterize "brain-injured" children.

In recent years, warnings have been sounded about including all brain-damaged children in one diagnostic category and using such terms as "hyperkinetic impulse disorder" to describe the brain-damaged child (Benton, 1962; Eisenberg, 1964). In fact, cerebral palsy (CP), brain damage, minimal brain dysfunction and hyperkinetic impulse disorder are all used interchangeably in the sense that research populations of "brain-damaged" may include any or all of these.

The results of a study by Bortner & Birch (1969) comparing the performance of brain-damaged, emotionally disturbed and control children on the Wechsler Intelligence Scale for Children (WISC) indicate that cerebral insult does not necessarily result in cognitive impulsivity as described by Strauss and his associates. Furthermore, many brain-injured children such as those suffering from cerebral palsy have gross motor impairments and are therefore less active than nonbrain-injured children and brain-injured children without gross motor deficits.

Three conclusions emerge as a result of these studies. First, it is important to describe the brain-damaged population more precisely in future work. Secondly, as suggested by Cruickshank (1967), a distinction should be made between sensory and motor hyperactivity. He suggests that these two factors are not necessarily present at the same time and many relatively quiet children may demonstrate the sensory characteristics of the hyperactive child. In short, motor hyperactivity is not always correlated with cognitive impulsivity. Finally, a particular brain-injured population might best be described as hyperactive, impulsive, both hyperactive and impulsive, or neither hyperactive nor impulsive.

In order to describe these variables for a particular group of brain-injured children, it is necessary to attempt to measure activity and impulsivity independently. Measures of these dimensions will be discussed in the following sections. Such measures will be used in this study to describe a specified cerebral palsy population. The diagnosis and behavioral correlates of cerebral palsy will also be outlined.

Background

Reflection-impulsivity. A test devised to measure the cognitive dimension of reflection-impulsivity in children is Kagan's (1964) Matching Familiar Figures Test (MFF). As operationally defined by Kagan, impulsivity results in shorter reaction times and a larger number of errors in situations of high response uncertainty. Thus, while studying the cognitive processes in the child, Kagan, Rosman, Day, Albert & Phillips (1964) and Kagan (1965a) found that some children, when presented with a task requiring them to match one picture from a set of alternatives to a standard, respond quickly and make a large number of errors, whereas other children appear to be able to delay their responses and reflect over the possible solution hypotheses. According to Kagan, Pearson & Welch (1966), reflective children seem to consider the validity of alternative solutions and are able to inhibit potentially incorrect responses. On the other hand, impulsive children appear to have little concern for the correctness of their solutions and report the first answer that occurs to them.

A review of the literature on the reflection-impulsivity dimension indicates that decision times are relatively orthogonal to verbal ability as measured by the vocabulary and information scales of the WISC (Kagan, 1966) and a section of the Otis-Lennon Mental Ability Test dealing with verbal skills (Eska & Black, 1971). Similarly, Lewis, Rausch, Goldberg & Dodd (1968) found no significant relationship between the full scale Stanford-Binet IQ scores and latency on the MFF.

However, most studies revealed either low or significantly negative error-IQ correlations (Eska & Black, 1971; Kagan et al., 1964; Lewis et al., 1968; Ward, 1968; Yando & Kagan, 1968).

The pervasiveness of a reflective or impulsive attitude in situations of high response uncertainty has been demonstrated in a tachistoscopic recognition task (Kagan, 1965b). The average response times of second and third grade children to the recognition of incongruous pictures were positively associated with response latency in the MFF. Similarly, Kagan et al. (1966) found that impulsive children also had higher error scores and shorter response latencies on inductive reasoning tasks. This preferred conceptual tempo appears to be relatively stable with increasing task complexity (Yando & Kagan, 1970). Although Eska & Black (1971) were unable to find support for the generality of this dimension, they attributed the lack of intraindividual stability in response times to low task involvement in their subjects. In addition to the MFF, third grade children in this study were asked to tell a story about six pictures presented to them and were also asked to choose the preferred toy from a selection of seven. Only one significant relationship emerged from the intercorrelations of the various tasks, namely the correlation between response latency on the MFF and the picture story task in the case of the boys. These results led to the conjecture that neither the pictures nor the toys were challenging enough and thus aroused little interest in the children.

While a trend towards reflection or impulsivity can be detected as early as infancy (Kagan, 1965a, 1971), individual differences along this dimension have been observed in children as young as 27 months (Repucci, 1970). In this study, children who displayed longer response times in a conflict situation also showed more sustained directed activity with toys than impulsive children. Further evidence of these individual differences has come from studies with preschoolers (Lewis et al., 1968), kindergarten children (Ward, 1968), elementary school pupils (Eska & Black, 1971; Kagan, 1965c; Kagan et al., 1964; Messer, 1970), college students (Drake, 1970), and adults (Yando & Kagan, 1968). Moreover, an individual's position along this dimension remains fairly stable despite the existence of a developmental trend towards reflection with age (Campbell & Douglas, 1972; Kagan, 1965a).

There are indications of the modifiability of the reflection-impulsivity dimension though whether these changes are permanent has not been established. In an attempt to establish a set for delayed responses, Kagan et al. (1964) asked some subjects to respond as quickly as possible in a task requiring decision-making, whereas subjects in another group were told to take their time and to think about the answers. It was found that subjects in the "slow" group made significantly fewer errors and had longer latencies than subjects in the "fast" group.

Situational variables such as induced anxiety have resulted in increased latencies and fewer errors for impulsive subjects (Kagan, 1966; Messer, 1970; Ward, 1968). Furthermore, it has been demonstrated that a teacher's position on the reflection-impulsivity scale influences the conceptual tempo of the children (Yando & Kagan, 1968). Also, children previously classified as impulsive temporarily increased their response latencies on the MFF after witnessing the performance of a reflective model on an identical task (Debus, 1970).

