THE EFFECT OF RITALIN ON WISC-R BLOCK DESIGN, WISC-R CODING AND BENDER GESTALT DEVELOPMENTAL SCORES OF HYPERACTIVE CHILDREN

DISSERTATION

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By

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Psychological research suggests that Ritalin reduces the rate of maladaptive behaviors in hyperactive children but does not improve their academic performance. Teachers, however, often assert that writing skills and other graphic work are improved by Ritalin. Twenty elementary school children who had been diagnosed as hyperactive and who were taking Ritalin were tested using WISC-R coding, WISC-R block design, and Bender Gestalt. Ten of the subjects were assigned to a group which was first tested when the children were off Ritalin and subsequently tested when they were on Ritalin. The sequence was reversed for the remaining ten. This procedure was designed to counterbalance the effect of practice. Direct difference t-tests indicated that there were no differences between groups regarding any of the three dependent measures. Thus, results indicate that the popular conceptions among educators regarding the efficacy of Ritalin for improving visual-motor efficiency is open to serious question.
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Introduction

Hyperactivity is a problem long recognized as interfering with the learning process in elementary-age children. However, the first Diagnostic and Statistical Manual of Mental Disorders (DSM) of the American Psychiatric Association (1952) did not recognize the problem, but by the time of the publication of DSM-II (1968), the condition was characterized as a "hyperkinetic reaction," a classification which is often socially referred to as "restlessness" or "constant motion." It was assumed that this restlessness was concomitant with a short attention span which interfered with the learning process. As early as the 1970's, it was said to occur in five to ten per cent of the American school population (Wender, 1971).

By the time DSM-III was published (1980), it had been assumed that the major factor of consequence was, indeed, the shortening attention span. The condition was called "attention deficit disorder," with the hyperkinetic aspects considered symptomatic or adjunctive. Specifically the title was 314.01 Attention Deficit Disorder with Hyperactivity.
This was to be differentiated from 314.00 Attention Deficit Disorder without Hyperactivity. Treatment of the problem preceded the official definition. As early as the 1930's, Bradley (1937) reported that amphetamines produced a calming effect in institutionalized children. By the mid-1960's amphetamines were commonly prescribed to treat hyperactivity in the classroom. In fact, Wender (1971) urged trial medication in all such "suspected" cases. Subsequently, Sroufe (1972) reported that up to ten per cent of the students in some school districts were receiving amphetamines to counteract hyperactivity (1972).

Research into effectiveness of drug treatment has repeatedly demonstrated effects in terms of reducing rates of inappropriate classroom behaviors such as fidgeting, out-of-seat behaviors, talking out, and other similar behaviors. Sprague and Toppe (1966) and Conners, Eisenberg, and Barcai (1967) both indicated that attention span was similarly effected in such students.

The foregoing research from 1937 to 1975, frequently suggested that the problem of hyperactivity in the classroom could be solved in most cases by the simple use of a drug. The restless behaviors which kept students from sitting still and doing their work apparently had significantly improved. However, there appears to have been a flaw in the research up to this point. It had omitted consideration of actual educational achievement.
Intellectual functioning up to this point had been only superficially examined. Paired associate learning was examined by Conners, Eisenberg and Sharpe (1964). Knights and Hinton (1968) examined variations in intelligence test scores. Prior to 1975, only one study dealt with academic performance per se, i.e., Sulzbacher (1972) noted fluctuating and highly variable improvement in academic performance. He noted, however, that some of the children responded equally well to a placebo.

In 1975, Ayllon, Layman, and Kandel examined the relative effects of behavioral analytic techniques versus drug therapy. The study will be examined in detail later, but Ayllon's conclusion was as follows: "the present results suggest that continued use of Ritalin and possibly other drugs to control hyperactivity may result in compliant but academically incompetent students."

Subsequent research from the behavior analytic point of view confirmed Ayllon's findings. Barkley and Cunningham (1978) surveyed medical and psychological research on hyperactivity and concluded in Clinical Pediatrics, that scholastic performance was usually not improved by the use of drugs. In the small percentage of subjects where achievement did improve, the effects were "scattered and inconsistent."

