RESPONSE SELECTIVITY AS A FUNCTION OF
DEVELOPMENTAL ACTIVITY LEVEL

by

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A dissertation submitted in partial fulfillment
of the requirement for the degree

of

DOCTOR OF PHILOSOPHY

in

Psychology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1975
ACKNOWLEDGEMENTS

I would like to gratefully acknowledge the help, support and assurance given by my wife, Marva, in completing this effort. I would also like to express my appreciation to my graduate committee, especially to Glendon Casto, Ph.D., Chairman, Sebastian Striefel, Ph.D., and Frank Ascione, Ph.D., for their advice and encouragement.

Wilford W. Beck III
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ABSTRACT

Response Selectivity as a Function of Developmental Activity Level

by

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Utah State University, 1975

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Department: Psychology

Research in hyperactivity has been primarily concerned with demonstrating causal relationships with cerebral dysfunction of the effects of drugs on improving learning performance. Studies which have attempted to focus on other factors influencing learning performance have demonstrated IQ and perceptual motor differences between hyperactive and normal children.

More recently Koegel and Covert have shown that, among a group of autistic children, over-selectivity of components from a stimulus complex may adversely influence learning performance on a simultaneous discrimination task. There have been no demonstrations of this phenomena with hyperactive children.

The present study employed a simultaneous discrimination task composed of two stimulus complexes. Each complex in turn consisted of three geometric forms. Children were randomly selected, rated for activity level and then trained to respond reliably to a specific complex. Once the discrimination to one of the complexes was established, the child was exposed to random

pairs of components (one from the $S^D$ complex and one from the $S^\Delta$ complex). Responses to either $S^D$ or $S^\Delta$ were recorded.

A significant relationship was found between over-selectivity for one or more $S^D$ components as a function of increasing activity level. Response errors were found to be related to selectivity but not to activity level.

It would appear that performance deficits in learning a discrimination task may be, in part, related to over-selective focusing which results in failure to learn and, hence, to integrate the entire stimulus complex.
CHAPTER I

Introduction

Hyperactivity is a diagnostic label applied to children who exhibit—"short attention span and poor powers of concentration; impulsiveness; irritability; explosiveness; variability; and poor school work" (Laufer & Denhoff, 1958). Hyperactive children who display a behavioral constellation such as that just described are of prime concern to teachers, as well as parents, since they constitute a major educational problem. That is learning and management.

Generally, the cause of learning problems in the hyperactive child has been attributed to his excessive activity and concomitant lack of attention and concentration. While such a causal explanation logically follows post hoc from the behavioral description of hyperactivity, the explanation fails to adequately identify other specific factors--aside from a general activity factor--which might interact with attention and concentration.

Much of the current research in hyperactivity has been concerned with causative relationships, such as, changes in cerebral functioning, effects of drugs on performance and early post-natal conditions. Where the focus of the investigator has been on the educational performance of the hyperactive child, his main concern has been to show the effects of drugs on learning performance or to demonstrate differences in educational level and/or IQ scores between hyperactive and normal children. This research, too, has contributed relatively
little to our understanding of the way in which concentration and attention affect learning performance.

Recently, investigators (Koegel & Covert, 1972; Koegel & Wilhelm, 1973; Lovaas & Schreibman, 1971) have identified a tendency for autistic children to be over-selective, that is focus on one stimulus component of a complex stimulus, when learning a discrimination task. Over-selectivity appeared to be related to activity-level and resulted in variable learning performance. Some non-autistic children also exhibited over-selectivity and exhibited similar deficits in performance. It is possible that such over-selectivity may be a factor effecting concentration and attention in hyperactive children.

Since research has not focused on the question of over-selectivity of stimuli as a factor in attentional deficits of hyperactive children, the purpose of this study will be to investigate the influence of over-selectivity on learning performance of children exhibiting a variety of activity levels.
CHAPTER II

Review of Literature

Because of the uniqueness of the research question few relevant studies are available specific to hyperactivity. Research specific to the selectivity problem will be reviewed and pertinent studies providing possible alternative positions cited.

Hyperactivity is a diagnostic label applied to children who exhibit—"short attention span and poor powers of concentration; impulsiveness; irritability; explosiveness; variability; and poor school work" (Laufer & Denhoff, 1958). Such children contrast sharply with normal children having high activity levels. Normal children with high activity levels are able to focus attention and inhibit movement when they are required to do so. Abrupt and often unprecipitated emotional outbursts are infrequent and not characteristic of the normal child. Specific learning disabilities are largely absent in these children.

Much of the early research postulated some form of neurological impairment to explain hyperactivity (Eisenberg, 1966; Laufer & Denhoff, 1957; Minde, Webb, & Sykes, 1968). Although this focus has provided useful, if limited, insight into the problem of hyperactivity, the failure to find significant evidence for this point of view has raised questions concerning its viability (Bax, 1972; Werry & Sprague, 1970).