Very little work has been devoted to exploring the relationship between cognitive impulsivity and motor activity in normal children. Kagan et al. (1964) did observe the playground behavior of second and third grade boys. They noted that impulsive boys engaged in more gross motor activity than nonimpulsive boys in this situation.

In summary, Kagan's Matching Familiar Figures Test has become a definition of reflection-impulsivity. A consistent negative relationship between response speed and accuracy has been demonstrated. Yet, this dimension is relatively independent of verbal intelligence. Though it has been related to developmental variables and environmental antecedents, its relationship to activity level in normal children has been relatively unexplored. At this point, the data from clinical studies becomes relevant.

Reflection-impulsivity in hyperactive children. Most of the research on the reflection-impulsivity dimension has been carried out with normal subjects, and at present there is a dearth of information about the relationship of an individual's conceptual tempo and his clinical status. One of the few studies in this area was carried out by Campbell, Douglas & Morgenstern (1971). They found that children whose chief complaint was hyperactivity, which had been present from early childhood and thus created a problem both at home and at school, had significantly higher error scores and shorter reaction times on the MFF than a matched group of control subjects. It was also found that there was a clear relationship between group membership and cognitive style, with the hyperactive children being predominantly impulsive and normal children predominantly reflective. It should be noted that children exhibiting gross signs of brain damage were excluded from this study.

In a review of investigations dealing with hyperactive children, Douglas (1972) reappraised the complex of symptoms associated with hyperactivity. Whereas it has generally been assumed that hyperactive children emitted more undirected motor activity than control children, she noted that measurement of activity level may have been confounded by other variables. Motor activity was presumed to be the guiding factor used by parents, teachers, and other professionals to classify children as hyperactive. However, it is possible that raters were reacting to deficits in attention, impulse control, and the ability to approach problems analytically. Tests which tap these variables consistently differentiate hyperactive and control children.

Though evidence generally supports the hypothesis that the children in these studies were both motorically and cognitively hyperactive, Douglas' review makes two facts clear. First, activity level is a very heterogeneous concept. This conclusion is supported by studies which show that different methods of measuring activity level have low intercorrelations (Cromwell, Baumeister & Hawkins, 1963). Secondly, it is important to measure impulsivity and activity level independently. With these factors in mind, measures of activity level will be reviewed.

<u>Measures of activity level in children</u>. Two general methods of measuring activity level are relevant to this study. These are parental questionnaires and direct observation or measurement of a child's movements.

With regard to parental questionnaires, the Werry-Weiss-Peters

Activity Scale is one method of obtaining information concerning the child's motor activity while at home, during trips and in school (Werry, 1968). As such, this multiple choice questionnaire is frequently used to determine treatment effects in drug studies of hyperactive children. Although no normative data are available for this scale, it was found that this method of obtaining information proved fairly reliable as long as the behaviors to be observed were objectively defined (Lapouse & Monk, 1958; Werry, Weiss, Douglas & Martin, 1966). For all seven activity categories covered by this questionnaire, the major emphasis is placed on the amount of gross motor activity displayed by the children. Behaviors such as wriggling, general restlessness and manipulation of body and objects thus figure more prominently than cognitive activities such as incessant talking or attention seeking. Cognitive impulsivity as it is usually defined is not tapped in this scale (see Appendix A).

Since the behavior categories in this scale seem to be tapping motor activity, are very clearly defined and can be quantitatively analyzed, it was decided to use it as an indirect measure of activity level in the present investigation.

A second manner of obtaining data on motor activity level relies on direct measures. Kagan et al. (1964) attempted to code the classroom and playground activity of normal school-aged children. They recorded limb and trunk movements during 10-second intervals for one or two 2-hour sessions. The amount of limb and trunk movements of children observed at their desks did not differentiate impulsive and nonimpulsive children.

In addition to coding observations of activity level, some attempts have been made to collect data using mechanical or electrical devices. The self-winding chronometer devised by Shulman & Reisman (1959) is such a device. It has been used in studies of kinesis in neurologically impaired and normal children. No significant difference in the total amount of activity recorded on the watch was found between the two groups. A possible reason for these findings is that what appears to be hyperactivity in these children is in fact task-irrelevant activity. More specifically, the difference between the two groups might be in the quality and not in the quantity of motor activity.

Devices which record the amount of vibration and wriggling of the subjects are also employed. Such a device is the stabilimetric chair designed by Sprague & Toppe (1966). It consists of a seat mounted on a platform which records posterior-anterior and left-right motion of the child while seated on it. An adaptation of this seat was used by Sykes, Douglas, Weiss & Minde (1971) in a study of hyperactive children. Due to technical problems, these investigators were unable to use the cushion for all four testing sessions. However, scores for the first two sessions indicated that hyperactive children were significantly more restless than normal control children. In the present study, the cushion used by Sykes et al. served as a direct measure of motor activity during the testing session.

Neither these measures of activity nor those of impulsivity have been explored in brain-damaged children. In the present study, an attempt was made to define the brain injured population in more precise terms than has been common. The following sections will provide some background on this diagnostic category.

Cerebral palsy: definition and description. Frequent reference is made to CP as one of the major categories of brain damage. Though it can loosely be defined as a form of motor impairment due to injury to the brain, both the type and severity of the condition are dependent on the locus and extent of the injury. Thus, CP is a very global term. Broadly speaking, it can be subdivided into five major categories each ranging from very mild to very severe. The two most common forms are spasticity and athetosis. Spasticity in turn can be subdivided into a) monoplegia: loss of control in one limb; b) paraplegia: loss of control in both legs; c) hemiplegia: loss of control in one arm and the corresponding leg and d) quadriplegia or diplegia: loss of control in all four limbs (Deaver, 1955; Oswin, 1967). These impairments are due to damage sustained in the cerebral cortex, whereas athetosis is largely the result of injury to subcortical, basal ganglion structures (Bortner & Birch, 1962). Athetosis is characterized by a lack of motor control of the whole body which may be accompanied by dribbling, lack of facial muscle control, speech impediments and hearing losses. It usually causes impairment in all four extremities (Deaver, 1955).