What, then, accounts for the lack of academic improvement in students whose reported attention to relevant teaching materials and cues is so improved? Barkley, et. al. (1978)
suggested that they "...may be less alert to other people and their surroundings," but this speculation is not consistent with the pervasive view among teachers and educational administrators. Such children, receiving appropriate dosages, are uniformly regarded as more responsive to relevant cues in the academic environment, but especially to the teacher and the assignments. Barkley offered the alternative answer that "...stimulant medications are simply unable to influence those etiological variables" to which Barkley assigns the causal power. However, these variables remain hypothetical and unidentified.

Although the etiological variables remain a matter for medical research, there remains at least one unresearched concomitant variable which has often been associated with the hyperactive symptom cluster. Perceptual-motor dysfunctions have long been associated with the condition and are mentioned in DSM-III (1980).

Statement of the Problem

There is mounting evidence from the psychological community that Ritalin does not improve the academic achievement of hyperactive students. This finding, however, is contradictory to the opinions of teachers and administrators who appear to believe that achievement does improve when Ritalin is used. The belief is that increased efficiency in graphic work such as handwriting and copying
from the board. If Ritalin makes students compliant due to reducing their alertness, i.e., sedating them, then some reduction of visual-motor efficiency might be demonstrable. On the other hand, if the educational community is accurately reporting improved graphic work, then visual-motor efficiency may be found to improve under experimental circumstances. The problem is to determine which, if either of these views, may be supported by a study of visual-motor efficiency.

Purpose of the Study

The purpose of the present study was to determine the probability of improved or decreased visual-motor efficiency in hyperactive students when taking Ritalin. Hyperactive students are defined as students who have been stabilized by Ritalin. Visual motor efficiency is defined as 1) Koppitz developmental scores on the Bender, 2) scaled scores on the WISC-R Block Design, and 3) scaled scores on the WISC-R Coding subtest. If Ritalin retards or has no effect on visual-motor efficiency, this fact might account for continuing academic difficulty despite improved classroom behaviors. If Ritalin does improve visual-motor efficiency, as it reportedly improves in-seat and independent paper and pencil assignments, research into the etiology of this problem should probably examine other variables.
Hypotheses

Hypotheses are specified as follows for the three dependent variables.

1. The difference between the pre- and post-test means of the Bender Gestalt scores is equal to zero.

2. The difference between the pre- and post-test means of the WISC-R Coding subtest scale scores is equal to zero.

3. The difference between the pre- and post-test means of the WISC-R Block Design subtest scale scores is equal to zero.

Limitations of the Study

Threats to internal and external validity center around random subject selection as it pertains to differing rates of psychological development and differing sensitivities to medication. A small group size does reduce the degree to which results of this research may be generalized to populations of hyperactive children outside the population from which the samples were drawn. An $N$ of 30, however, is often used in drug-effect studies, and it may be assumed that any significant effect found may be an intense effect.

The visual-motor developmental rates will be less diversified if extreme IQs are avoided. Therefore, subjects were chosen with IQs ranging from 85 to 115. Also, this
possible limitation can be minimized by limiting subjects to those with no WISC-R difference of more than 20 points between verbal and performance IQ scores. Substantial differences are common in hyperactive children but differences of more than 20 points may indicate a condition not typical of the majority. For example, certain kinds of brain damage are known to effect visual-motor efficiency quite directly (Weschler, 1944) resulting in a decline from previous levels of visual-motor efficiency.

The potentially limiting effect of extremely varying sensitivities to Ritalin were addressed by selecting subjects who had been on medication a minimum of three months. This should have allowed ample time for medication adjustment and stabilization as a result of parent and teacher feedback to the family physicians.

Significance of the Study

Ritalin has become suspect in terms of its adequacy for helping children achieve in school. More research concerning the details of its effects is in order. If no significant difference between the two groups is found, then the use of Ritalin is suspect in terms of its adequacy to help students in any way other than making them more compliant for teachers. If a difference is found in that the Ritalin group exhibits improved visual-motor efficiency beyond a chance level, then the results of the study will have strongly suggested that the
failure of Ritalin-treated students to improve their rates of academic achievement lies elsewhere than in the visual-motor factors of this study.

