Stimulus Overselectivity: An Investigation of Determinants

Margaret T. McGlinchey
Western Michigan University

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STIMULUS OVERSELECTIVITY: AN INVESTIGATION OF DETERMINANTS

by

Margaret T. McGlinchey

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Department of Psychology

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Stimulus overselectivity: An investigation of determinants

McGlinchey, Margaret Theresa, Ph.D.
Western Michigan University, 1988
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Margaret T. McGlinchey
DEDICATION

I would like to dedicate this dissertation to my parents, Margaret and Edward McGlinchey, for their support throughout my educational endeavors.
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CHAPTER I

INTRODUCTION

When a child is presented with a compound stimulus, one which is composed of multiple components and responses to it come under the control of only a subset of the available components, the phenomenon is referred to as stimulus overselectivity. This has been observed in autistic children (Gersten, 1983; Koegel & Rincover, 1976; Koegel & Schreibman, 1977; Koegel, Schreibman, Britten, & Laitinin, 1979; Lovaas, Schreibman, Koegel, & Rehm, 1971); normal children (Bickel, Stella, & Etzel, 1984; Koegel & Wilhelm, 1973); learning disabled students (Bailey, 1981); and educable mentally impaired students (Bailey, 1981).

The initial focus of research on overselectivity was the identification of correlates such as trait variables ("intelligence"), developmental level, diagnostic impairment and language level. Recent research has focused upon the remediation or elimination of stimulus overselectivity (Allen, 1983; Koegel & Rincover, 1976; Koegel & Schreibman, 1977).

Several researchers have suggested that stimulus overselectivity may be a variable involved in some of the learning problems that handicapped children experience. Bailey (1981) stated that it may be involved in the problems of learning disabled children. She said that overselectivity may be linked to the heterogeneous nature of their problems. Some may have receptive problems or an arithmetic
reasoning disability. She suggests that future research examine the relationship between a specific learning disability and stimulus overselectivity. Lovaas et al. (1971) offered several implications of stimulus overselectivity for understanding autism and certain kinds of learning. They stated that much learning involves a contiguous presentation of two stimuli. Contiguous presentations involve presenting a stimulus complex. Assuming that the autistic child's response to the appropriate stimulus is somehow blocked because of stimulus overselectivity, many types of learning may be affected. Lovaas et al. (1971) have suggested these effects might occur in a number of ways:

1. Most human behavior, such as language and cognitions, is based on the prior acquisition of conditioned reinforcers. Since conditioned reinforcers acquire and maintain their strength through pairing with primary or unconditioned reinforcers, behavioral deficits in autistic children could be related to a failure of such conditioning to take place. Without such conditioning, the number of potential reinforcers for autistic children would be limited to those which are unconditioned.

2. Another possibility has to do with the inappropriate affect that autistic children frequently emit. The way in which appropriate affect is established may be very similar to the process which establishes conditioned reinforcers. For example, the contiguous occurrence of reinforcing stimuli with a parent may not come to elicit positive affective responses in the presence of the parent alone for autistic children as it does generally with normal children.
3. Another possibility involves the superficial, meaningless, or echolalic speech that many autistic children demonstrate. Multiply controlled and complex verbal behavior involves simultaneous presentations of auditory, visual, or other stimuli. Overselective responding would prevent many of these other stimuli from gaining control.

4. Teaching new discriminations is usually facilitated by the addition of extra cues or prompts to the stimuli to be discriminated. After learning has occurred those superfluous cues are faded out. Although this fading procedure is usually very effective, it would not be if stimulus overselectivity was operating concurrently.

5. Daily performance of autistic children is often sporadic. Stimulus overselectivity may also be a factor in the autistic child's variable response to already functional stimuli. For example, responding inconsistently to significant adults such as teachers or parents when seen in a different environment (Lovaas et al., 1971, p. 221).

Early investigations of stimulus overselectivity (e.g., Lovaas et al., 1971) used an experimental paradigm which, according to a subsequent analysis (Allen, 1983), was not adequate to demonstrate stimulus overselectivity. The paradigm used two phases: a training phase and a test phase. During the training phase, a stimulus consisting of two components (e.g., a circle and a square) was displayed and a response emitted in their presence was reinforced. During the test phase, the components were presented separately. If the subject responded to one component significantly more than the other,
stimulus overselectivity was inferred. This inference was based on the fact that autistic children responded as such, whereas normal children responded to each component with equal strength. According to Allen (1983), the paradigm used was not adequate because during the test phase, the components of the S+ were presented separately, therefore subjects were forced to choose between two incorrect stimuli. This situation may not have accurately reflected the actual control maintained by each S+ element.

Schreibman, Charlop, & Koegel (1982) employed a three-phase paradigm: (1) training, (2) testing, and (3) retraining (with test stimuli) in an effort to demonstrate that overselectivity could be eliminated. During the initial training phase, three stimuli were presented to the subjects. The positive stimulus (S+) had two components; each of the other stimuli (S-s), which had only one component, differed from both components of the S+ and from each other (see Figure 1, left column). Subjects were trained until they reached a criterion of 90% correct responding in 20 consecutive trials. Subsequently, the subjects were tested with three stimuli, one of which was the S+ during training; the others each contained one component of the S+ (see Figure 1, second column). If the subject responded less than 100% to the S+, the investigators inferred that overselectivity had occurred. Further training on the test stimuli was given until the subjects met the 90% criterion. New training and test discriminations were presented until the child responded at 100% on two consecutive test discriminations after initial training. At this point the investigators inferred that overselectivity had been
Figure 1. Sample Training and Testing Stimulus Sets Used in Allen's (1983) Initial Training, Multiple Difference Testing, and Minimal Difference Testing.
eliminated. However, as may be seen from the second column of Figure 1, there are multiple differences between the test stimuli: although each S- has one component of the training stimulus, one S- has two figures and the other has one. Furthermore, orientation of the separate components of the S+ with respect to each other remained constant during Schreibman's et al. (1982) intervention. Consequently, discrimination breakdowns with respect to orientation of the S+ elements would be more likely (Becker, Engelmann, & Thomas, 1975).