Some researchers have suggested that hyperactivity may be a result of social-psychological processes. Bax (1972) reports that social, cultural and
ethnic values may lead to conflicts with the dominant social system. This in turn leads to acting out behavior frequently diagnosed as hyperactivity. Keogh (1971) points out that high activity level itself may contribute to the maladaptive behavior pattern of hyperactive children but activity level alone does not provide a satisfactory explanation for the behavior or for the related learning problems.

Behavior problems associated with hyperactivity, as well as difficulties in learning are of prime concern to teachers. Recently there have been efforts to identify psycho-educational factors that might be useful in differentiating hyperactive and non-hyperactive children with normal controls on measures of intellectual ability, academic achievement, perceptual motor performance and reading skill. They found that IQ scores were significantly lower ($p < .001$) for the hyperactive group. This difference held up across all the measurements. However, when the intelligence variable was controlled, differences in academic achievement and perceptual motor performance disappeared. The authors conclude that the main effect of IQ was the only significant differentiating variable found. They suggest that the absence of a difference in perceptual-motor performance raises serious doubt as to the role of this variable in producing learning disabilities in hyperactive children. Minde, Lewin, Weiss, Lauiguer, Douglas, and Sykes (1971), reporting on a follow-up study of 37 hyperactive elementary school children after 5 years of schooling report similar findings to those above regarding IQ scores. However, they discovered poor perceptual motor coordination in hyperactive children. Such
contradictions are not uncommon in research on hyperactivity particularly as it relates to learning processes and education in general. In concert with this finding, Keogh (1971) has suggested that relatively little empirical evidence has been reported as to the nature of educational deficits among hyperactive children.

Nevertheless, hyperactive children often show variable performance on school learning tasks (Thelander, Phelps, & Kirk, 1958). Such variability is often observed in the day-to-day performance of the hyperactive child on reading and math tasks. The child may demonstrate an understanding and functional knowledge of the skills one moment but is unable to demonstrate that knowledge a short time later. One explanation for the variability relates to the stimulus complexity of the task to be learned and the inability of the hyperactive child to focus his attention. It has been suggested that the impulsive behavior of the hyperactive child prevents him from attending to all of the relevant stimuli in a given learning task. He, therefore, makes more incorrect decisions than a less impulsive child as a result of sampling less information (Drake, 1970; Kagan, 1965). The inability of the hyperactive child to inhibit reacting to stimuli was also demonstrated by shorter response latencies. This is consistent with problems of attending and distractability. In a related study, Sykes, Douglas, and Morgenstern (1973) found that hyperactive children were unable to sustain their attention on a task over three consecutive 5-minute periods. They suggest that hyperactive children lack inhibitory control and as a result make more anticipatory and multiple responses than non-hyperactive
controls. Of particular interest, however, was the finding that on a self-pacing task, where the hyperactive child controlled his work rate, his performance was significantly better than under experimenter-paced conditions. Although this finding cannot be directly compared to Kagan's (1965) response latency finding (the tasks for subjects not being equivalent) it does suggest that hyperactive subjects will respond more accurately to complex stimuli if less rigid time requirements are used. Further, it suggests that, given enough time, the hyperactive child is able to assimilate the necessary stimulus information.

The lack of accuracy in responding by hyperactive children to complex stimuli appears to be a function of the proportion of the stimulus complex viewed. Drake (1970) found that hyperactive children visually scanned a smaller portion of the stimulus complex. Drake indicated that the limited stimulus control exhibited by the hyperactive children seems to be in part related to their making fewer eye movements as measured by the eye fixation camera used in the experiment. The children, therefore, identify specific, but not necessarily salient aspects of the stimulus complex. Responses are more frequently incorrect because of the subjects' response to irrelevant dimensions of the stimulus.

The several studies cited above suggest that the hyperactive child's limited information processing capability as reflected by incorrect responses is caused by his impulsiveness (Kagan, 1965), restricted visual responses to a scanning of the stimulus complex (Drake, 1970) or in his lack of sustained
attention (Sykes et al., 1973). They have not, however, attempted to identify if the hyperactive child responds selectively to a stimulus complex—that is, to a specific component of the complex—another possible explanation for the incorrect responses to a stimulus complex. A consistent response to a single component of a stimulus complex would suggest that the hyperactive child is under control of that particular single component stimulus but not to the other stimuli making up the complex stimulus. This would further suggest that the child is making some sort of decision as to what to pay attention to rather than impulsively responding, contrary to Kagan's (1965) suggestion, and is basing his responses on the relevant information obtained from the stimulus component. The selectivity notion would also argue against the lack of sustained attention as an explanation for response error proposed by Sykes et al. (1973) since the subject would appear to be able to maintain his attention toward the controlling stimulus.

Support for the over-selective theory has been demonstrated in investigations with autistic children with hyperactivity (Koegel & Covert, 1972; Lovaas & Schrieberman, 1971; Lovaas, Schriebman, Koegel, & Rhem, 1971), as well as, in animals (Reynolds, 1961; Sutherland & Holgate, 1966). Koegel and Wilhelm (1973) have shown that some normal children used as control subjects in a selectivity study with autistic children also demonstrated stimulus selectivity features. The investigators did not, however, report any particulars regarding these children beyond the selectivity data. Selectivity has been shown
to interfere in learning a discrimination task, as well as, preventing later recognition of previously learned material.