Definition of Terms

**Behavior Analysis** The analysis of ongoing behavior by the use of Skinnerian theory followed by the derivation of a plan to create new behaviors and/or increase or decrease the rate of behaviors currently in the repertoire of the organism.

**Contingency** The extent to which the occurrence of a given behavior is dependent on specified environmental events.

**Ritalin** A psychostimulant drug which is generically known as methylphenidate, and which, until puberty, often has the effect of reducing activity level in children. It is the most frequently prescribed drug of the psychostimulant class for the purpose of reducing hyperactivity in children.

**Hyperactivity** A condition characterized by a greater rate of activity than usual in children, often of an irrelevant and trivial nature including activity of an exaggerated muscular kind, often accompanied by low frustration tolerance, poor visual-motor coordination, short attention span and low achievement in school.

**Visual-motor developmental level** A score on the most common test of visual-motor functioning which is given in terms of age equivalencies.
**Visual-motor efficiency** The age equivalency score on the Bender-Gestalt test subtracted from mental age and given a plus or minus sign depending upon whether they are above the mental age or below.

**Mental age** That score which is most likely to have been achieved by a person of a given IQ, as per tables given for the WISC-R.

**Attention span** The length of time a person attends to a given stimulus, such as in-class assignments, puzzles, reading materials, and similar materials.

**Classroom Management** A system of organized environmental contingencies arranged for the control of student behavior. These systems often exchange tokens, points or tangible reinforcers for increasing amounts of on-task and otherwise appropriate classroom behavior. Punishment procedures may also be part of the system.

**Review of the Literature**

**Medical Model Etiology**

The medical view of hyperactivity in children has, since the late 1930s, assumed that the behavior is a symptomatic manifestation of some underlying organic abnormality. Some relatively recent authorities have assumed a metabolic dysfunction but traditionally, medical researchers have assumed brain damage to be the underlying and ultimately
irreducible primary cause. The work of such researchers as H. I. Preston (1945) fostered this assumption. Preston found that a sample of children known to be anoxic at birth were later found to exhibit symptom patterns which included hyperactivity. It was suggested that this kind of damage produced hyperactivity in forty per cent of the cases, hypoactivity in forty percent of the cases and epileptic conditions in the remainder of cases. This kind of research and conclusion was consistent with the often-noted clinical observation that brain injured persons do frequently manifest hyperkinetic behavior as well as shortened attention spans, impulsiveness, hostility outbreaks, and decrements in visual-motor efficiency. Marzolf stated the medical model logic as follows:

> Children who are exceedingly distractable, given to emotional outbursts upon slight provocation and to splurges of somewhat eccentric activity, who find it virtually impossible to function under pressure, and who often show distortion of perceptual processes are probably brain injured (1958, p.330).

The reported decrements in visual-motor efficiency of such children are typically noted on the Bender-Gestalt Test and the Weschler intelligence scales performance tests in general and in the Block Design subtest in particular (Bakwin, 1976). Both the Bender Gestalt and the Block Design require the ability to efficiently perceive and efficiently reproduce
or copy. The Bender requires the subject to copy a graphic series of geometric figures with a pencil. This includes copying angles, and it is with the complexities of angulation that decrements may occur.

Parenthetically, it should be noted that Weschler devised the Weschler Adult Intelligence Scale originally, not to yield an IQ per se, but rather to show different areas of intellectual functioning disrupted by various kinds of organic damage to the brain. Binet had conceived of intelligence as global and noncategorical. Therefore, Binet's questions and tasks had randomly alternated between vocabulary, general information, math, and puzzles. Weschler, seeking to investigate and demonstrate specific intellectual functions damaged by specific kinds of cerebral assaults, simply grouped Binet's test items into Aristotelian classes, i.e., all the math questions were asked in a scaled group, vocabulary in another group, and general information in another. Perhaps more importantly, the test was divided into two halves, yielding separate I. Q. scores pertaining to verbal skills and manual skills.