Allen (1983) eliminated the confounding described above and in so doing demonstrated that overselectivity had not been eliminated. In the study, after subjects met Schreibman's et al. (1982) criterion during the testing phase, they were tested with the four figures shown in the third column of Figure 1. The subjects did not perform at the 100% correct level. These results indicated that Schreibman's et al. (1982) procedure had not eliminated stimulus overselectivity. Subjects' responses were based on characteristics other than those specified by the experimenters. At this point the author implemented Critical Difference Training which involved presenting S- stimuli that were minimally different from the S+ and are depicted in the fourth column of Figure 1. Critical Difference Training eliminated stimulus overselectivity for all three Allen's (1983) subjects. That is, subjects met criterion of 90% correct responding on two consecutive sets of Minimal Difference Tests. In his discussion, the author states that,

It is unclear from these experiments whether these discrimination gains resulted from more careful attention to the S+ or the inference of a 'rule' about critical
elements of the S+ in these types of compound stimuli. Furthermore, whether such gains would generalize to untrained novel compound stimuli (i.e., other than the geometric forms in these experiments) needs to be assessed in future research. (Allen, 1983, p. 25)

In the studies previously described, generalization to "untrained novel compound stimuli" has never been assessed because the teaching and testing paradigms were not designed to teach a generalized response. The stimulus sets were presented in succession, but knowing about defining characteristics of the S+ in Set 1 did not facilitate responding to the defining characteristics of the S+ in Sets 2 or 3, etc. The only generalized rule that could be derived from a series of discriminations such as Schreibman's et al. (1982) or Allen's (1983) is that the child should select the stimulus array s/he has seen before, because only the S-s were novel in the test condition.

A second problem is related to the fact that in both the Schreibman et al. (1982) and Allen (1983) studies, the S+ was held constant across all conditions; the irrelevant characteristics of the S+ were never varied. Irrelevant characteristics refer to aspects of the stimulus that were not the intended stimuli for the discrimination, for example, size or color of the stimuli. Since irrelevant stimuli of the S+ were held constant, it is not clear how subjects would have responded had the irrelevant characteristics of S+ been varied. For example, how would children have responded to a novel S+ that had the same relevant characteristics but different irrelevant characteristics? One such stimulus would be two spatially separate components, a line and ellipse but a different size or color. The discrimination would probably not be maintained with these novel
examples, since training for generalization was not done. If all irrelevant characteristics are held constant across each positive example of the training stimulus, then any or all irrelevant characteristics may become, in a sense, "essential" or defining characteristics of the S+. When children fail to respond to an example not used in training, their behavior might be described as "overselective." By holding the irrelevant characteristics of the S+ constant across conditions, we may actually be inducing or setting the occasion for overselectivity. Overselective responding, that is, responding to some but not all of the defining characteristics or irrelevant characteristics, is consistent with the contingencies of reinforcement in effect.

Many of the examples of overselectivity in relation to practical learning have involved children responding to irrelevant characteristics of the positive example or training stimuli. One researcher describes the autistic child who did not show any sign of recognition of his father when his father did not have his glasses on (Schreibman & Lovaas, 1973). Another describes a child who learned to respond to the instruction "Touch your nose" but when trainers were changed, the response did not maintain (Rincover & Koegel, 1975). Upon analysis, researchers discovered that in the first case, the response was controlled by the glasses worn by the father. In the second case, an arbitrary hand movement of the first trainer was the controlling stimulus. When irrelevant characteristics of the S+ are not varied, or are held constant across the S+ and S−, we should expect them to gain control over responding in the same way that we expect control from
the stimulus components considered by the experimenter to be essential characteristics.

The adequacy of the term "stimulus overselectivity" to describe the phenomena has been previously questioned (Allen, 1983) and it is still an important question. There are times when it is very appropriate to be overselective. For example, a teacher holds up a large red square and says, "Red." She then holds up a small blue circle and says, "Not red." The S+ (red) is the stimulus the teacher would like to gain control over the child's response "red." The teacher hopes that irrelevant characteristics such as size and shape will not gain control over the child's response "red". The manner of presentation described above, however, will frequently result in responses of some children being controlled by color, some may be controlled by the shape, others by the size, and some may be controlled by multiple attributes. Those for whom responses are controlled by the intended stimulus (S+ = red) would be called "high performers," whereas those for whom responses are controlled by the unintended stimuli (i.e., small, square) would be called "overselective." Both groups are equally "overselective," with the difference being that one group responds overselectively to the stimuli intended by the teacher (S+) whereas the other group responds overselectively to the unintended irrelevant stimuli.

Inferences are frequently made about the verbal processes that high performers go through in an effort to learn from a teacher presentation which is confusing. A student's behavior is frequently "overselective," but when it also happens to be consistent with the
teacher's "intentions," it is not identified as a problem. It is not clear that the term "stimulus overselectivity" communicates the difficulty handicapped children have in learning from conventional teaching strategies. It is also difficult to identify children as having the trait "overselectivity" or to predict the situations in which they would be overselective. Furthermore, the "durability" of the phenomena is questioned, since researchers have seen decreases in overselectivity simply by repeating test trials with no intervening training (Schreibman, Koegel, & Craig, 1977).

Although perhaps not intended by Lovaas et al. (1971), over time and with additional studies, "stimulus overselectivity" has become a type of explanatory fiction. The logic that "stimulus overselectivity" is responsible for common behavioral deficits of handicapped children is an example of circular reasoning. Why do children fail to respond appropriately to complex stimuli necessary for learning cognitions? Because they respond "overselectively." How do we know they respond overselectively? Because we present them with complex stimuli and they are controlled by only one component. Given this circular reasoning, the concept becomes functionally useless as an explanation.