Koegle and Wilhelm (1973) found that autistic children who were trained to respond to a card with two visual cues responded to only one stimulus when the same stimuli were presented singly. They concluded that autistic children show over-selectivity in sensory input and, therefore, fail to attend to the entire stimulus complex presented to them.

In an earlier study, Koegel and Covert (1972) found a similar relationship between activity level of autistic children and their ability to respond correctly to a discrimination task. Self-stimulatory behavior of these children was found to interfere with the acquisition of trained responses on a two choice discrimination task. As the self-stimulatory behavior was suppressed using aversive techniques (specific to the particular behavior exhibited by each child), the frequency of correct responses increased. Koegel and Covert conclude that the self-stimulatory behavior may well have precluded attention to all the stimuli presented to them for discrimination. This view would also be consistent with findings of Lovaas and Schriebman (1971) and Lovaas et al. (1971).

Lovaas et al. (1971) have suggested that the variability in behavior and learning rates of autistic children is related to their selectivity in responding to stimuli encountered in their environment. Such children respond to one aspect of a stimulus complex and in doing so fail to respond to relevant stimuli within the same stimulus class. Unless the stimulus complex contains the discriminated
component at some later time, the child is unlikely to respond in the same way as he had previously.

In studies with lower animals a similar phenomena has been observed although not necessarily related to functional activity. Reynolds (1961) and Sutherland and Holgate (1966) have reported similar findings in pigeons and rats, respectively. They suggest that as the animal learns more about, or attends more, to one cue in a stimulus complex, it learns less about other relevant cues. Reynolds (1961) describes this in terms of an attentional deficit. Both autistic and hyperactive children exhibit attentional deficits as observed in their variability in behavior and learning. Stimulus over-selectivity may well be a contributing problem to both types of children.

Stimulus over-selectivity has been demonstrated to be related to activity level and to interfere substantially in the learning of discrimination tasks in autistic children (Koegel & Covert, 1972; Koegel & Wilhelm, 1975; Lovaas & Schriebman, 1971; Lovaas et al., 1971). The presence of high activity levels in hyperactive children may also lead to over-selectivity of stimuli in comparison to less active children.

The problem that exists is that research has not focused on the question of over-selectivity of stimuli as a factor in attentional deficits of hyperactive children. The possibility that attentional deficits observed in hyperactive children may stem from reacting to limited stimuli rather than to many stimuli, as has been thought, needs further exploration. The present study
was carried out to clarify the problem of stimulus selectivity of hyperactive children as compared to non-hyperactive children.

It was hypothesized that in a random sample of 40 children, those designated as high activity children will:

1. Select fewer $S^D$ stimulus components from a $S^D$ stimulus complex and more $S^A$ components than other children in the sample.

2. Be more selective than other children in their responses to $S^D$ stimulus components indicating variable control by the $S^D$ stimuli.

3. Demonstrate significantly shorter response latencies to $S^D$ components during test trials than other children in the sample.
CHAPTER III

Method

Subjects

Forty male subjects between the ages of 6 and 9 were selected from students attending Edith Bowen Lab School on the Utah State University campus. Subjects were randomly selected from grades 1 through 4. Only male subjects were selected for this research since evidence suggests that hyperactivity is predominantly found in male children (Stewart, 1966). The particular age range was selected to provide a school sample. The range was restricted at the top, however, since activity level has been found to diminish as the child reaches puberty (Eisenberg, 1966).

In order to control for the influence of medication, neurological impairments, intellectual deficits and severe emotional factors on the research variables, all subjects were required to meet the following conditions for inclusion in the study:

1. Not presently taking medication for hyperactivity.
2. Not currently undergoing psychological therapy or involved in programs for exceptional children.
3. No "hard" neurological signs or other evidence from a physician that the child is neurologically impaired.
4. No evidence of intellectual impairment.
Conditions 1 through 3 were determined from information given by the parents of the child at the time that permission was obtained to include the child in the study. The subjects' school records were used in order to assure that criteria 4 was met.

**Perceptual Selectivity Procedure**

**Training stimuli.** All subjects were trained to respond to one of two stimulus complex's projected on a screen by means of a slide film projector. Each projected slide contained two stimulus complex's made up of three visual stimuli each. The stimuli, as shown in Figure 1, were geometric shapes formed by juxtaposed triangles which are solid black in color.

![Stimuli used in Complex A (top) and Complex B (below).](image)

Two stimulus complexes were used with a total of six geometric shapes.