Damage to the cerebellum may result in ataxia, another form of CP characterized by a loss in balance and coordination. This condition is rare in its pure form. Resistance to slow passive motion constitutes another form classified as rigidity. Very frequently, damage to the brain covers several areas and it is often difficult to make a clear-cut diagnosis. Thus, a further category is that of the mixed type.

In addition to the actual motor impairment, CP children may suffer from other handicaps such as learning disabilities, hearing deficits, poor eye sight and speech defects (Oswin, 1967). A very high percentage --

approximately 60 to 70% -- are mentally retarded (Deaver, 1955). Yet, there is not necessarily a relationship between the severity of the physical handicap and the severity of the intellectual impairment. In fact, children with severe physical handicaps may exhibit greater intellectual abilities than less severely impaired children. Similarly, perceptual deficits may be present regardless of the extent of the motor involvement. Thus, there may be manifestations of perceptual impairment even without a visible physical handicap (Oswin, 1967). However, there is some evidence in the literature indicating that poor performance on some perceptual tasks is a function of the severity of the neurological involvement, regardless of the diagnostic category (Cobrinik, 1959). Moreover, in spite of a similar trend in this direction, Bortner & Birch (1962) also found that athetoid children performed significantly better than spastics on the WISC block design subtest, suggesting that spastics are more impaired perceptually than athetoids.

The nature of their handicaps causes many of these children to lead a very passive and frustrating life. The lack of normal childhood experiences and development very often results in further problems in the areas of emotional and behavioral adjustment.

In summary, CP is a very global term encompassing a wide range of motor deficits resulting from damage to specific areas of the brain. Disturbances in cognition, perception and emotional adjustment may accompany the actual physical handicaps. In order to select a relatively homogeneous sample of CP, it is necessary to specify (1) the type and extent of motor impairment and (2) the level of intellectual functioning. In this study, only spastic children of mild to moderately severe impairment and average intelligence were used. The following discussion of behavioral traits is to some extent limited to children in this category.

Behavioral correlates of cerebral palsy in children. Most of the studies to be reviewed in this section utilized CP children as subjects. In those studies whose samples were not defined, the subjects are referred to as brain-damaged.

With regard to activity level in brain-damaged children, several conflicting notions have appeared in the literature. Benton (1962) noted that the term "hyperkinetic impulse disorder" was frequently used to describe the complex of behavioral traits associated with brain damage in children of adequate intelligence. In addition to motor hyperactivity, such behavior characteristics as distractibility, impulsivity and short attention span are usually associated with this syndrome. As noted previously, these first descriptions of the brain-injured child stem from the work of Strauss & Lehtinen (1947) and Strauss & Kephart (1955). Support for this notion has come from clinical descriptions of children with minimal cerebral dysfunction (Clements, et al., 1963; McCarthy & McCarthy, 1969).

On the other hand, Browning (1967) proposed a hypothesis of hypo-responsiveness, suggesting that with IQ held constant, brain-damaged children are generally less responsive than normal children for any given time interval and stimulus situation. He reviewed studies of stimulus generalization, responsiveness to illusions, and verbal utterances in an effort to demonstrate that brain-injured children are hypo-responsive. However, both Browning and proponents of the hyperactivity hypothesis failed to make a distinction between cognitive and motor activity as suggested by Cruickshank (1967). This investigator proposed that there are two forms of hyperactivity which may occur together or separately: "sensory hyperactivity", which is sometimes referred to as distractibility, and "motor hyperactivity", also referred to as hyperkinetic activity. It is therefore possible for a child to be relatively passive physically and yet react impulsively on a cognitive level. Thus, there is at present no conclusive evidence indicating that brain-injured children are motorically either hypo- or hyperactive.

With regard to cognitive style, a number of studies have indicated that brain-injured children make more errors on perceptual tasks than nonbrain-injured children (Berko, 1954; Birch & Lefford, 1964; Cobrinik, 1959; Dolphin & Cruickshank, 1951; Stephenson, 1957). Cobrinik (1959) used CP subjects and found that these children made significantly fewer correct responses than nonbrain-injured subjects on a hidden figures test.

Several hypotheses regarding the nature of the perceptual deficit in these children have been made. It has been suggested that perceptually deficient children simply do not "see" the solution. This hypothesis has not been supported by studies which have controlled for visual anomalies (Mednick & Wild, 1961; Santostefano, 1964). Furthermore, Bortner & Birch (1962) found that visual discrimination could be viewed as a separate process from visual reproduction and that in brain-injured children visual perception is often intact. These investigators presented two groups of CP children ranging in age from eight to 18 years with a modified version of the WISC block design subtest. Even though the children experienced difficulty in reproducing the designs, they were nevertheless able to discriminate between correct and incorrect reproductions of most of the failed tasks. The investigators suggested that this discrepancy between the ability to discriminate and the ability to reproduce reflects different stages in ontogenetic development. Visual reproduction, representing a higher level of development and requiring more complex processes would thus be more susceptible to brain injury than visual discrimination which is at a lower ontogenetic level. It would seem that it is not possible to conclude that inability to see differences in stimuli could fully account for the poor performance of brain-injured children on such tasks.

Another theory which has been advanced is that brain-injured children perform poorly on perceptual tasks because they do not attend to relevant stimuli. They are distractible and impulsive. However, in order to evaluate this theory, it is necessary to use some direct measurement of this dimension such as the recording of response latencies in tasks of high response uncertainty.