Weschler's findings in his years of work with Bellvue cases of all kinds of organic etiologies included the finding that the most typical kind of effect from acute brain trauma resulted in diminution of the manual or performance half of the test with particular negative impact upon the Block Design subtest (1944, 1956). Since visual--motor problems were
frequently found to accompany hyperactivity in children (Weschler, 1956, Marzof, 1958), along with other symptom behaviors such as hostility outbreaks, impulsivity and short attention span, it was reasonable for the medical community to hypothesize that the underlying cause of hyperactivity was some brain damage in the history of the child prior to the onset of the symptoms.

Accordingly, from the 1960s to the mid 1970s, the medical model view of hyperactivity crystallized into the creation of the label "minimal brain dysfunction" (MBD) or "minimal brain injury" (MBI). The creation of the label, however, was not accompanied by a means of diagnosing the physical presence of this presumed disorder, which resulted in its being called "...our most fashionable form of consequential ignorance" (Marzof, p. 496). Due to continued criticism regarding the lack of specificity of the label and lack of diagnostic procedures for establishing its existence, the label has dropped from use. The influence of a behavioristic approach to treatment, focusing on behavior as the problem rather than as a symptom of the problem, has also probably contributed to this change in practice.

Research and reports of clinical observations by Feingold (1973, 1975, 1976) supported the metabolic hypothesis by reporting that dietary sensitivity is correlated with an increase in the rate of hyperactive behavior. Feingold has hypothesized that salicylate-like substances such as apples,
berries, tomatoes, apricots, prunes and cucumbers, as well as artificial colors and preservatives contribute, to the condition in children so organically predisposed.

A study by Rose (1978) supported this theory rather well. Two hyperactive children were treated by the Feingold diet. The diet deleted the suspect food additives. The changes in baseline suggested that at least some children may be hyperactive as a result of allergies or dietary sensitivities. The functional relationship was demonstrated in a double-blind reversal design with the baseline based upon on-task observations made in the classroom. On the days when an artificial food coloring (tartrazine #5) was added to the diet, significant disruptions from on-task behavior occurred. This data, recorded by teachers who were unaware of which treatment the children were receiving, agreed with parental records concerning manageability in the home. The findings support the general medical model conception of the physiological basis of hyperactivity, at least in some cases.

However, whether hyperactivity rests upon internal physiological variables remains a moot point. Diagnostic procedures continue to rest upon such vagaries as "soft signs" on EEGs. The condition itself seems to be redefined and renamed with each publication of the DSM. Irrespective of nomenclature or presumed internal etiology, however, it is not likely that many teachers will delete suspect foods such as additives and food colorings, from school or home menus.
The Effect of Ritalin

Medical treatment of hyperactivity began in 1937 when Bradley reported that Benzedrine produced the unexpected result of reducing the stereotypic and disruptive behavior in institutionalized children. A series of such reports continued in medical journals so that by the 1960s Ritalin and other psychostimulants became the standard treatment for children diagnosed as hyperactive, or in any instances when hyperactivity was suspected due to disruptive classroom behavior (Winder, 1971). By the close of the 1960s, the incidence of the condition in the general population was said to range from five to ten per cent (Winder, 1970). Ten percent of the children in some school districts were being given Ritalin (Srole, 1972), yet even the most fervent advocates reported it was only helpful in reducing activity in one-half to two-thirds of the children to whom it was given (Fish, 1970).

Barkley and Cunningham surveyed the medical and psychological research in 1978. Of the studies which they reported as having statistical merit, they stated the results could be combined "...to yield a single crude estimate of the effects of the stimulants on scholastic performance," (1973, p. 90). They reported that the effects on achievement skills were scattered and inconsistent. The authors concluded that the lack of improvement in achievement which the research
usually reported could not be dismissed because it seemed to be the case regardless of experimental design, different achievement measures, different types of drugs, dosage levels, and titration procedures.