In light of these uncertainties about stimulus overselectivity, a concentration of research efforts on designing teaching strategies that are more effective than "a commonly employed teaching procedure" (Schreibman et al., 1982, p. 487) might be more productive. This would be achieved by clearly differentiating relevant from irrelevant stimuli in teacher presentations in order that relevant stimuli will
control responding. As a step in this direction, the present investigation asked the following questions:

1. Can students who demonstrate overselectivity on an initial learning task similar to Schreibman's et al. (1982), learn to attend to all relevant features of a complex stimulus and transfer that stimulus to novel examples of the stimulus complex which vary the irrelevant characteristics of the stimulus?

2. Can students who do not demonstrate overselectivity on an initial learning task similar to Schreibman's et al. (1982), demonstrate the phenomenon given a more complicated task and a more stringent stimulus control test? Further, can they also learn to attend to all relevant features of a complex stimulus and transfer that stimulus control to novel examples of the stimulus complex which vary the irrelevant characteristics of the stimulus?
CHAPTER II

METHOD

Subjects

The six boys and three girls who participated in this study were identified by school personnel as having a specific learning disability as defined by the Michigan State Board of Education Special Education Rules (1985). They were enrolled in specific learning disability classrooms kindergarten through third grade in Kalamazoo Public Schools. Their ages ranged from 7-10 years ($x = 8.2$) and their intelligence quotients ranged from 72-92. They were selected from a group of 16 children to participate in the study by means of a screening which categorized them into one of two groups: (1) overselective learners and (2) non-overselective learners according to criteria established in previous studies. The screening process is described in the following Procedure Section.

Setting

All training and test sessions to be described were conducted in rooms which were generally free from distractions. In all sessions the student was seated in a chair facing the experimenter.
Materials

The stimulus materials used in the study consisted of sets of 6 cm x 9 cm white laminated cards on which were drawn various geometric forms as shown in Figures 2 and 3.

**Stimulus Materials Used in Subject Selection**

Two groups of stimulus cards were used in the selection process: Initial Training Stimuli and Minimal Difference Stimuli. The former consisted of six sets of three cards. As may be seen in the left column of Figure 2, in each set, one of the three cards (designated as S+) contained two spatially separate components, one of which was a geometric form and the other a line or a dot. The other two cards in each set (designated as S-s) contained only one geometric form. The Minimal Difference Stimuli, shown in the right column of Figure 2, were six sets of four cards each. In each set the S+ stimulus card from the Initial Training set was accompanied by three S-s. Two of the S-s contained one of the spatially separate components of the S+ and a novel form, while the remaining S- contained both components of the S+ but in reversed position.

**Stimulus Materials Used in the Experiment**

Four groups of stimulus cards were used in the experiment: Initial Training Stimuli, Minimal Difference Test Stimuli, Generalization Probes, and Generalization Training Stimuli.
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<tr>
<th>SET</th>
<th>INITIAL TRAINING</th>
<th>MINIMAL DIFFERENCE TEST</th>
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Figure 2. Stimulus Sets used in the Procedure to Identify Subjects as Overselective or Not Overselective.
**Figure 3.** Task Stimuli for the Initial Training, Minimal Difference Test, Generalization Probes, and Generalization Training of Task I.
Initial Training Stimuli

In the Initial Training, the S+ consisted of a visual stimulus that had three defining characteristics. The other two cards were S-s and were designed such that the students could respond to only part of the three relevant components and make a correct response (see Figure 3). For example, in Task I the defining characteristics were:

1. Three and only three objects.
2. The middle object must be a dot.
3. All objects are on a horizontal plane.

The S+ in the Initial Training for Task I consisted of the three characteristics described above. The specific objects were a triangle, dot, and square. The S- cards were an inverted triangle and circle on one card and a diamond and rectangle on the other card. Examples of the Initial Training Stimuli for Task I are presented in Figure 3. For each task trained, two sets of test stimuli were developed.

Minimal Difference Test Stimuli

These test stimuli were designed in a manner similar to Allen (1983). In this test, the S+ from the Initial Training was used. Three new S-s were developed which were minimally different from the S+. The Minimal Different Test used in the present study had the same design feature: each S- was designed so that only one of three
relevant cues had been omitted on each card. An example of Minimal Difference Test Stimuli is presented in Figure 3.

**Generalization Probe Stimuli**

The second set of test stimuli was the Generalization Probes. For each task taught, 10-12 Generalization Probes were designed. As in the Minimal Difference Test, each S- was designed so that only one of the defining characteristics was omitted. For example, in Task I the Minimal Difference Test consisted of the S+ (as previously described) and three new S-s. One S- had more than three objects but was on a horizontal plane and had a dot in the middle. One S- had three objects on a horizontal plane but the dot was not in the middle. The third S- had three objects and a dot in the middle but they were not positioned on a horizontal plane. If a child consistently selected the card that did not have the dot in the middle, it would appear that this component had acquired very little control over responding (i.e., overselectivity). By recording specific errors on the Generalization Probes it was possible to determine which defining characteristics were consistently ignored and by inference had failed to acquire stimulus control over responding.

The Generalization Probes differed from the Minimal Difference Test in one way. The Minimal Difference Test used the same S+ that was trained, but used new S-s, whereas the Generalization Probes used a new example of the S+ in addition to new S-s for each probe. In drawing the new S+ and S-s, the specific objects and color of the objects were varied randomly. For example, in Task I: Probe 1, the
S+ consisted of a black star, black dot, and blue ball, while the S-s consisted of: (a) a black triangle, dot, and square on a diagonal plane; (b) a black dot, triangle, dot, blue square, and black dot; and (c) black triangle, red circle, and dot - not in the middle. Examples of Generalization Probes are presented in Figure 3.

In the Minimal Difference Test, since the S+ is held constant across training and testing it would be possible for students to infer a "rule" such as "Touch the one you've seen before." In other words, students may have selected the S+ because they had a learning history with respect to that card, whereas the other choices (S-s) were novel. Given the possibility that students' responses were controlled by this variable, control by the experimenter-specified characteristics would be less clear. If one were responding to the experimenter-specified characteristics of the S+, one would expect 100% performance on the Generalization Probes (assuming they are good test items). Stimulus overselectivity could be inferred if performance was not at this level.