The format for the training stimuli is similar to that used by Koegel and Wilhelm (1973) as noted above. However, Koegel employed two stimuli in each training complex rather than three. Koegel and Wilhelm found that their
normal subjects quickly discriminated the two-stimulus complexes. Since it was expected that a two-stimulus complex would, therefore, not discriminate adequately between hyperactives and non-hyperactives, the stimulus complexity was increased. Eimas (1969) has reported that children are able to attend to three or four stimuli by the time they reach 5 to 6 years of age. For that reason, three stimuli were used in each stimulus complex to avoid ceiling effects on the data.

Additionally, geometric shapes were used instead of pictures of familiar objects, as were used in the Koegel and Wilhelm (1973) study. This precaution was taken to ensure that there would be no difference in stimulus value as a function of subject familiarity and experience.

**Apparatus.** Paired stimulus complexes were presented to each subject via a 61 x 61 cm translucent Plexiglas screen. A slide projector positioned behind the screen and holding transparencies of the stimulus complex was used to project the images of the stimuli on the screen. Lights positioned behind the screen and connected to push buttons placed directly in front of the subject were used to indicate the subject’s response. (See Appendix B.) The translucent screen was divided medially by a black line 5 mm in width. When projected on the screen, each stimulus complex of the pair appeared on one or the other side of the black division line. Thus the stimulus complexes were clearly separated one from the other.

**Training procedure.** The subject was seated at a table across from the experimenter. The experimenter presented the child with the following
instructions:

"I am going to show you some pictures which have different shapes printed on them. You are to choose the picture which you think is correct. When you have decided which picture is the correct one, push the button which is in front of it. Do the same thing for each pair of pictures I show you. When you pick the correct picture I will put a token in the box next to you. You can trade the tokens in for pennies when you're finished."

No further comment was made for the remainder of the training session.

Following the instructions, the paired stimulus transparencies were projected on the Plexiglas screen in front of the child at a distance of approximately 61 cm.

The first complex chosen by the child was designated the $S^D$. Each complex was chosen equally often across children. All responses to the $S^D$ were reinforced with tokens which were turned in at the end of the session for pennies. Each trial was terminated by a response from the child. A 5-second interval separated each trial.

The position of the training stimuli for each trial was alternated randomly. Randomization was achieved by designating odd-even numbers for left-right positioning of the $S^D$. Numbers were obtained from a random number table.
Training was terminated when the child reached a criterion of 10 consecutive correct responses to the $S^D$. The child was then tested on each of the components of the $S^D$ and $S^\Delta$ stimulus complexes. Test trials directly followed the training trials. Each child was run to completion in one session.

**Test stimuli.** After the child had acquired the discrimination between the paired training stimuli as indicated above, he was tested on each of the components of the stimulus complex. This assessed the amount of control each component exerted on the child's responding.

Each component was presented individually using the procedure followed during the training session. One component from the $S^D$ complex was paired with one component from the $S^\Delta$ complex and projected on the Plexiglas screen. A record was kept of the response time latency using a hand held stop watch. Reliability checks were made on the recorded time intervals by a second observer. Inter-rater reliability was taken on randomly selected subjects. The point-by-point reliability ranged from .82 to .90.

**Test procedure.** Individual stimulus components for both the $S^D$ and $S^\Delta$ stimulus complex pair were presented randomly for sequential order and for position, i.e., each having an equal chance of appearing on either the right or left side.

The stimulus complex pair was presented during the testing procedure employing a VR3 schedule. This procedure made the trials with the stimulus complex less discriminable from trials with component stimuli during testing. The position of presentation of each complex was alternated as was done during
the training procedure. Correct responses to the \( S^D \) stimulus complex were reinforced using token rewards in order to maintain the discrimination learned during training.

Responses to a single \( S^D \) stimulus component were not differentially reinforced. Thus, the child was unable to acquire correct responding to component stimuli during the testing procedure as a result of reinforcement.

Subjects were exposed to 55 pairs of test stimuli and 25 pairs of reinforced training stimuli during the test phase.

**Open-Field Procedure**

Each child in the sample was given a single 15-minute trial in an open-field test to assess his activity level as measured by quadrant entry frequency.

Quadrant entry scores have been found to be valid indicators of differences in activity level between normal and hyperactive children (Pope, 1970) and between normal children when age was used as a dependent measure (Routh, Schroeder, & O'Tuama, 1974). The score for each child was analyzed in terms of its relationship to the results of the perceptual selectivity measure and scores obtained on the Hyperactive Rating Scale.

**Open-field setting.** A 6 x 6 meter room was divided in four equal parts by strips of white masking tape approximately 4 cm wide. Each quadrant of the room contained an identical selection of toys, as well as, a small youth-size table and chair. The toys consisted of a puzzle, Lincoln logs, a wooden truck, modeling clay, etch-a-sketch, crayons and blank paper.
Open-field procedure. Each child was brought to the play room by the experimenter and given free-play instructions following a procedure detailed elsewhere (Routh et al., 1974).

During each session a record of the number of quadrants entered was kept. Recording of quadrant entries was performed by assistants trained in the procedure prior to the actual study. The assistants remained in the room during the entire play period. They appeared, however, to be engaged in work at their desks which were set to one end of the room and outside the play area. A criterion of .90 accuracy in recording was required for observers prior to initiating this part of the study. Random reliability checks during trials gave inter-observer reliability data from .85 to .98.