The long-term studies summarized by Barkley, et al., were particularly supportive of the thesis that psychostimulants produced no long-term beneficial effect on either academic achievement or long-term life adjustment. They cited studies by Weiss, et al., (1975) which gave a three to five-year comparison of 24 hyperactive children treated with Ritalin. Minde et. al. (1972) reported a five year follow-up of 76 hyperactive boys (29 on Ritalin, 29 on Imiprimine, and 18 on placebo), etc.

Subsequently, Weiss and Hechtman (1979) followed the educational careers of students who were first diagnosed as hyperactive when they were elementary school children. They found that these students had exhibited lower school achievement and more behavioral problems than normal comparison groups regardless of whether or not they had been medicated.

How is it that teachers uniformly insist the students learn better on Ritalin? A study by Rie and Rie (1977) suggests an answer more flattering to our teachers than the usual conclusion. Often it is concluded that teachers regard quiet students as synonymous with good students. Ritalin was found in the Rie and Rie study to improve the recall of story
content over a two hour period but not over a period of twelve days. The same study also contains the interesting aside that nonhyperactive children learn less efficiently on Ritalin.

The overall conclusion, however, from the foregoing studies was that long term learning, as measured on achievement tests and long term life achievement, are not positively effected by Ritalin, even though there may be some momentary improvement in retention and classroom compliance. Ironically, it would seem that Ritalin offers only symptomatic relief while ignoring or intensifying the more pertinent underlying problem of learning efficiency.

**Ritalin and Behavior Effects**

Ullmann and Krasner (1975) noted the need for a systematic comparison of drug treatment and behavior analytic techniques. That same year, Ayllon, Layman, and Kandel (1975) did exactly that, by alternating drug and behavioral treatments on three hyperactive, low-achieving children. Hyperactivity data were taken at twenty-five second intervals during mathematics and reading classes. Phase 1 consisted of the subjects taking medication for 17 days. Phase 2 consisted of no medication for 17 days. Phase 3 consisted of no medication but with the introduction of a reinforcing point system for achievement on sequences of different problems. The point system allowed subjects to earn school supplies, lunch items and free time. Phase 4 continued as in Phase 3,
but with a similar point system for reading.

When medication was terminated in the absence of the behavioral control system, a three-fold escalation of hyperactivity occurred. This finding was consistent with the findings of previous studies which had shown that Ritalin reduced the frequency of impulsive, irrelevant and inappropriate behaviors. However, the study also showed low reading scores when Ritalin was used. There was an immediate decrease in hyperactivity when the point system started even though the system aimed at academic productivity rather than the suppression of hyperactive behaviors per se. When on Ritalin, the students averaged about 12 per cent correct academic responses but about 85 percent when Ritalin was discontinued and behavior management was begun. Even without the behavior management program, however, there was a slight increase in academic efficiency. The percentage of correct answers increased when Ritalin was terminated. These results suggested Ritalin might interfere with academic efficiency despite reducing the rate of apparently inattentive and irrelevant behaviors. This runs counter to the general anecdotal opinion of teachers that these children are often able to copy problems on the page better, and do their work better, after taking ritalin.

A part of Ayllon et. al.'s general approach was subsequently repeated by Robinson, Newby, and Ganzell (1981) who used larger groups and a group statistical design with
treatments sequenced BAB. Eighteen students from a special education class were used. Tokens were earned for learning new vocabulary words and for helping fellow students do the same. Tokens were exchanged for time to play pinball or electronic games. Again, the contingencies were not arranged to reduce hyperactive behavior per se but rather to improve academic efficiency in terms of time on task, accuracy and speed. Once more, the result was to achieve control of the hyperactive behavior while improving academic skills.

Ritalin effects were again compared to behavior management in a study by Rapport, Murphy, and Bailey (1982) which yielded some consistently functional relationships in response to an ABACBC sequence of independent variables.