Reynolds, Newsom, and Lovaas (1974) previously defined an overselectivity score as being equal to the absolute difference between response percentages for two separate components of the S+. This was determined by presenting the components of the S+ separately and measuring the rate of responding. For example, in their study, the S^D complex consisted of a click and tone. When presented separately for one subject, responding was 100% for one component and 1% for the other component. The selectivity score was 99. Whereas for another subject, the percentages were 13% and 6%, resulting in a selectivity
score of 7. This analysis suggests that consistently ignoring a specific component is a relevant aspect of stimulus overselectivity. A similar analysis could be accomplished by analyzing specific errors on the Generalization Probes.

**Generalization Training Stimuli**

The third type of training was called Generalization Training. This training was implemented only after the first failure on the Generalization Probes. For each task taught, about twelve sets of Generalization Training Stimuli were developed. Each set contained one S+ and two S-s. Three to four sets were designed to teach students to attend to each of the critical characteristics. Irrelevant characteristics were varied across sets including such variables as color of the objects. For example, in Task I, Sets 1-4 were designed to teach students to attend to plane as a defining characteristic. In Set 1, the S+ consisted of a square, dot, and triangle. The S-s also consisted of a square, dot, and triangle, but they were positioned on different planes (i.e., diagonal). In Set 4, the S+ consisted of a cross, dot, and heart, while the S-s consisted of the same shapes but again varied the plane. The specific objects drawn on the cards were irrelevant, and so they were varied across training sets. Sets 5-7 were designed to teach the dot in the middle as a defining characteristic; Sets 8 and 9 taught the number of objects and Sets 10-12 sampled the range of variability of irrelevant characteristics. Examples of Generalization Training Stimuli are presented in Figure 3.
Interobserver Agreement

A graduate student was trained to score the students' responses during all conditions. The experimenter and observer recorded data with each presentation of a training or test trial. Each response was scored as correct or incorrect. During training and testing, interobserver agreement observations were conducted across 27% of the total sessions. The observations were distributed across conditions and subjects.

Procedure

Selection of Subjects

The Schreibman et al. (1982) and the Allen (1983) procedures were employed to select a group of "overselective" learners and a group of "non-overselective" learners according to the criteria established by these studies. The first phase of the selection process consisted of Initial Training; the second phase consisted of Minimal Difference Testing.

Initial Training involved the simultaneous presentation of three stimulus cards of a set in a random order spaced 4 cm apart. The subject was instructed to "touch the correct card." If the S+ was touched, the experimenter verbally acknowledged the subject by such statements as "Good job," "That's good," or "That's the right one." If the subject touched one of the S- cards, the experimenter said, "No" and removed the cards. Subjects were also praised for paying attention and sitting appropriately.
During the early phase of Initial Training, subjects were reinforced each time they made the correct response, e.g., pointed to the S+. In order to minimize the difference between training and subsequent testing, this reinforcement schedule was gradually changed to one in which, on the average, they were reinforced only one time for four correct responses (VR-4).

Initial Training Trials were given using one set of stimulus cards until the subject made eighteen correct responses within twenty trials. When this criterion was achieved, the Minimal Difference Test was administered. The test consisted of twenty trials during which the four Minimal Difference Stimulus cards were presented (see Figure 2) and in each trial the subject was instructed to "touch the correct card" (S+). During the series of twenty test trials, no reinforcement was given. After the twenty test trials were given for the first set, Initial Training was started for the second set. This training and testing cycle was continued until the six sets were completed. Subjects who achieved the 90% correct criterion (18/20 trials) over five of the six sets were categorized as "non-overselective." Subjects who performed at 70% correct or below on five of the six sets were categorized as "overselective." Of the sixteen subjects who were screened, three were eliminated because of variability in performance and four were eliminated because of excessive absences. Of the nine remaining subjects, four were "non-overselective" and five were "overselective."
Experimental Procedure

Trials were presented when the child was displaying good eye contact and was not engaged in off-task behavior. Each trial consisted of presenting the S+ and corresponding S-s, and the instruction "touch the correct card." During training, responses were initially reinforced on a continuous schedule which was gradually shifted to a variable-ratio 4 schedule. The schedule was shifted to reduce the discriminability of errors made based on differences between reinforced training trials and non-reinforced test trials. Incorrect responses were followed by a verbal "no" and removal of the task stimuli. The position of the S+ was randomized across trials.

Training sessions were conducted four to five days per week for 20-30 minutes. Initial Training, Minimal Difference Testing, and Generalization Probes all occurred on the same day. Generalization Training (if necessary) and Generalization Probes occurred during the next session. This training and testing cycle was repeated with each task and is depicted in Figure 4. A total of four tasks were taught.

Initial Training

The student was presented with the training stimuli for the first task. Training was completed when the student met a criterion of 90% correct across twenty trials on a VR-4 schedule. At this point, the Minimal Difference Test was administered which consisted of the S+ used in training and three novel S-s. The students received ten trials of this test, with the position of the S+ being
Figure 4. Flowchart of the Experimental Procedure
randomized on each trial. If the student performed at less than 90% on the Minimal Difference Test (i.e., evidence of overselectivity based on previous research), then the next training was implemented.

**Critical Difference Training**

The students were presented with 10-20 additional training trials using the stimuli from the Minimal Difference Test. Following this training, 10 more test trials were presented and then the Generalization Probes were administered. The goal of the Generalization Probes was to determine if the student's responses were controlled by the experimenter-specified characteristics of the S+. This would have been inferred in previous studies based on performance being at 90% on the Minimal Difference Test.

If the student initially performed at 90% on the Minimal Difference Test, then the Critical Difference Training was not needed and Generalization Probes were immediately administered. Generalization Probes were administered until a failure occurred. A failure on a probe meant that the student's responses were not controlled by the experimenter-specified characteristics (i.e., stimulus overselectivity). When a failure occurred, the student received Generalization Training.