In order for a child to be given a score for entering a quadrant the following criteria had to be met:

1. If walking, both feet must have crossed the quadrant boundary—a score was given each time this occurred.

2. If crawling, the upper torso must have crossed the quadrant boundary. If the child layed across the boundary and played with toys in a new quadrant, this was scored as a crossing.

3. A child who straddled a line (walking a boundary) was given a score only the first time he stepped into the adjacent quadrant.

Quadrant entries were recorded on individual record sheets. Each quadrant entered was noted by recording the number of that quadrant. The timing for the 15-minute session utilized a 15-minute audio tape with 1-minute
intervals. The total number of quadrant entries during the 15-minute session constituted the subjects quadrant entry score.

If a child, while exploring the room, attempted to open the door during the session, he was told that the time was not yet up. If, however, he became upset or wanted to leave, he was allowed to do so and was escorted back to his class. In any case all children were returned to their respective classes at the completion of the session by the assistants.

The observers for this phase of the study were naive regarding the child's performance on the perceptual selectivity procedure. Experimenter bias was, therefore, controlled.

Rating Scale for Hyperactivity

Teachers were asked to rate all children involved in the study using the Rating Scale for Hyperactivity. (See Appendix C for sample of scale.) The Rating Scale for Hyperactivity was used to provide an additional measure of activity level and was analyzed in terms of the relationship between the child's scores on this instrument and scores on the perceptual selectivity and open-field procedures.

The scale was developed as an objective procedure for assessing specific traits and behaviors found to be important in the syndrome of hyperactivity (Davids, 1971). Davids reports that general unpublished studies, as well as, published studies (for example Denhoff, Davids, & Hawkins, 1971) have found the scale to have, "adequate reliability and to possess considerable clinical utility" (Davids, 1971, p. 499).
Because no data regarding validity is available, the scales usefulness in selection of subjects was limited and, therefore, was not used for selection purposes. However, its clinical utility as one means for evaluating activity level has been established.

Teachers rated each child from 1 ("much less") to 6 ("much more") on six scales. Each of the traits or behaviors being rated are defined with some examples given of the sorts of things being assessed. A score of 24 or more is considered to be indicative of the presence of hyperactivity.

Scores from the Rating Scale for Hyperactivity were not tabulated until scores from the perceptual selectivity and open-field procedures were completed. Thus the possibility of biasing either the experimenter or the assistants were reduced. None of the results from either of these procedures was available to teachers at the time they rated the children on the scale. Rating bias due to knowledge about the children's performance was, therefore, avoided. Additionally, for the purposes of the present study, labels given to each scale were deleted to reduce the possibility of influencing the rater.

**Analysis of the Data**

Each subject was given a ranking based on the degree of selectivity demonstrated in his responses to $S_D$ components. Each subject's responses to $S_D$ components were averaged by dividing the number of responses made to a given $S_D$ component by the total number of possible opportunities to respond. Thus if a subject gave 10 responses to a component which was presented on 20 occasions his score would be .50. Each of the three $S_D$ components for every
subject was similarly figured. The Selectivity Index (SI) was in turn computed from these scores using the equation:

$$SI = S^D(h) - \frac{S^D(m) + S^D(l)}{2}$$

where $S^D(h)$ is the highest scored component, $S^D(m)$ the next highest and $S^D(l)$ the lowest. Subjects were ranked based on their SI score.

The derivation of rankings based on the SI permitted the use of multiple correlation and regression techniques to analyze the relationship between the dependent variable, selectivity and the independent variables of response latency to $S^D$ stimuli, and response error to $S^D$ stimuli, as well as, activity ratings on both the teacher rating scale and the open-field test. A one-tailed test of significance was adopted for data analysis since the hypothesis employed directional predictions.

Response latency was recorded for each test trial, as well as, for each reinforced trial during the test session. A mean latency score was then calculated for each subject.
CHAPTER IV
Results

Three major hypotheses directed this research. Results relating to each hypothesis are presented as follows:

Hypothesis 1: The relationship of activity level to response errors was not significant. Thus, the first hypothesis was not supported.

Hypothesis 2: The relationship of activity level to selectivity was found to be significant supporting the second hypothesis.

Hypothesis 3: The relationship of activity level to response latency for component stimuli was found to be significant, supporting the third hypothesis.

Selectivity and Activity Level

A multiple correlation was run on data collected for selectivity and the two independent activity variables, teacher activity rating and the open-field measure of locomotor activity. Only teacher rating of activity level was found to correlate significantly with selectivity (Table 1). This result supported the hypothesis that children exhibiting high activity rates would be more selective in their responses to $S^D$ component than their less active counterparts. On the other hand, the open-field measure of locomotor activity failed to correlate significantly with selectivity yet showed a significant correlation with teacher activity rating ($r = + .30$, $p < .05$). Because the open-field variable failed to
Table 1

Correlations Between Selectivity and Main Independent Variables

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<td>Test response latency</td>
<td>35</td>
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<tr>
<td>Open-field activity</td>
<td>35</td>
<td>-.07</td>
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<tr>
<td>Teacher activity rating</td>
<td>35</td>
<td>.29**</td>
</tr>
<tr>
<td>Response error</td>
<td>35</td>
<td>.54***</td>
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*p = < .05.