Research has lent some support to the idea of the brain-injured child as being more impulsive. Lowry & Campbell (1972), for instance, found that both focal and general epileptic school-aged children rated more impulsively on the MFF when compared to nonbrain-injured children. In this study, impulsivity was directly measured but CP children were not used.

Those studies which did utilize CP children did not directly measure cognitive style. However, White (1971) observed that CP preschoolers who made significantly more errors on a discrimination and form sorting task than either normal or economically disadvantaged subjects, seemed to respond more impulsively.

One study seems contrary to the expectations of distractibility and impulsivity in brain-damaged children. A factorial analysis of the intercorrelations of WISC subtest scores of emotionally disturbed and brain-damaged children revealed that the brain-damaged group had loadings similar to a standardization sample with respect to a factor consisting of attentional, concentration and number components. However, the emotionally disturbed children produced much heavier loadings on this factor than either of the other two groups (Bortner & Birch, 1969). Although these findings seem to contradict the notion of impulsivity, Bortner & Birch also suggested another plausible explanation for this discrepancy, namely that the performance of emotionally disturbed children is influenced by more diverse behavior tendencies than the brain-damaged group. In summary, most of the clinical observations and studies still seem to support a hypothesis of impulsivity.

Another group of investigators have put forth a different hypothesis as to why brain-injured children perform poorly on perceptual tasks. Mednick & Wild (1961) found that after having trained subjects to lift a finger from a reaction key whenever a certain lamp was lit, CP children did not respond as frequently as a control group of nonbrain-injured subjects when other lights on the panel were illuminated. The investigators regarded these results as evidence of lowered stimulus generalization in the brain-damaged group, suggesting that these children are more stimulus bound and concrete.

Thus, while there appears to be general agreement that CP children perform poorly on perceptual tasks, several theories have been advanced to account for this deficit. Similarly, there still appears to be some controversy regarding activity level and cognitive style in these children.

Statement of the problem. Several facts emerge from the review of the literature. First, there is no conclusive evidence linking brain damage in children with hyperactivity. In fact, some investigators have suggested that brain-injured children are actually less active physically than nonbrain-injured children. Second, there seems to be a general failure to distinguish between motor activity and cognitive style. And third, while it has been established that brain-injured and specifically CP children perform poorly on perceptual tasks, several theories have been advanced to account for this perceptual deficit. One of the hypotheses is that impulsivity characterizes the response style of brain-injured children and contributes to perceptual deficits. In view of these findings, it was decided to explore the relationship of motor activity and cognitive style to clinical status.

Although measures of activity level and cognitive style have been used independently on different populations, they have not been combined in an investigation of brain-injured children. In the present study, motor activity in spastic CP children was investigated with two measures of activity level, one direct and one indirect. Though evidence from the literature suggests that these children are motorically hypoactive, clinical observations seem to indicate that they are in fact hyperactive. On the basis of these conflicting views, their scores on both the stabilimetric cushion and the Werry-Weiss-Peters Activity Scale were compared to those of a matched control group of nonbrain-injured children.

Since impulsivity is frequently cited as one of the behavioral correlates of brain damage, it was also expected that these children would perform impulsively on a perceptual recognition task. Specifically, it was hypothesized that CP children will make more errors and have shorter latencies on the MFF than a control group of nonbrain-injured children.

Finally, a third purpose of this study was the investigation of the nature of the relationship between motor activity and cognitive style in these children. Although the amount of gross motor activity was found to differentiate between impulsive and nonimpulsive neurologically intact boys, there is at present no indication to suggest that motor hyperactivity necessarily results in cognitive impulsivity, and that there is a one to one relationship between these two personality dimensions. In short, an attempt was made to investigate the performance of spastic CP children on a perceptual matching task and to explore the relationship between cognitive style and motor activity levels.

Method

Subjects

A group of 15 CP children and a matched control group of 15 nonbrain-injured children participated in this study (see Appendix B). All experimental subjects were out-patients at the Montreal Children's Hospital and were of at least dull normal intelligence. In all cases, estimates based on WPPSI, WISC or Stanford-Binet scores were obtained from hospital records. Only children medically diagnosed as spastic CP cases were accepted into the clinical group. Thus, children with such related problems as hyperactivity, epilepsy or other known disabilities were excluded. The experimental subjects belonged predominantly to the lower-middle and middle class socio-economic levels.

The CP group consisted of four girls and 11 boys ranging in age from 6 years 5 months to 12 years 9 months, with a mean of 8 years 11 months. Their IQ's ranged from 78 to 114 with a mean of 98.5. Six of the children were students in a school for handicapped children. Of the remaining nine children attending regular schools, only two children were in special classes.

The control group consisted of children from normal classes in a predominantly middle class elementary school in the Montreal area. The children in this group were individually matched with their CP counterparts on the basis of age, sex and IQ. Their ages ranged from 6 years 6 months to 12 years 10 months with a mean of 9 years. A t test for matched samples indicates that the two groups did not differ significantly with respect to age ($t = .76$, $df = 14$, $p > .05$). The IQ for the control group ranged from 79 to 114, with a mean of 99.9. Again, the two groups were well matched with respect to this variable ($t = .47$, $df = 14$, $p > .05$). It is necessary to note that the estimates of intellectual functioning were based on a number of measures, and that not all IQ measures were obtained immediately prior to the MFF administration. Though the data were used for matching of the subjects, this possible source of error must be kept in mind.

Parents of the children selected for both groups were contacted by mail and only children for whom parental permission was secured were tested.

Test Materials

Measures of activity level. General activity level while at home, during trips and in school was evaluated by means of the Werry-Weiss-Peters Activity Scale (Werry, 1968) (Appendix A). The weighted scores obtained from the answers served as an indirect measure of motor activity.