**Generalization Training**

For each task 10-12 stimulus sets were developed. Each set attempted to bring the student's responding under the control of one of the three experimenter-specified characteristics of the S+. This
was accomplished by using minimally different S- s. In addition, irre­
relevant characteristics of the S+ were varied across the ten to

was accomplished by using minimally different S- s. In addition, irre­
relevant characteristics of the S+ were varied across the ten to
twelve sets. This was done to sharpen the stimulus control of the S+
and reduce the inappropriate stimulus control by irrelevant aspects
of the S+. Each set was presented until the student made five con­
secutive correct responses. When this criterion was met, the next
set was presented. During this training, Generalization Probes were
periodically administered usually after each of three sets were
trained to criterion. This procedure of training and testing was
repeated until the student made a correct response on each probe, or
until all ten to twelve stimulus sets were trained.
CHAPTER III

RESULTS

Interobserver Agreement

Interobserver agreement percentages were 95% or above during all but 2 of the 31 reliability observation sessions. The percent agreement during those two sessions were 90% and 82%.

Initial Training Phase

The data in Table 1 describe the students' performance on the Minimal Difference Test after Initial Training and where needed, Critical Difference Training. Since the Initial Training and Critical Difference Training always required 90% or better performance before testing, the training data will not be displayed. The table shows that, generally, the students were able to perform at 90% or better on the Minimal Difference Test after Initial Training. There were twelve occasions (out of 36 total) when a student required Critical Difference Training in order to perform at criteria on the Minimal Difference Test. Two of nine students (Dave and Sally) required Critical Difference Training on three of four tasks, and for one student this training was not effective on one task (Dave, Task II). Two of nine students (Reg and Anthony) did not require Critical Difference Training on any of the four tasks, while the other five students required Critical Difference Training on only one of the
Table 1

Performance on the Minimal Difference Test after Initial Training (IT) and, When Needed, Critical Difference Training (CDT)

<table>
<thead>
<tr>
<th>Name</th>
<th>Task I IT</th>
<th>CDT</th>
<th>Task II IT</th>
<th>CDT</th>
<th>Task III IT</th>
<th>CDT</th>
<th>Task IV IT</th>
<th>CDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jane</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Reg</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Dan</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Gary</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Dave</td>
<td>100%</td>
<td>40%</td>
<td>37%</td>
<td>10%</td>
<td>100%</td>
<td>80%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Brent</td>
<td>10%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Nan</td>
<td>30%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>Anthony</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Sally</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

four tasks. After Initial Training, and Critical Difference Training when needed, all students, with the exception of Dave (37% on Task II) and Nan (95% on Task IV) performed at 100% on the Minimal Difference Test across all tasks. This part of the study replicated findings by Allen (1983).

Critical Difference Training

The Minimal Difference Test has been described as a more sensitive measure of stimulus overselectivity and used in a previous study to measure the phenomenon (Allen, 1983). However, if the students'
responses were indeed controlled by the experimenter-specified characteristics of the S+ as the results of the Minimal Difference Test suggest (i.e., not overselective), then one would expect these students to perform at a similar criteria on the Generalization Probes. Figure 5 represents the percentage of tasks in which each student was able to perform on the Generalization Probes after meeting the criterion of the Minimal Difference Test. There were only three occasions (out of 36) following the Minimal Difference Test in which a student was able to perform at criterion on the Generalization Probes.

Figure 5. Percent of Tasks in Which Discrimination was Maintained on Novel Generalization Probes After Mastery on the Critical Difference Test.
Probes: Reg, Gary, and Sally, all on Task III. On these few occasions, it appears that these students' responses were indeed controlled by experimenter-specified characteristics of the S+. There is no evidence of stimulus overselectivity on Task III after Initial Training for Reg and Gary, and Critical Difference Training for Sally.

These results suggest that although four students were initially selected because they were not overselective on the Allen Minimal Difference Test (1983), their performance on the Generalization Probes was "overselective." Because the Generalization Probes varied irrelevant aspects of the S+, the fact that these students could not perform on this test suggests that their responses were controlled at least partially by irrelevant aspects of the S+: stimulus overselectivity could be inferred.

Generalization Training

After the first failure on a Generalization Probe, students were provided with Generalization Training. Students were presented trials with each stimulus set until they reached a criteria of five consecutive correct responses, after which a new stimulus set was trained. Probes were administered periodically, usually after each of three sets of examples. The data in Figure 6 depict the percentage of tasks on which each student was able to perform at 100% on the Generalization Probes after Generalization Training. Generalization Training was needed across all tasks for all subjects except the three students during Task III, (Reg, Gary, and Sally).
Only one student performed at 100% on all four tasks (Nan). This student was in the "overselective" group. The other students, both overselective and not overselective, varied in performance from 25% to 75%. The group originally identified as "not overselective" performed at criterion on 56% of the tasks (9 of 16 tasks). The group identified as "overselective" performed at criterion on 55% of the tasks (11 of 20).

Several students did not achieve 100% but performance improved as the Generalization Training continued. This is indicated by the...
reduction in errors on the Generalization Probes (see Figures 7, 8, 9, and 10). These figures depict the students' performances on Generalization Training for Tasks I, II, III, and IV, respectively.

After the Generalization Training on Task I most students, with the exception of Gary, responded correctly to all but one probe (see Figure 7). For four of the students, the error was on Probe 5 (see Figure 3). Gary did not master the discrimination during the Generalization Training and additional trials did not improve his performance.

The Generalization Training on Task II resulted in criterion performance for four students: Sally, Nan, Brent, and Reg. The five students who did not perform at criterion were exposed to additional training trials the following day. This additional training was effective for Jane and Anthony (see Figure 8).

The data for Task III are depicted in Figure 9. Three students did not require Generalization Training on this task. Reg, Gary, and Sally were able to perform on the Generalization Probes after Initial Training or Critical Difference Training. All other students performed at criterion after the Generalization Training.

