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The Comparison of Selection-Based and Topography-Based Verbal Behavior Across Populations

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THE COMPARISON OF SELECTION-BASED AND TOPOGRAPHY-BASED VERBAL BEHAVIOR ACROSS POPULATIONS

by

Carl T. Sundberg

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Western Michigan University
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Michael (1985) distinguished between selection-based (SB) and topography-based (TB) verbal behavior. Several studies comparing the ease of learning the two systems have shown conflicting results. The data indicate that subjects with fewer lower verbal skills have done better with TB systems (subjects with developmental disabilities in studies by Hodges & Schwethelm, 1984; Sundberg & Sundberg, 1990; Weirmanski, 1984; Wraikat, 1991; Wraikat, Sundberg, & Michael, 1991; and the bottom half of subjects in Cresson, 1994). The higher functioning subjects have done better (or have not shown a difference) with SB systems. (Bristow & Fristoe, 1984; Stratton, 1992; Tan, Bredin, Polson, & Grabavac 1995; Potter, Huber, & Michael, 1997; and the top half of subjects in Cresson 1994).

The primary purpose of this study was to manipulate aspects of the SB system to see if two populations of subjects were differentially affected. One group of subjects consisted of highly verbal college subjects; the other, of low verbally skilled subjects with developmentally disabilities. A secondary purpose was to make another comparison of a SB system with a TB system. This comparison was accomplished by exposing each subject to a matching-to-sample task under three conditions and to one condition involving
signing-to-sample. In the first condition, all of the symbols on the board remained in a fixed location. In the second condition, the location of each symbol changed after every correct response. In the third condition, all of the symbols were identical and only location was relevant. In the final condition, subjects were taught to make a sign when presented with a word or object.

Initial findings indicated that the college subjects relied heavily on the distinctiveness of each symbol, while the developmentally disabled subjects relied heavily on the location of each symbol. These results, along with a protocol analysis conducted with the college subjects, indicated that the conditional discriminations required in the SB tasks were mediated by TB responding. It was apparent that the developmentally disabled subjects were not engaging in this mediating behavior. The results also indicated that the developmentally disabled subjects performed better with the TB signs than with the SB symbols, while the college subjects showed no significant difference.

These results may explain the inconsistencies in results from previous studies in this area.
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Finally, I dedicate this dissertation to the memory of my father, Enoch Sundberg.

Carl T. Sundberg
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INTRODUCTION

Traditional Approaches to Language

Language is a critical aspect of human life. Individuals who lack the ability to communicate are at a tremendous disadvantage. Wants and needs are less likely to be met, preferences can not easily be conveyed and social relations are difficult to form. Education in even the most basic living skills is difficult when one lacks an effective method of communication. The lack of an effective language repertoire is one of the major features of mental retardation. The inability to successfully communicate with others may produce inappropriate social behaviors such as physical aggression, self-abuse, tantrums or social withdrawal. Moreover, these behaviors are often reinforced and can themselves come to function as verbal behavior for the person emitting them (Sundberg, 1987). For example, tantrum or self-abusive behavior may function as escape or simply as a means for attention. Such inappropriate behaviors may be the most effective form of communication for this person. Since there are no appropriate responses in the person's repertoire (such as, "leave me alone." or "I don't like peas and carrots.") the behaviors that have been successful in the past under similar circumstances come to strength. Given the serious nature of many of these behaviors, teaching appropriate communication skills to those with development disabilities is a critical issue. Unfortunately, there have been
several barriers to the development of this effective teaching technology, most of which evolve from debates over issues associated with language development. For example, a common observation in the development of language indicates that auditory comprehension or reception precedes productive speech. A common sense analysis would suggest that receptive language is highly influential in the development of productive speech. This interpretation is also supported by the fact that receptive comprehension emerges before expressive behavior, developmentally (Chomsky 1959, Lennenberg, 1972).

Traditional theories regarding this relation assume a special process of understanding the meaning of a word common to both the verbal responses of the speaker and to the nonverbal responses of the listener. For example, Chomsky’s theory of language presupposes that these responses manifest an internalized knowledge of language (Chomsky, 1964). Similarly, Bloom (1974) states that understanding and speaking involve learning the same word and linguistic structures. In such accounts, varied usage of a particular word is said to demonstrate an underlying concept or knowledge of a word’s meaning.

There is some disagreement among researchers, however, as to whether the use of grammar reflects an underlying set of rules which the child develops through maturation (e.g., Chomsky, 1964 and Lennenberg 1972) or whether the development of grammar follows an echoic model (Skinner 1957).
Proponents of the cognitive approach to language suggest that language is controlled by an internal processing system that is often compared to a computer. Incoming information is classified and stored for future recall. Causality is assigned to these cognitive structures and when language fails to develop for an individual, a defective cognitive structure is often cited.

Skinner's (1957) theory differs markedly from the traditional view. Skinner treats the behaviors of the individual as both speaker and listener as separate subject matters, not as manifestations of linguistic knowledge. "The process through which a person becomes a listener differs from those through which he becomes a speaker" (p. 195). In acquiring a verbal repertoire the speaker does not necessarily become a listener, and vice versa.