The treatments, with the illusion of additional sub-treatments under B, were as follows:

- A-Baseline
- B-Ritalin 5 mg. Subj. 1 & 2
- Ritalin 10 mg. Subj. 1 & 2
- Ritalin 15 mg. Subj. 1 & 2
- Ritalin 20 mg. Subj. 1 only
- A-Baseline
- C-Behavioral technology
- B-Ritalin
- C-Behavioral technology

The dependent variables of hyperactivity and achievement were each measured in two ways. Direct classroom observations of activity levels were complimented by teacher rating scales.
The Abbreviated Conners Teacher Rating Scale showed less hyperactivity, and direct observation showed more on-task behavior when Ritalin was introduced and with each increase in dosage of Ritalin.

However, the result of the achievement measures was less clear. Some students improved and some did not. Each child improved to a point and then declined. The improvements achieved were not consistent but erratic. The first subject showed a slight and insignificant improvement in the percentage of assignments completed when the dosage levels were increased beyond 5 mg. daily. The second subject showed slight improvement in reading up to 15 mg. per day but dropped below baseline when 20 mg. were delivered. In mathematics, the second subject vacillated erratically in completion of assignments and accuracy of assignments but there was an upward trend until a 20 mg. dosage was administered. At that point, the gains were lost. The results of this phase of the study may be summarized as follows: 1) Ritalin did consistently improve on-task time and manageability and 2) While subject tolerance was different, some achievement behaviors may improve but will level off and deteriorate if the subject is over medicated. The CBC phase of the study, however, did show consistent improvements in both levels of achievement for both subject matter areas, far above previous achievement levels. Alternating this behavioral technology treatment with Ritalin indicated the superiority of the behavioral techniques.

Varying tolerances or sensitivities to the medication
should be equalized in any search because understanding improved on-task behavior does not yield commensurate achievement improvements.

Methods for Collecting and Analyzing Data

Subjects

The subjects of the investigation consisted of twenty children with an age range between six to twelve years of age from among those children in eight small school districts in Denton County who had taken Ritalin for more than three months. Children older than twelve years were deleted on the grounds that they might be experiencing the reversal effect known to occur at puberty. Children younger than age six were excluded because the WISC-R subtest measures do not extend below age six. Names were converted to numbers and the investigator drew corresponding numbers from a table of random numbers, assigning them to treatment sequence A and B alternately until each group consisted of 10 counterbalanced subjects.

Procedure

Parents of the selected subjects were contacted and asked for their help and participation, but without the exact nature of the test instruments being disclosed. Parents were told, "We are doing a study of children who are on Ritalin. We will test children to see how Ritalin effects a certain kind of learning. We would like to include your child." When asked
what kind of testing would be done, parents of special education students were told that it was the same kind of testing which had been done previously on their child. Parents of regular education students were told that the testing consisted of drawings and work with blocks. Parents were asked to withhold medication on the appropriate test morning. In every case, the parents were quite willing to have their children participate so that the originally designated 20 cases remained intact.

Sequence A was tested with medication first, then tested without medication. Sequence B was tested without medication first and then tested with medication. In each case, testing was conducted in the first two hours of school. After each student was tested without medication, he was immediately allowed to receive his medication from the nurse, or, in the case of older students, to take it himself.

Procedure for Collecting Data

Bender Gestalt, WISC-R Block Design and WISC-R Coding tests were administered to all subjects within a two-week period. The testing was done at school in testing areas which were familiar to all of the students with two exceptions, in which the testing was done within the students' homes. Procedures for administration of the Bender Gestalt followed those suggested by Koppitz (1973) with the exception that students were given a second sheet only when they asked for it.

Each subject was presented an ordinary sheet of blank
white paper, approximately eight and one-half by eleven inches, and a number two pencil, with an eraser. After rapport was established, the test was introduced by announcing the equivalent of: "I have nine cards here with designs on them for you to copy. Here is the first one. Now go ahead and make one just like it." The cards consisted of a series of geometric figures which include circles, triangles, overlapping angles, dots, and wavy lines. There was no time limit for completion of the test. Questions were answered with such statements as: "Just make it look as much like the design on the card as you can." The card was laid on the table or desk just above his paper where the student was seated. When he finished one card, it was replaced by the next one in the sequence. The cards are numbered for sequential presentation. The Koppitz (1973) developmental scoring system was used to determine the number of errors, the summary of which constitutes the Bender developmental score.