Figure 10 presents the data from Task IV. Generalization Training was effective for Reg, Dan, Brent, and Nan. Sally was correct on all probes after Generalization Training except Probe 1. Additional training trials during the next session were effective for Jane but not for Anthony or Dave.
Figure 7. Correct and Incorrect Responses on Probe Trials for All Students on Task I, During Initial Training, Critical Difference Training, and Generalization Training.
Figure 8. Correct and Incorrect Responses on Probe Trials for All Students on Task II, During Initial Training, Critical Difference Training, and Generalization Training.
Figure 9. Correct and Incorrect Responses on Probe Trials for All Students on Task III, During Initial Training, Critical Difference Training, and Generalization Training.
Figure 10. Correct and Incorrect Responses on Probe Trials for All Students on Task IV, During Initial Training, Critical Difference Training, and Generalization Training.
Comparison of Groups

Trials to Criterion

The data in Table 2 indicate the number of trials to criterion for each student across each task. Some students have an asterisk next to their trial number for a given task. This indicates that for those tasks the criterion of the Generalization Probes was never met.

Table 2

Total Number of Trials for Each Task Including Initial Training, Critical Difference Training, and Generalization Training

<table>
<thead>
<tr>
<th>Name</th>
<th>Task I</th>
<th>Task II</th>
<th>Task III</th>
<th>Task IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jane</td>
<td>93</td>
<td>210*</td>
<td>84</td>
<td>205*</td>
<td>592</td>
</tr>
<tr>
<td>Reg</td>
<td>89</td>
<td>95</td>
<td>51</td>
<td>121</td>
<td>356</td>
</tr>
<tr>
<td>Dan</td>
<td>86</td>
<td>201*</td>
<td>115</td>
<td>108</td>
<td>510</td>
</tr>
<tr>
<td>Gary</td>
<td>235*</td>
<td>189*</td>
<td>41</td>
<td>129</td>
<td>594</td>
</tr>
<tr>
<td>Totals</td>
<td>503</td>
<td>695</td>
<td>291</td>
<td>563</td>
<td>2052</td>
</tr>
<tr>
<td>Average</td>
<td>126</td>
<td>174</td>
<td>73</td>
<td>141</td>
<td>513</td>
</tr>
<tr>
<td>Dave</td>
<td>121</td>
<td>218*</td>
<td>114</td>
<td>193*</td>
<td>646</td>
</tr>
<tr>
<td>Brent</td>
<td>141</td>
<td>93</td>
<td>121</td>
<td>99</td>
<td>454</td>
</tr>
<tr>
<td>Nan</td>
<td>107</td>
<td>144</td>
<td>69</td>
<td>116</td>
<td>436</td>
</tr>
<tr>
<td>Anthony</td>
<td>133</td>
<td>188</td>
<td>63</td>
<td>234*</td>
<td>618</td>
</tr>
<tr>
<td>Sally</td>
<td>105</td>
<td>120</td>
<td>71</td>
<td>132</td>
<td>428</td>
</tr>
<tr>
<td>Totals</td>
<td>607</td>
<td>763</td>
<td>438</td>
<td>774</td>
<td>2582</td>
</tr>
<tr>
<td>Average</td>
<td>121</td>
<td>153</td>
<td>88</td>
<td>155</td>
<td>516</td>
</tr>
</tbody>
</table>

*Indicates that the subject did not meet criterion for mastery next to their trial number for a given task.
reached. Additional training trials were provided during each of those tasks. They were effective in only three situations: Tasks II and IV for Jane, and Task II for Anthony. As can be seen in Table 2, there was very little difference between the groups with respect to average number of trials or number of tasks in which criterion was met.

Error Analysis

In the present study an analysis similar to that completed by Reynolds et al. (1974) can be accomplished by analyzing specific error patterns. As mentioned previously, all S-s of the Minimal Difference Tests and Generalization Probes were designed so that only one relevant cue had been omitted. Analysis of errors makes it possible to determine if the same omission is consistently being made (i.e., stimulus overselectivity) or if the errors are random. Table 3 contains percentages determined by dividing the total number of errors made on the same type of S- card. For example, on Task I Jane made three errors. During each of these probes, she selected the card that was on a horizontal plane, had the correct number of objects, but the dot was not in the middle. This suggests that she was not attending to the "dot in the middle" as a defining characteristic. However, Sally made five errors. Two errors were due to selecting the S- card that did not have a dot in the middle. Two errors were due to selecting a card that was on an incorrect plane, and one error was due to selecting the card that had the wrong number of objects. The ratio of errors (ER) due to selecting the same type of S-
card for Sally was two of five errors. This results in an "oversel-
 ectivity" percentage score of 40% for Task I. A percentage score of
100% indicates that the student consistently selected an S- card that
omitted the same relevant characteristic of the S+ (i.e., the S-card
that did not have the dot in the middle). The last column of Table 3

Table 3

Error Analysis for Each Student, Overselective (OS) and Not
Overselective (NOS), Across Tasks. The Percentage of Errors Due to
Selecting the Same Type of S- Across Probes