A more objective and direct measure of activity during the testing session was provided by a modified version of the Sprague & Toppe (1966) stabilimetric cushion. Both posterior-anterior and lateral motions of the subject activated microswitches which were connected to a digital counter. Thus, it was expected that the score on the counter accurately reflected the child's activity during the test performance.

Measure of cognitive style. The Matching Familiar Figures Test (Kagan et al., 1964) was used as a measure of cognitive style. This test consisted of 14 sets of familiar objects, two practice items and 12 test items. Each set consisted of a standard and six variants of which only one was an exact duplicate of the standard. (Sample items and instructions can be found in Appendix C).

Procedure

Prior to or during the testing session, the parents of each child were asked to fill out the Werry-Weiss-Peters Activity Scale. Each subject was tested individually. CP children were seen at the Montreal Children's Hospital or, if the parents were unable to bring their child to the hospital, a home visit was arranged. All the control subjects except one were tested in the school.

In order to obtain an estimate of their intellectual functioning, the Peabody Picture Vocabulary Test was administered to those control subjects for whom no IQ data were available. The MFF was then administered to all subjects while they were seated on the cushion. Each standard and its variants were presented simultaneously and the subject was asked to find the variant which was identical to the standard. A maximum of six trials was permitted per item at which point the experimenter indicated the correct answer. Latency to the first response and number of errors were recorded for each item.

Testing was completed in one session lasting approximately one half hour.

Results

Measures of Activity Level

Motor activity during the testing session. The number of movements for each child during testing was measured using the stabilimetric cushion. The scores of children in both groups were variable with the number of recorded movements ranging from 0 to 50 with an average of 10.27 for the experimental group, and from 0 to 27 with an average of 11 for the control group.

Since the subjects were matched, the Wilcoxon matched-pairs signed-ranks test (Siegel, 1956) was used to test the significance of the difference in scores of the two groups. This difference was not significant ($T = 46$, $N = 14$, $p > .05$). It can be concluded that CP children were not more active than nonbrain-injured children on this measure.

It was feared that the audible clicks of both the seat and the counter might have acted as a distracting influence for the children. Although most of the children became aware of the sounds, only one child in the experimental group discovered the relationship between his movements and the clicks and deliberately wriggled to produce the sounds. This accounts for the score of 50 in the CP group. However, elimination of this score and its control counterpart did not affect the results ($\underline{T} = 32$, $\underline{N} = 13$, $\underline{p} > .05$).

General activity level. Answers to the Werry-Weiss-Peters Activity Scale were scored in accordance with general directions, with a score of 0 for a "No" answer, a score of 1 for an answer of "Some", and a score of 2 for an answer of "Much". As in the case of motor activity during the testing session, the Wilcoxon test showed that the scores were not significantly different ($\underline{T} = 32$, $\underline{N} = 14$, $\underline{p} > .05$), indicating that the two groups did not differ in general activity level as rated by their mothers.

The questionnaire consists of 33 questions and it is thus possible to obtain a maximum score of 66. It is interesting to note that in relation to this score, both groups obtained relatively low averages with the experimental group obtaining an average of 14.35 points and the control group averaging 11.67.

Activity level intercorrelations. In order to determine if there was a relationship between these two activity measures, the Spearman rank correlation coefficient (Siegel, 1956) was computed for each group. In the case of the experimental subjects there was agreement between scores on the stabilimetric cushion and scores on the Werry-Weiss-Peters Activity Scale ($\underline{r_s} = .467$, $\underline{N} = 15$, $\underline{p} < .05$, one-tailed). For the control group, however, the correlation between these two measures was not significant ($\underline{r_s} = -.134$, $\underline{N} = 15$, $\underline{p} > .05$).

Exclusion of the seat score of 50 in the CP group resulted in eliminating the significant seat-questionnaire relationship (r_s = .387, N = 14, $p > .05$). The result for the control group was not appreciably affected by the removal of the counterpart of this score (r_s = -.176, N = 14, $p > .05$).

Measures of Cognitive Style

Error and latency comparisons. Two scores can be obtained from the MFF test: a) the total number of errors and b) the mean latency for each subject. The Wilcoxon test was used to compare the two groups on these measures. As was predicted, the CP children made significantly more errors than the control group (T = 23.5, N = 15, $p < .025$, one-tailed). Inspection of the total number of errors for each test item (see Appendix D) indicates that CP children made more errors than the control group on all but two items. These data suggest that the two groups experienced difficulty on the same items.

Contrary to expectation, a comparison of mean latencies produced no significant difference between the two groups (T = 41, N = 15, $p > .05$), indicating that CP subjects did not respond more quickly than control subjects. However, an examination of response times on an item by item basis indicates that control subjects had somewhat longer latencies than the CP group (see Appendix E). The one deviation from this pattern was due to the exceptionally long latency of 238 seconds for item 9 by one of the CP children. An analysis of variance of the data classified according to groups and items indicates that there was a significant item effect (F = 1.99, df = 11 and 154, $p < .05$). However, both the group effect and the Group x Item interaction resulted in F ratios smaller than 1, further corroborating the results that the CP group did not respond more quickly than the control group.

A combination of error and latency scores can be used to determine a subject's classification as either reflective or impulsive. Thus a reflective child is one who scores above the median in latency and below the median in number of errors, whereas an impulsive child scores above the median in errors and below the median in latency. A median split performed on the combined scores indicates that out of 11 impulsive children, seven were CP subjects, whereas out of 11 clearly reflective children, seven belonged to the control group. These differences, however, were not significant ($X^2 = .727$, $df = 1$, $p > .05$).

In summary, these data do not support the hypothesis that CP children are more impulsive than matched controls. It is necessary to look for other explanations of their poor performance on perceptual tasks.