**p = < .05.

***p = < .01.

(Notes: one-tailed tests)

correlate significantly with the dependent measure, it was subsequently dropped from the regression analysis conducted later.

It was of some concern that no individual component was anymore likely to be discriminated than any other across subjects. Failure to do so would have confounded any finding of selectivity by making it difficult to discriminate between subject specific selectivity (i.e., a response determined by unique subject characteristics) and specific effects of the stimulus component. Results show no significant relationships between individual components and selectivity nor between components and response errors to $S^D$ components.

This indicates that the components were essentially equal in stimulus value and complexity for all subjects.
Activity Level and Response Error

Teacher activity ratings failed to correlate at a significant level with response error to $S^D$ components ($r = .03$, $p > .05$, $df = 35$). Thus the hypothesis that a direct relationship would exist between a child's activity level and errors made to the $S^D$ components was not supported. Likewise the relationship between the open-field measure of activity level and errors was not significant ($r = .18$, $p > .05$, $df = 36$). Of interest is the finding that the relationship between selectivity and response error to $S^D$ components is significant (Table 1). When errors are made they are more likely to be made by subjects who are also highly selective.

Multiple Regression Analysis

The results of a step-wise multiple regression analysis of the best predictor variables of selectivity is shown in Table 2.

As expected teacher activity rating and $S^D$ response error showed significant predictive value. Of equal interest, however, was the finding that response latency to the $S^D$ complex presented during test sessions contributed significantly to the overall prediction of selectivity (Table 2). The combination of the four predictor variables of teacher activity rating, response error to $S^D$ components, response latency to $S^D$ complex and component $B_2$ account for .55 variance in predicting selectivity and give a multiple correlation of $r = +.74$. The relationship of the multiple predictor variables to the criterion variable is shown in Figure 2. Prediction appears best in the middle and upper range of scores.
A relationship between selectivity and teacher ratings of activity level was found. Selectivity was also found to be related to response errors to $S^D$ components but activity level was not. The open-field measure of activity level was not sensitive to differences in activity level and, therefore, did not relate significantly to any of the dependent measures.

### Table 2
Regression Analysis of Selectivity

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher activity rating</td>
<td>1</td>
<td>878.59</td>
<td>4.27*</td>
</tr>
<tr>
<td>Response error</td>
<td>1</td>
<td>4968.86</td>
<td>24.12**</td>
</tr>
<tr>
<td>Component $B_2$</td>
<td>1</td>
<td>754.48</td>
<td>3.66</td>
</tr>
<tr>
<td>Response latency ($S^D$ complex presentations during testing)</td>
<td>1</td>
<td>1779.24</td>
<td>8.64**</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>200.00</td>
<td>$\frac{r^2}{=}$.55</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p = < .05.

**p = < .01.
Figure 2. Multiple correlation of response latency, error, activity rating and $B_2$ (solid line) and selectivity (dotted line).
CHAPTER V

Discussion

The results of the present study lend support to the hypothesis that selectivity may adversely influence the learning performance of hyperactive children. The positive relationship between activity level and selectiveness indicates a trend toward increasing over-selectiveness on a complex stimulus as the child's activity level increases. Over-selectiveness resulted in the child failing to attend to the other components despite those components being of equal importance in the stimulus complex. It is not clear at this point whether the most selective subjects would fail to identify the $S^D$ complex if the discriminated component were removed. However, at least one investigator has reported this to be the case with autistic children (Koegel & Wilhelm, 1973).

The failure to attend to other components of the stimulus complex had compounding effects on the over-selective subjects error performance. Over-selective subjects made more errors. Teachers have observed that hyperactive students tend to make more errors on tasks requiring concentration and recall. Given the present findings, it is possible to speculate that hyperactive students make errors not necessarily because they fail to attend to the stimulus (i.e., are more distractible) but because they discriminate only one part of the total stimulus complex. Hence such a child would simply fail to recognize the total stimulus when presented at a later time. It does not appear entirely accurate to say, therefore, that hyperactive children make errors because they
fail to concentrate or are more distractable. That is not to say that hyper-active or even overly active children do not demonstrate distractable behaviors. The evidence is too strong to deny (Laufer & Denhof, 1957; Stewart, 1966). However, had distractability been demonstrated in this study one would expect to witness its effect on response latency. This was certainly not the case as the results show. Rather it might be better stated that they focus their attention in too limited a way. As a consequence of this, they make more errors. Limited focusing of the subject's attention has also been observed by Drake (1970) in her sample of impulsive subjects. Her finding of limited visual scanning and stimulus sampling is consistent with the selectivity explanation offered here.