The WISC-R administration was done in accordance with the manual. In the case of Block Design, the student was presented with four blocks or cubes and shown that each of them was identical to the others in that each had a white side, a red side and a side which was half red and half white. The student's task was to copy models of other blocks arranged by the examiner or to copy pictures of designs which could be made with the blocks. This is a timed test with bonus points for speed. The score of each student was converted to a scaled score by referring to the manual table which takes
the student's age into account.

The WISC-R Coding test was administered in the manner prescribed by the manual which, in essence, instructs the student via explanation and sample practice in the procedure for copying symbols onto a form. The number of symbols copied within the time limit equaled the raw score which was converted to a scaled score by referring to the table in the manual which takes the student's age into account.

Results

The students' identification numbers, ages, WISC-R scale scores, and Koppitz error scores are reported as follows:

Table 1

<table>
<thead>
<tr>
<th>GROUP A: PRETEST ON MEDICATION</th>
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<tbody>
<tr>
<td>Subject</td>
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<td>---------</td>
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<tr>
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Table 2

GROUP B: POSTTEST ON MEDICATION

<table>
<thead>
<tr>
<th>Subject</th>
<th>C-A</th>
<th>Bender on-off</th>
<th>Block Design on-off</th>
<th>Coding on-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>6-0</td>
<td>6 6</td>
<td>11 3</td>
<td>14 10</td>
</tr>
<tr>
<td>12</td>
<td>6-0</td>
<td>9 4</td>
<td>13 1</td>
<td>16 8</td>
</tr>
<tr>
<td>13</td>
<td>10-1</td>
<td>11 8</td>
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<td>7-10</td>
<td>9 9</td>
<td>10 6</td>
<td>4 5</td>
</tr>
</tbody>
</table>

The statistical procedure used in this study was the Direct Difference Method for t tests (Hopkins and Glass, 1973). This procedure was used on the Bender error scores as well as the WISC-R Block Design and Coding scaled scores. The decision as to the level of significance required, in order to reject the null hypothesis, was set at the .05 level of significance. In this study, degrees of freedom equaled 19 for each of the three t tests. This required a t value of 2.09 to reject H. The obtained t for the Bender difference scores was calculated at .760 (p > .05). The Block Design t equaled 1.33 (p > .05) and the Coding t equaled 1.10 (p > .05). Thus, the obtained t test values were not found to be statistically significant for any
of the measured dependent variables.

It is interesting to note, however, that there were wide discrepancies among the various individual scores obtained. For example, subject number 12 from sequence B, exhibited no acceptable WISC-R Coding test behaviors when he was off medication but achieved an above average scale score of 13 when on medication. He worked diligently when he was off medication but none of the symbols he was able to produce were correct. When on medication, he completed the form with minor errors and his scaled score indicated an above average eye-hand coordination speed for his age. Practice effects in this case could not have been a factor because the subject was tested on medication first. This student's achievement in Block Design also showed a strikingly superior score when he took medication. When on medication, his work was within the normal range. When off medication, he scored within the retarded range. On the same occasions, this subject illustrated an inability to score any points on Object Assembly when off medication but did score normally, working all puzzles correctly, when on medication. Clinically, it was also observed that this child has no spoken vocabulary when off medication but speaks words when on Ritalin. While this subject was an exceptional case, there were other cases observed in which large WISC-R scale score changes (over 3 scale scores) were in the direction of medication improvement. In fact, the above raw data does seem to indicate that a small subgroup of the elementary hyperactive student population is
beneficially effected by psychostimulants. However, these individuals are obviously masked by group statistical techniques. Further inquiries into this trend may be especially fruitful if speed of eye-hand coordination measures are investigated in preselected students.