Latency-activity level correlations. Kagan, et al. (1966) suggested that it is more convenient to use latency as an index of reflection-impulsivity when sample sizes are small. This is possible since there is always a strong negative correlation between latency and errors. In the present study, the error-latency correlations for both groups were significant beyond the .05 level ($r_s = -.502$, $N = 15$, $p < .05$ for the control group; $r_s = -.600$, $N = 15$, $p < .05$ for the experimental group) and are thus consistent with previous findings.

The relationship between impulsivity (using latency as an index) and motor activity in both groups was investigated by using the Spearman rank correlation coefficient and a correction for ties. As can be seen from Table 1, none of the correlations approached significance. Thus,

Table 1

Latency-Motor Activity Correlations (r_s)

for Cerebral Palsy and Control Groups

Group	Latency-Seat	Latency-Questionnaire
CP	.078	-.027
Control	-.013	.025

neither the CP group nor the control group showed any significant correlation between latency and activity on the stabilimetric cushion ($r_s = .078$, $N = 15$, $p > .05$ and $r_s = -.013$, $N = 15$, $p > .05$ respectively). Similarly, there was no significant relationship between latency and general activity level according to the Werry-Weiss-Peters Activity Scale ($r_s = -.027$, $N = 15$, $p > .05$ for the experimental group and $r_s = .025$, $N = 15$, $p > .05$ for the control group).

Latency-IQ and error-IQ correlations. Correlations between latency and IQ of .134 ($N = 15$, $p > .05$) and .41 ($N = 15$, $p > .05$) obtained for the control and CP groups were not significant. This finding is consistent with results of previous investigators who found latency to be relatively orthogonal to verbal IQ.

Similarly, error-IQ correlations of -.349 ($N = 15$, $p > .05$) for the control group and -.483 ($N = 15$, $p > .05$) for the CP group were not significant. Due to the large number of errors made by CP subjects on the MFF test, it was considered important to analyze the performance IQ-error relationship in the 10 CP subjects for whom these data were available. A low negative, but nonsignificant correlation ($r_s = -.219$, $N = 10$, $p > .05$) was obtained, indicating that poor performance on the MFF test was relatively independent of performance IQ in these subjects.

Analysis of error patterns. As the total number of errors effectively discriminated between the two groups, but neither full scale nor performance IQ measures were significantly related to error measures, it was decided that an examination of the children's response patterns might shed some light on the nature of the differences. Thus, the possibility that different response strategies were responsible for the larger number of errors by the CP group was investigated. In order to record the responses, the variants for each stimulus item were numbered from one to six, starting with the item in the upper left-hand corner of the page, proceeding across the three items on the upper line and continuing with the lower line, thus ending with the item in the lower right-hand corner.

When the various response forms were examined, it was found that the children followed one or more of four different patterns. The first one was a random selection of answers, that is no set pattern of responding. This manner of responding was used most frequently by the control subjects.

A second pattern of responding was that of choosing variants in series. (For the purposes of this paper, a series was considered to consist of at least three variants following each other consecutively, either forwards or backwards for the same item, such as 1-2-3 or 6-5-4). Ten of the 15 CP children used this pattern at least once, whereas only five of the 15 control subjects responded in this manner at least once. However, using a $\underline{X}^2$ analysis, no significant association between group membership and this particular response style was found ($\underline{X}^2 = 2.13$, $\underline{df} = 1$, $\underline{p} > .05$).

A third response pattern consisted of a form of perseveration, in which the same variant was chosen more than once for any given standard. This occurred for at least one item for eight of the CP subjects, whereas it only occurred for four of the control subjects. Again the association between group membership and this response form was not significant ($\underline{X}^2 = 1.25$, $\underline{df} = 1$, $\underline{p} > .05$).

The fourth and most interesting pattern which emerged was that of position effect. It was found that some subjects frequently began with a variant in a particular position regardless of its appropriateness. Thus one CP child began with the first variant 10 out of 12 times, out of which only two first choices were correct. Another CP child chose the variant in first position seven times with only one initially correct choice, and chose variant number 4 the remaining five times with no correct first choice. It was decided that any position which was chosen at least five times with no more than one correct first choice would be considered a position effect. Therefore, using five as a cut-off point, it was found that only one control subject exhibited this tendency, whereas seven CP subjects manifested a similar pattern, with one of these children actually using two different positions. Use of the Fisher exact probability test (Siegel, 1956) indicates that there was a clear association between group membership and the tendency to begin the responses to any given item with a variant in a particular position. (p = .0176). These results suggest that CP and normal children do not employ the same response patterns.

Discussion

The results of the present study indicate that the spastic CP children investigated do not differ significantly from a normal control group with respect to motor activity. While it may have been expected that these children would be less active motorically due to their physical handicaps (Oswin, 1967), neither the scores on the stabilimetric cushion nor the results of the Werry-Weiss-Peters Activity Scale support this hypothesis. Nor was the clinically observed hyperactivity supported by the results of the study. These findings may in part be explained by the nature of the sample tested. Only spastics of at least dull normal intelligence and with no other associated defects were accepted into the experimental group. Thus, more than half of the children in this group were able to attend classes in regular school and were not confined to the restricted environment usually associated with physically handicapped individuals. The extent to which each of these variables is responsible for the normal physical activity levels cannot be established in this investigation. However, both hyperactivity and hypoactivity have been reported as consequences of inadequate environmental and physical stimulation (Yarrow, 1961).