<table>
<thead>
<tr>
<th>Name</th>
<th>Task I</th>
<th>Task II</th>
<th>Task III</th>
<th>Task IV</th>
<th>No. of Tasks &gt;50%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*ER %</td>
<td>ER %</td>
<td>ER %</td>
<td>ER %</td>
<td></td>
</tr>
<tr>
<td>Jane</td>
<td>3/3 100%</td>
<td>3/7 43%</td>
<td>2/2 100%</td>
<td>9/9 100%</td>
<td>3/4</td>
</tr>
<tr>
<td>Reg</td>
<td>2/4 50%</td>
<td>1/2 50%</td>
<td>0/0</td>
<td>—</td>
<td>1/4</td>
</tr>
<tr>
<td>Dan</td>
<td>2/4 50%</td>
<td>9/12 75%</td>
<td>2/3 67%</td>
<td>1/3 33%</td>
<td>2/4</td>
</tr>
<tr>
<td>Gary</td>
<td>10/12 100%</td>
<td>10/14 100%</td>
<td>0/0</td>
<td>—</td>
<td>2/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dave</td>
<td>4/7 57%</td>
<td>7/11 64%</td>
<td>2/2 100%</td>
<td>7/10 70%</td>
<td>4/4</td>
</tr>
<tr>
<td>Brent</td>
<td>5/6 83%</td>
<td>1/1</td>
<td>—</td>
<td>2/3 67%</td>
<td>3/4</td>
</tr>
<tr>
<td>Nan</td>
<td>2/3 67%</td>
<td>4/4 100%</td>
<td>0/0</td>
<td>—</td>
<td>3/4</td>
</tr>
<tr>
<td>Anthony</td>
<td>4/7 57%</td>
<td>5/9 56%</td>
<td>1/2 50%</td>
<td>8/20 40%</td>
<td>2/4</td>
</tr>
<tr>
<td>Sally</td>
<td>2/5 40%</td>
<td>2/2 100%</td>
<td>0/0</td>
<td>—</td>
<td>1/4</td>
</tr>
</tbody>
</table>

*ER: Error Ratio - Number of Errors on the Same S- to Total Errors

is the number of tasks in which the percent of errors on one S- is
above 50%. The "overselective" group had a score above 50% on 65% of
the tasks (13 of 20 tasks), whereas the "not overselective" group had this score on only 50% of the tasks (8 of 16 tasks).

Table 4 is an analysis of the total number of errors to each S- for each task. During Task II 68% of student errors was due to selecting the S- that did not have a square in the middle. On Task IV 55% of student errors were due to selecting the S- that did not have a solid colored dot.

<table>
<thead>
<tr>
<th>Task I</th>
<th>Plane</th>
<th>Dot</th>
<th>Number Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Errors</td>
<td>16 (31%)</td>
<td>25 (49%)</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>Task II</td>
<td>Plane</td>
<td>Square</td>
<td>Number Objects</td>
</tr>
<tr>
<td># of Errors</td>
<td>14 (22%)</td>
<td>42 (68%)</td>
<td>6 (10%)</td>
</tr>
<tr>
<td>Task III</td>
<td>No. Leaves</td>
<td>Shape</td>
<td>Angle</td>
</tr>
<tr>
<td># of Errors</td>
<td>1 (8%)</td>
<td>6 (50%)</td>
<td>5 (42%)</td>
</tr>
<tr>
<td>Task IV</td>
<td>No. Objects</td>
<td>Inside</td>
<td>Solid</td>
</tr>
<tr>
<td># of Errors</td>
<td>11 (20%)</td>
<td>5 (9%)</td>
<td>30 (55%)</td>
</tr>
</tbody>
</table>

*Nine errors on Task IV were not accounted for.*
CHAPTER IV

DISCUSSION

The present study was designed to investigate two questions. First, can the overselectivity phenomenon be demonstrated in students who were previously identified as "not overselective"? Second, by changing only the teaching stimuli used, can stimulus overselectivity be eliminated and can that stimulus control be transferred to novel examples of the stimulus complex?

All nine students in the study were able to perform on the Minimal Difference Test after Initial Training and when needed, Critical Difference Training. These results replicated the effects of Allen (1983). The data at this point could have been described as a demonstration of stimulus overselectivity being eliminated. However, when the Generalization Probes were administered stimulus control by the experimenter-specified characteristics of the S+ did not maintain. This indicates that other aspects of the stimulus complex, not necessarily those specified by the experimenter, had acquired control. If a discrimination between the S+ and the S− can be made in terms of characteristics other than those specified by the experimenter, the discrimination may be learned in terms of those other characteristics (Becker et al., 1975).

This study indicates that by holding the irrelevant characteristics of the S+ constant across training and testing we may actually be inducing or setting the occasion for stimulus overselectivity.

40
Allen (1983) designed Critical Difference Training stimuli and Minimal Difference Test stimuli in a manner that Becker et al. (1975) described as "controlling irrelevant stimuli" (p. 61). Becker et al. (1975) described the implications of this procedure: "When irrelevant characteristics are held constant in training, the more new examples differ from the training examples in irrelevant characteristics, the more likely a breakdown in discrimination" (p. 62).

Four students were selected for this study because their performance on visual discrimination tasks met the criteria of "no evidence of overselectivity" as established in previous research (Allen, 1983; Schreibman et al., 1982). However, without Generalization Training, only two of these students were able to perform on any of the Generalization Probes at criterion. These two students met the criterion for mastery on Task III. On all other occasions (14 of 16 tasks taught) these students demonstrated some level of stimulus overselectivity. These results indicate that stimulus overselectivity may be more appropriately described as a function of the teaching and testing paradigm rather than as a function of the organism or handicap as has been previously suggested (Bailey, 1981; Lovaas et al., 1971).

The defining characteristics of a stimulus related directly to the "set-to-be-discriminated-from-each-other" (Becker et al., 1975, p. 66). If the experimenter-specified characteristics of the S+ consist of three defining characteristics, it may not be sufficient to "control irrelevant characteristics" in the design of the teaching paradigm. Whether or not it is sufficient depends at least in part
on the conditions under which one expects the discrimination to be maintained (i.e., "the set-to-be-discriminated-from-each-other" Becker et al., 1975, p. 66). If the contingency is originally designed such that a student may respond to any one of three separate defining characteristics and be reinforced, one should not be surprised when the contingencies change to see the behavior change also (i.e., the discrimination is not maintained). Stimulus overselectivity should be expected.