As alluded to above, the response latency result is another finding which does not seem to support the usual expectations of hyperactive or impulsive children (e.g., Kagan, 1965; Sykes et al., 1973). The absence of a significant relationship between response latency to $S^D$ components and activity level would seem to indicate that even the highly active subjects were able to control their response rates. The failure to find shorter response latencies for the more active subjects may possibly be attributed to the effects of prior exposure to reinforcement. Subjects were rewarded for making accurate and well deliberated discriminations to the $S^D$ complex on a CRF schedule during training. The selection of a VR3 schedule to present the $S^D$ complex during the test session was made to maintain responding and reduce the discriminability of the $S^D$ complex trials from the $S^D$ component trials.
This may have been effective enough to maintain the controlled deliberate response behavior previously developed during training. Freiburg and Douglas (1969) have reported on the effectiveness of a CRF schedule in facilitating learning in hyperactive children by maintaining attention to the task, as well as, more deliberate responding. Other researchers have reported similar successes in attaining behavioral control over deviant behaviors, as well as, in training hyperactive children while employing CRF schedules of reinforcement (Alabiso, 1975; Dubros & Daniels, 1966; Patterson, 1965; Patterson, Jones, Whittier, & Wright, 1965). The absence of a significant relationship between activity level and response errors could also be explained in this way.

Another reason for the failure to find a significant difference in response latency may have to do with what others have called social setting events (Steinman, 1970; Peterson & Whitehurst, 1971). Thus, it is probable that experimenter's presence and instructions influenced the subjects and maintained responding even when a change in reinforcement schedule occurred. The experimenter becomes a conditioned stimulus for reinforcement as a result of the earlier training session. Additionally the history each child has with adults acting as social reinforcers may augment the experimenters influence during the session.

The positive relationship between selectivity and response errors lends support to the idea that selectivity may be a significant reason for errors in the performance of hyperactive children. Such errors are made because the
child simply fails to attend to more than a small portion of the stimulus task. For example, any number or letter sequence which the child is required to learn (e.g., 529 or dog) may represent a learning task analogous to the stimulus complex found in the present study. While the child may learn to recognize the number or word during an initial exposure, later, any number or word containing the discriminated component may be regarded as the same as the original number or word because of the presence of the $S^D$ component. Further, the child may fail to recognize even the original stimulus word or number sequence for the same reason. The retention and acquisition variability reported by teachers and researchers with hyperactive children (Kagan, 1966; Keogh, 1971; Thelander et al., 1958) and reported by researchers working with autistic hyperactive children (Koegel & Covert, 1972; Lovaas et al., 1971), can be directly related to the failure of subjects to discriminate more than a small portion of the stimulus complex. It remains to be seen whether selectivity can be adequately demonstrated using number and letter stimuli. However, to further delimit the effects of selectivity in a normal learning situation and increase the applicability to remediation, additional research is needed using such standard stimulus presentations.

There is reason to suspect that selectivity may be less pronounced within a laboratory setting than in the natural environment. The failure to find a relationship between activity ratings and response latency suggests that behavior may be controlled by the more artificial setting. Aman and Sprague (1973) report that settings requiring "formal" behavior expectations (e.g.,
classroom) generate different behaviors in hyperactive children than those that are "informal" (e.g., home, play, etc.). The hyperactive child was observed to be less active and better controlled in the formal setting. The laboratory setting with its conditions and instructions is more formal in this sense than even the classroom. Added to this difference between the laboratory and the classroom conditions is the high variability in stimulus complexity in the natural environment as compared to the limited variance of stimuli in the current study. While stimulus complexity was controlled in this study, this is obviously not the case in a classroom. Selectivity may, therefore, be found to vary with the complexity of the stimulus array encountered by each child. If this could be established, it might then be possible to vary the complexity of material presented to a child to minimize selectivity and maximize learning.

Errors and variable performance explained from a selective attention point of view differs greatly from explanations given by Kagan (1965) related to impulsive undercontrolled responding and distractability. The subjects in this study did not differ significantly in terms of response latency nor errors along the activity variable. What tie-in then does activity level have to selective attention?

One possible explanation comes from recent evidence regarding physiological differences found between hyperactive and non-hyperactive children. Several studies have shown that hyperactive children demonstrate more slow wave EEG activity and lower skin conductance levels than normal

Implied in these findings is hypo-arousal rather than hyper-arousal of hyperactive children. It is thought that the reticular activating system (RAS) responsible for the alerting functions in mid-brain is not providing sufficient stimulation. The child is then able to attend to and process less information simply because he is not "alert." Another equally relevant observation accompanies this finding. Wave patterns and electro-dermal levels noted above are more characteristic of younger children leading to the speculation that hyperactive children may demonstrate developmental lags. No research has addressed either the information processing or the developmental lag notion directly.

In conclusion it must be noted that the present study raises more questions than it answers. While selectivity was demonstrated to be related to activity level of a sample of elementary school children, the selectivity was to essentially neutral "nonsense" stimuli. Further research is needed to establish whether selectivity can be demonstrated to letter and number combinations. Only when such data is available can a more exact explanation be given of the influence of selective attention on classroom learning.