**Discussion**

The study conducted by the author was suggested by the mutually contradictory conclusions of the educational and psychological communities concerning whether or not Ritalin helps hyperactive children to perform better academically. Recent psychological research, referred to previously, clearly indicated that compliance rather than achievement is primarily improved with the administration of Ritalin to hyperactive students. Teachers and school administrators, however, often remain convinced that Ritalin improves performance in conjunction with compliance. Teachers and observant administrators note anecdotally that students on Ritalin perform faster and more accurate desk work, do better copying from the board, write clearer, or in the case of younger students, form letters more clearly and accurately. Such observations suggest that achievement should improve with the use of this drug, yet the empirical evidence remains contradictory.

Using a two-tailed *t* test the author investigated the possibility that the behavioral research findings might have resulted from learning interference effects of
psychostimulants. If this were the case, the present research might have demonstrated significant performance decrements while on Ritalin. It did not show this. On the other hand, the author considered the alternate possibility that teacher observations were correct and that paper and pencil tasks did improve with Ritalin, which would have suggested improvement in visual motor efficiency. While the findings did not support the anecdotal teacher reports, they were in that direction. A study of Coding alone, on a one tailed t test might substantiate such opinions. The inconclusive findings were in that direction.

The author also noted some confirmation of teacher reports of student difficulties with graphic assignments in that students off Ritalin appeared to make more erasures, exhibit harder line pressure and to work in spurts. In this vain, WISC-R Coding procedure allows the examiner to bring the subject's attention back to the task by showing where to continue. While no data were taken, it appeared that there were more prompts necessary on Coding when subjects were off Ritalin.

The direction of the data on Coding and the test observations suggest that a subsequent study of eye-hand coordination speed alone might be in order. The Detroit Motor Speed Test deemphasizes the perceptual aspects in favor of fine motor speed alone. The data and observations of the present study suggest that the perceptual efficiency is probably no factor, whereas motor speed may be a problem. Speed was no
factor in scoring the Bender, a mild factor in the Block Design and a major factor in Coding. It is perhaps meaningful that the data graduated in the direction of speed and away from the direction of perceptual efficiency, i.e., the means were virtually synonymous between the two conditions on the Bender, mildly disproportionate in the direction of Ritalin effect on the Block Design, and near statistical significance on the Coding tests. Accordingly, the Detroit Test of Learning Aptitude subtest for motor speed, which further deemphasizes perception in favor of speed, seems the most appropriate follow-up instrument. Conversely, the present findings suggest that there is little reason to follow up with further testing of perceptual processes independent of motor speed.

The present study also addresses the question as to whether or not perceptual-motor dysfunction underlies hyperactivity or attention deficit disorder. Such children often exhibit motor anomalies such as foot twitching and restlessness in their seats. They are reported by teachers as having difficulty doing desk work or copying from the board, which may be the result of perceptual inefficiency. If this is true, then perceptual-motor dysfunction might underlie the condition. If true, then all manifestations of the disorder should abate when Ritalin is administered. However, difficulties in academic achievement do not abate when Ritalin is administered. If the present study had shown evidence of improved perceptual-motor functioning associated with Ritalin, perceptual-motor functioning might have been ruled out as the
underlying cause of the disorder. No evidence of improved perceptual-motor functioning associated with Ritalin does leave open the possibility that Ritalin fails to deal with the underlying problem of perceptual-motor dysfunction. If subsequent research should show improved motor speed with fewer erasures, this might clarify the reason teachers believe Ritalin improves academic achievement.

Finally, however, the present study suggests that single organism research might establish a functional relationship in certain individuals which might lead the way to other assessment techniques which would ascertain whether or not Ritalin is helpful in specific cases within the school system. If, for example, it can be determined that subject number 11 continues to show the same kinds of dramatic performance changes (8 scale score reduction in Coding when on Ritalin) in an ABAB design, then it might be reasonable to suggest discontinuing Ritalin. Conversely, if subject number 12 can be shown to continue to demonstrate improvement changes of two to three standard deviations in testings of Block Design and Coding consistently, then it would be reasonable to advise the physician of the apparent beneficial effect.
References