It may be of interest to note that a significant correlation was found between the two motor activity scores for the experimental group, when the subject who was aware of the clicks was included, whereas no such relationship could be established in the control group. Although all the children were equally exposed to this sound, only one child reacted by deliberately producing the clicking sounds. Since this child's behavior can be taken as a reflection of his particular personality, his data should not be excluded from discussion. In view of the general lack of intercorrelations reported among the various measures of activity level in other studies (Cromwell et al., 1963), the significant relationship between the two activity scores for the CP group merits further investigation. Questionnaires such as the Werry-Weiss-Peters Activity Scale are mainly based on parental and clinical observations. Although this particular scale is generally used with hyperactive children, it nevertheless covers behaviors common to all children. Thus, since there is relatively frequent contact between parents of CP children and clinicians, they may both be aware of and look for the same behavior patterns. This hypothesis may partially account for the correlation of scores on this scale and the relatively objective measure of motor restlessness during the testing session.

As operationally defined by Kagan's MFF test, the CP children tested are not cognitively impulsive as are general and focal epileptics (Lowry & Campbell, 1972) or hyperactive children (Campbell, et al., 1971). Although Kagan (1966) suggested that brain-damaged children are more likely to be impulsive, the present results are inconsistent with the notion of hyperactivity and impulsivity associated with the brain-injured child (Strauss & Kephart, 1955), Strauss & Lehtinen, 1947), and are more in line with Benton's (1962) findings. He noted that the "hyperkinetic impulse disorder" is rarely manifested by children with obvious neurological impairment. On the other hand, neither is there any evidence of hypo-responsiveness as suggested by Browning (1967).

While the CP children had shorter latencies than the control group in an item by item analysis, the difference in reaction times between the two groups was not significant. The only meaningful difference occurred in the number of errors. Thus the production of a larger number of errors by the CP group is more in line with Cobrinik's (1959) study and suggests that the poorer performance is related to central factors other than attentional deficits and impulsivity. An analysis of the types of errors made tends to confirm the hypothesis that these children experience difficulty in dealing with visual information. The significant position effect found in the

CP group lends support to Mednick & Wild's (1961) suggestion that these children may be more concrete and stimulus bound. It would seem that they are completely overwhelmed when they must deal with a perceptual problem of high response uncertainty. They tend to resort to developmentally immature response strategies. In part, choosing the correct answer on the basis of position may contribute to the clinical observation of impulsivity in some brain-injured children.

It should be emphasized that the present results apply only to a very specific group of CP children. Other diagnostic groups such as athetoids may manifest different behavioral patterns. Generalizations with respect to these findings must therefore be limited to spastic CP children. With these reservations in mind, it is possible to discuss the implications of the present findings and their relevance to the educational development of these children. Since the CP children were not cognitively more impulsive than normal subjects, training in delaying responses and the more efficient use of the time intervals would not significantly benefit their school performance. Instead, it may be more beneficial to subject these children to very specific training in visual perception. As noted by Birch & Lefford (1964), these children's difficulty appears to be mainly in the areas of visual analysis and synthesis, and as such, training should be concentrated in these areas. It would also seem to be more important to structure perceptual problems so that they are within the range of competence or only mildly difficult for the CP child. This procedure would ensure that CP children do not become overwhelmed, make large numbers of errors, and become even less selfassured about their problem solving abilities. Further research probing the impairment in handling visual information and its relationship to cognitive style might prove fruitful.

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Appendix A

Werry-Weiss-Peters Activity Scale

	No	Some	Much
DURING MEALS			
Up and down at table	___	___	___
Interrupts without regard	___	___	___
Wriggling	___	___	___
Fiddles with things	___	___	___
Talks excessively	___	___	___
TELEVISION			
Gets up and down during program	___	___	___
Wriggles	___	___	___
Manipulates objects or body	___	___	___
Talks incessantly	___	___	___
Interrupts	___	___	___
DOING HOMEWORK			
Gets up and down	___	___	___
Wriggles	___	___	___
Manipulates objects or body	___	___	___
Talks incessantly	___	___	___
Requires adult supervision or attendance	___	___	___
PLAY			
Inability for quiet play	___	___	___
Constantly changing activity	___	___	___
Seeks parental attention	___	___	___
Talks excessively	___	___	___
Disrupts other's play	___	___	___
SLEEP			
Difficulty settling down for sleep	___	___	___
Inadequate amount of sleep	___	___	___
Restless during sleep	___	___	___
BEHAVIOR AWAY FROM HOME (EXCEPT AT SCHOOL)			
Restlessness during travel	___	___	___
Restlessness during shopping (includes touching everything)	___	___	___
Restlessness during church/movies	___	___	___
Restlessness while visiting friends, relatives, etc.	___	___	___
SCHOOL BEHAVIOR			
Up and down	___	___	___
Fidgets, wriggles, touches	___	___	___
Interrupts teacher or other children excessively	___	___	___
Constantly seeks teacher's attention	___	___	___

TOTAL

Appendix B

Subject Characteristics

Spastic cerebral palsied children

S 1: male, age 6 - 5, WPPSI F 91, V 95, P 88, paraplegic, attends school for handicapped children.

S 2: female, age 6 - 10, WPPSI F 78, V 90, P 69, quadriplegic, attends school for handicapped children.

S 3: male, age 7 - 1, WPPSI F 104, V 106, P 101, paraplegic, attends special class in regular school.

S 4: male, age 7 - 4, WPPSI F 109, V 116, P 99, hemiplegic, attends grade one in regular school.

S 5: female, age 7 - 7, WISC F 104, V 101, P 104, paraplegic, attends grade two in regular school.

S 6: female, age 7 - 9, WPPSI F 88, V 82, P 96, diplegic, attends grade two in regular school.

S 7: male, age 7 -11, Stanford-Binet 94, paraplegic, attends school for handicapped children.

S 8: male, age 9 - 5, WPPSI F 96, V 97, P 96, hemiplegic, attends special class in regular school.

S 9: male, age 11 - 2, WISC F 99, V 103, P 94, diplegic, attends school for handicapped children.

S 10: male, age 11 - 8, WISC F 99, V 113, P 83, hemiplegic, attends grade six in regular school.