Another question raised by the study has to do with the influence of developmental level on selective attention. Various investigators have demonstrated relationships between maturational level and visual-perceptual processes in discrimination on learning (Eimas, 1969; Hale & Morgan, 1973). Whether
over-selectiveness is a special case of a perceptual developmental lag is open to question. However, several investigators have suggested a developmental lab explanation for hyperactivity generally (e.g., Marwit & Stenner, 1972; Routh et al., 1974). It is not unreasonable to expect a similar possibility with regards to selective perceptual functioning in hyperactive children.

Lastly, while the subjects used in the current study were rated on a scale for hyperactivity and obtained a range of scores from non-hyperactive to hyperactive, other indicators commonly used in making clinical diagnosis were not employed. Caution must then be exercised in generalizing from the data to an otherwise diagnosed hyperactive population.
REFERENCES

Aman, M. G., & Sprague, R. The state-dependent effects of methylphenidate and destroamphetamine. Journal of Nervous and Mental Disease, 1974, 158, 268-270.


Lovaas, O., Schreibman, L., Koegel, R., & Rehm, R. Selective responding by autistic children to multiple sensory input.


APPENDIXES
Appendix A: Parental Consent

Each child participating in this research project will do so with the agreement of his parents. Each parent will sign an authorization allowing his child to participate.

Each child will be free to leave the experiment when he wishes. No restraints either of a physical or chemical nature will be utilized in this project.

Agreement with the school of attendance will be obtained for each child prior to removing him from class.

Confidentiality will be maintained with regard to all subjects used in this research. No reports specifically identifying individual subjects will be issued.
Appendix B: Diagram of Apparatus
Appendix C: Hyperactive Rating Scale

Child's Name ___________________________ Birth Date _______________________

Rater's Name ___________________________ Date of Rating _______________________

Please rate the child on each of the characteristics (or behavior) listed on the following scales. Place a check mark at the point on the scale indicative of your estimate of the degree to which the child possesses the particular characteristic.

As you make each rating, judge the child in comparison with other children of the same sex and age. That is, the ratings should indicate your estimate of the child's behavior in comparison with the behavior displayed by other "normal children."

For each of the characteristics, which are defined below, place a check mark at one of the six points on the scales running from "much less than most children." Do not mark the midpoint on any of the scales. Even though it may sometimes be difficult to make a judgement, please make a rating on one or the other side of the scale.

1. **Hyperactivity.** Involuntary and constant overactivity; advanced motor development (throwing things, walking, running, etc.); always on the move; rather run than walk; rarely sits still.

<table>
<thead>
<tr>
<th>Much Less Than Most Children</th>
<th>Less Less</th>
<th>Slightly More</th>
<th>Slightly More</th>
<th>More More</th>
<th>Much More Than Most Children</th>
</tr>
</thead>
</table>

2. **Short Attention Span and Poor Powers of Concentration.** Concentration on a single activity is usually short, with frequent shifting from one activity to another; rarely sticks to a single task very long.

<table>
<thead>
<tr>
<th>Much Less Than Most Children</th>
<th>Less Less</th>
<th>Slightly More</th>
<th>Slightly More</th>
<th>More More</th>
<th>Much More Than Most Children</th>
</tr>
</thead>
</table>

3. **Variability.** Behavior is unpredictable, with wide fluctuations in performance; "sometimes he (or she) is good and sometimes bad."

<table>
<thead>
<tr>
<th>Much Less Than Most Children</th>
<th>Less Less</th>
<th>Slightly More</th>
<th>Slightly More</th>
<th>More More</th>
<th>Much More Than Most Children</th>
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</table>
4. **Impulsiveness and Inability to Delay Gratification.** Does things on the spur of the moment without thinking; seems unable to tolerate any delay in gratification of his (her) needs and demands; when wants anything, he (she) wants it immediately; does not look ahead or work toward future goals; thinking only of immediate present situations.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Much Less Than</th>
<th>Less</th>
<th>Slightly Less</th>
<th>Slightly More</th>
<th>More</th>
<th>Much More Than</th>
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<tbody>
<tr>
<td>Most Children</td>
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</tbody>
</table>

5. **Irritability.** Frustration tolerance is low; frequently in an ugly mood, often unprovoked; easily upset if everything does not work out just the way he (she) desires.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Much Less Than</th>
<th>Less</th>
<th>Slightly Less</th>
<th>Slightly More</th>
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<th>Much More Than</th>
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<tbody>
<tr>
<td>Most Children</td>
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6. **Explosiveness.** Fits of anger are easily provoked; reactions are often almost volcanic in their intensity; shows explosive, temper-tantrum type of emotional outbursts.

<table>
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<tr>
<th>Comparison</th>
<th>Much Less Than</th>
<th>Less</th>
<th>Slightly Less</th>
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VITA

Wilford William Beck III

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References:
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