Critical Difference Training

There were only 12 of 36 occasions in which a student required Critical Difference Training based on performance on the Minimal Difference Test. These results are different from the results of the procedures used in the initial selection of subjects for this study and the results from previous research (Allen, 1983). In the present study five students were selected and identified as overselective based on their performance on the initial selection procedures which were a replication of Schreibman et al. (1982) and Allen (1983). They were overselective on five of six sets trained. The differences in performance may be due to differences in the task stimuli. The most common error made during the initial selection procedures was selecting the S- that was a reversal of the S+ (see Figure 1). The task stimuli for the present study were not easily reversed, so there were no S-s designed as such (see Appendix).
Generalization Training

After Generalization Training both groups could perform at criterion on about 55% of the tasks taught. Performance improved steadily for most subjects but there were some exceptions. Gary's performance on Tasks I and II did not show improvement. Gary was non-compliant at several points throughout the study. This may have adversely affected his performance. Additional trials did not improve Dan's performance on Task II. In analyzing his errors, nine of twelve errors were due to not attending to the small square in the middle of the stimulus. It was later brought to the experimenter's attention that Dan was supposed to be wearing glasses.

Five students required additional Generalization Training on Task II. This training was only effective for one student. Task II was a slight variation of the defining characteristics of Task I. Task II consisted of three objects with a square in the middle and the objects were on a vertical plane. The students' previous history with Task I may have affected their performance on Task II. Stimuli that were an S- for Task I were now an S+ for Task II. If these two tasks would have been separated by more time and intervening tasks, performance might have been different. It is impossible to determine this from the present study.

Trials to Criterion

In the number of trials to acquisition, there were no differences between groups. Some procedures of the study may have
affected this measure. During Generalization Training, an arbitrary criterion was established which consisted of five consecutive correct responses on each set before training a new set. Through informal observation of the students during this training, it is not clear that this criterion was necessary in teaching the discrimination. After students made their first correct response to a training set, they very quickly and accurately made a correct response on the next four trials. This behavior was also observed during the initial selection phase, which had a criterion of 90% over 20 consecutive trials (Schreibman et al., 1982). It is impossible to determine the effect, if any, of these additional tasks in sharpening stimulus control.

Although there were no differences between groups, there were observed differences across subjects and within subjects. Another standard procedure of the study was to present the Generalization Training sets for each task in the same order to all students. When the first error was made on a Generalization Probe, Generalization Training began. If a student's error was due to not attending to the first defining characteristic taught in the Generalization Training, then it is possible that the number of trials to criterion for that student would have been lower on that task. For example, on Task II Reg's first error was selecting S- that had an incorrect plane (i.e., horizontal vs. vertical). Generalization Training Sets 1-4 were designed to teach plane as a defining characteristic. After this training a second Generalization Probe was administered. At this point Reg selected the S- that had the incorrect figure in the middle.
Generalization Training Sets 5-8 were designed to teach square as a defining characteristic. After these sets Reg performed correctly on each Generalization Probe. This standard procedure may have also resulted in a higher number of trials to criterion for some students. For example, on Task IV Brent's errors on all Generalization Probes were due to selecting the same type of S- on each probe. The defining characteristic related to his error was the last characteristic taught. Once he was exposed to those training sets, he performed at mastery on all Generalization Probes. If this defining characteristic was taught first, it is possible that 45 trials could have been eliminated for Brent.

Trials to criterion is typically considered to be a measure of one's learning rate. These data indicate that this measure can be affected by the teaching paradigm.

Error Analysis

The error analysis provided by this study is also subject to some of the same factors mentioned previously in relation to trials to criterion. In some situations, the first error made on a Generalization Probe involved selecting the S- that was trained last. As previously mentioned, this was true for Brent on Task VI. If the first error on a Generalization Probe involved an S- that was trained in the first three sets, that student frequently switched to another S- or the S+. If the student switched to another S-, the overselectivity score based on errors would have been lower (see Table 3). For many students, specific errors changed as a function of training.
or as training progressed. Again, it appears that the teaching paradigm directly affected the measure of stimulus overselectivity and perhaps the "durability" of it.

Students were asked after mastery of a task what made a card the "correct card." In all cases students were reluctant to say anything. They shrugged their shoulders and said, "I don't know." They did not articulate the defining characteristics. It is not clear whether they were afraid of being wrong (and so would have to go through more training) or they simply did not state subvocally any rules. When probes were administered informally to adults, they reported formulating a rule on the first probe trial and continued to select cards based on that rule until it no longer fit each new example or they were incorrect. Whether language or "rule" statements affect the tendency toward "stimulus overselectivity" is an area that future research might address.

The present study demonstrated that stimulus overselectivity can occur in students not originally described as overselective. It has also demonstrated that it can be eliminated once it has been observed.

Previous research has suggested that "efforts to develop assessment devices which are reliable and sensitive to the presence of overselective stimulus control are prerequisites to the development of OSC treatments" (Allen, 1983). In the present study, stimulus overselectivity appeared to vary within subject and appeared to be more a function of task variables and paradigms than a measurable
trait of the organism. Even as a function of the teaching paradigm, it can be eliminated or prevented.

The present study was completed with students who had the diagnosis of specific learning disability. Much of the previous research in the area of stimulus overselectivity has been done with students diagnosed as autistic. Whether or not the present results would be obtained with autistic children is a question for future research. However, there is no reason to suspect that results would be different given a group of autistic children with similar pre-skills (i.e., language, school history, history of learning visual discriminations, etc.).

The results of the present study should cause one to question the appropriateness of using stimulus overselectivity as a possible explanation for the learning difficulties of handicapped children. The phenomenon was induced in children previously identified as "not overselective." Furthermore, the phenomenon frequently varied as a function of changes in task conditions and was often eliminated. Future research efforts should focus on developing teaching procedures to analyze and develop teaching strategies that are designed to sharpen stimulus control, and avoid the occurrence of stimulus over-selectivity as an artifact of a teaching/testing paradigm.
REFERENCES


APPENDIX

TASK STIMULI
### TASK II

#### INITIAL TRAINING

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INITIAL TRAINING MINIMAL DIFFERENCE TEST

GENERALIZATION TRNG GENERALIZATION PROBES

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