S 11: male, age 12 - 1, WISC F 107, V 110, P 101, quadriplegic, attends school for handicapped children.

S 12: male, age 7 - 3, Stanford-Binet 111, quadriplegic, attends grade one in regular school.

S 13: female, age 7 - 5, approximate Stanford-Binet 90, diplegic, attends school for handicapped children.

S 14: male, age 11 - 4, Stanford-Binet 94, diplegic, attends grade six in regular school.

S 15: male, age 12 - 9, Stanford-Binet 114, hemiplegic, attends grade six in regular school.

Control children

S 1: male, age 6 - 6, PPVT 79, grade one.

S 2: female, age 6 - 10, PPVT 99, grade one.

S 3: male, age 7 - 2, PPVT 89, grade one.

S 4: male, age 7 - 9, PPVT 90, grade two.

S 5: female, age 7 - 5, PPVT 99, grade one.

S 6: female, age 6 - 11, PPVT 100, grade one.

S 7: male, age 8 - 1, PPVT 105, grade two.

S 8: male, age 9 - 1, WISC 99, grade four.

S 9: male, age 11 - 3, Lorge-Thorndike 100, grade five.

S 10: male, age 11 - 10, Lorge-Thorndike 99, grade six.

S 11: male, age 12 - 4, Lorge-Thorndike 112, grade six.

S 12: male, age 7 - 2, PPVT 114, grade one.

S 13: female, age 7 - 7, PPVT 102, grade two.

S 14: male, age 11 - 7, Lorge-Thorndike 106, grade six.

S 15: male, age 12 - 10, Lorge-Thorndike 106, grade seven.

Appendix C

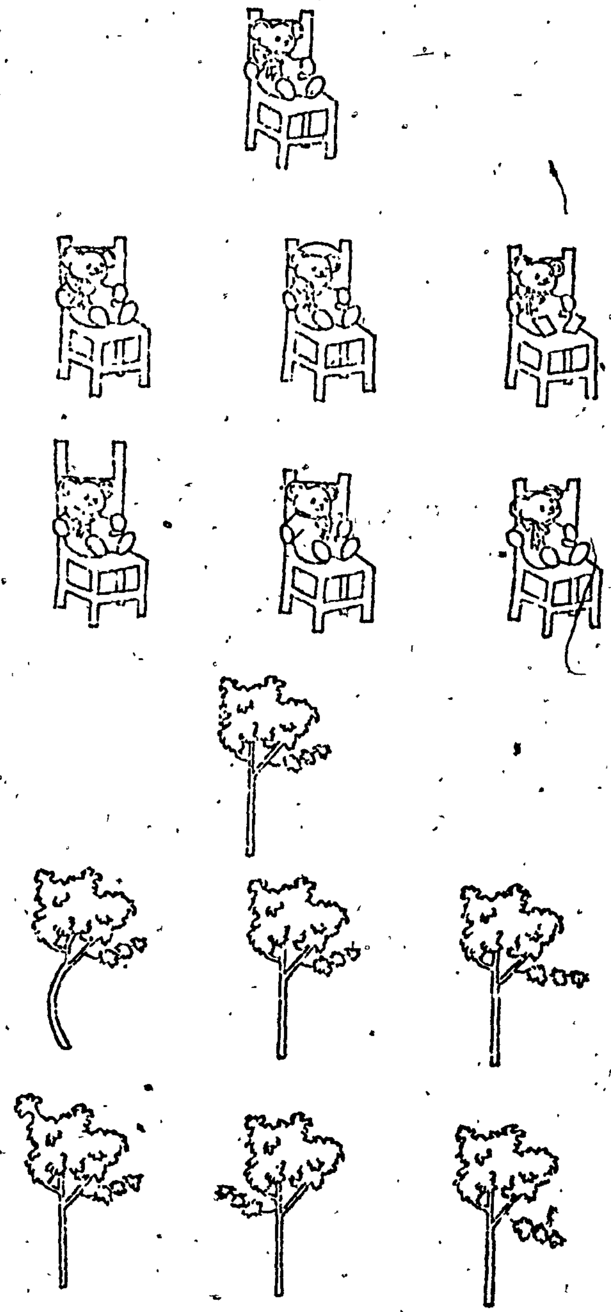

FIG. 1.—Sample item from MFF.

Administration of the MMF Test

The test is set up in a loose-leaf binder with the pages covered by clear plastic. The standard and variants for each item are placed on adjoining pages and are presented to the subject at right angles accompanied by the following instructions:

"I am going to show you a picture of something you know and then some pictures that look like it. You will have to point to the picture on this bottom page (point) that is just like the one on this top page (point). Let's do some for practice." The experimenter helps the child with the two practice items and then goes on:

"Now we are going to do some that are a little bit harder. You will see a picture on top and six pictures on the bottom. Find the one that is just like the one on top and point to it."

If the answer is correct, the experimenter will praise the child. If the answer is wrong, the experimenter will say: "No, that is not the right one. Find the one that is just like this one (point)." If the child does not find the correct solution after six trials, the experimenter will show the correct answer and will then go on to the next item.

Appendix D

Total Number of Errors Per Item

for Cerebral Palsy and Control Groups

Item	CP (Groups)	Control (Groups)
1	22	21
2	21	13
3	31	28
4	19	21
5	7	6
6	26	12
7	28	25
8	24	29
9	30	14
10	24	19
11	24	15
12	29	25

Appendix E

Mean Latency Per item for Cerebral Palsy and Control Groups

Item	CP (Groups)	Control (Groups)
1	6.93	10.93*
2	5.27	9.90
3	8.80	11.80
4	7.30	9.77
5	6.63	8.07
6	3.87	8.90
7	7.27	10.00
8	7.10	12.50
9	23.97	13.27
10	10.10	12.43
11	11.83	15.57
12	9.80	12.30