Skinner emphasizes that only a speaker can engage in verbal behavior and a listener mediates the reinforcement. In Verbal Behavior (1957) he writes:

The behavior of the listener in mediating the consequences of the behavior of the speaker is not necessarily verbal in any special sense. It cannot, in fact, be distinguished from behavior in general, and an adequate account of verbal behavior need cover only as much of the behavior of the listener as is needed to explain the behavior of the speaker. The behaviors of the speaker and the listener taken together compose what may be called a total verbal episode (p.2).

This is an important issue because many language training programs focus only on teaching a receptive repertoire, making the assumption that the expressive repertoire will develop automatically. This may be true in most cases, but the literature strongly supports the position that learning a receptive repertoire does not automatically
lead to the development of an expressive repertoire, especially in people with developmental disabilities (e.g., Guess, 1969; Guess & Bear, 1973; Hall and Sundberg, 1987). Thus, receptive training does not replace the training needed for teaching expressive behavior. Sundberg (1987) writes:

Receptive training does not teach a person to ask for or name things, it does not teach a person to initiate language, it is the teachers and caregivers who reap the benefits of a strong receptive repertoire because the person can now do what he is told. The expressive repertoire allows a person access to the reinforcers available from affecting an audience and only by speaking (or signing) can an individual benefit most directly from a language repertoire (p. 23).

Sundberg (1987) concludes that it is unwise to neglect expressive behavior in favor of receptive training. Receptive training is important but should not be the sole emphasis of language training.

Skinner's Functional Analysis of Language

Skinner's functional analysis of verbal behavior identifies seven major types of functional relations, which differ in terms of the controlling stimuli and/or the nature of reinforcement contingency upon verbal responses. In his analysis, the functional relation, not the form of the response, is critical for an account of verbal behavior. This analysis is unique because it makes no appeal to hypothetical explanatory entities (for example, innate language acquisition devices or internal mechanisms which accept, process, and store spoken words.) This functional approach departs radically from the linguistic tradition of studying the grammatical structure and "meaning" of verbal response products, regardless of the controlling
circumstances for the speaker's behavior.

Michael (1982) reorganized Skinner's verbal relations into five general categories. Following, is a brief description of the five categories as rearranged by Michael.

**Mand**

Skinner (1957) defines the mand as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation...and the response has no relation to a prior stimulus" (pp. 35-36). Michael (1988) redefined the mand as "a type of verbal operant in which a particular response form is reinforced by a characteristic consequence and is therefore under the functional control of the establishing operation relevant to that consequence" (p. 7). The term "establishing operation" was added to broaden the definition to include behavior that is evoked by motivational variables other than deprivation and aversive stimulation. An example of a mand would be a child asking for a glass of water (characteristic consequence) as a result of eating salty peanuts (establishing operation—or motivational variable).

**Tact**

Skinner (1957) proposed the term "tact" for the type of verbal relationship where the form of the response is controlled by a prior non-verbal stimulus. That is, by a particular object or event or
property of an event. An example of a tact would be a child saying "Knight" when presented with a chess piece. The reinforcement for a tact is typically generalized conditioned reinforcement, such as "yes, that is a knight," or "thanks, I wondered what that was called."

Intraverbal

According to Skinner (1957), the intraverbal is a type of verbal relation where the form of the response (what is said or what is signed) is controlled by a prior verbal stimulus (someone else's verbal behavior), and the response lacks point-to-point correspondence with the stimulus. That is, particular parts of the controlling stimulus do not control particular parts of the response. The response does not closely resemble the controlling stimulus. An example of an intraverbal would be a child saying, "Blue," in response to someone saying "Red, white, and." As with the other relations controlled by verbal antecedents, the consequences for the intraverbal tend to be generalized conditioned reinforcers.

Codic Behavior

Michael (1982) describes codic behavior as a type of verbal operant in which the response form is controlled by a verbal stimulus and there is point-to-point correspondence between the stimulus and the response product. That is, parts of the response are controlled by parts of the stimulus. For example, reading the
written word "elephant" out loud or writing the word "elephant" when spoken by another is a form of codic behavior. The written part "el" evokes the vocalization "el," the written part "e" evokes the vocalization "e" etc. This is not the case with the intraverbal. There is no part of the stimulus "hello" that controls part of the response "hi." Codic behavior also lacks formal similarity. That is, the stimulus and the response product do not resemble each other in the physical sense of resemblance.

Duplic Behavior

Michael (1982) describes duplic behavior as a type of verbal operant in which the response form is controlled by a verbal stimulus and there is point-to-point correspondence between the stimulus and the response product. And the response product has formal similarity with the controlling stimulus. An example of duplic behavior would be a child saying "elephant" as result of hearing someone else saying "elephant."

According to Skinner (1957), these different verbal operants are acquired independently even though they may look or sound alike. Furthermore, establishing one of these verbal operants will not automatically result in the appearance of the other. This observation by Skinner has only recently been confirmed in numerous experiments (e.g., Lamarre & Holland, 1985; Hall & Sundberg, 1987; Sigafoos, Doss & Reichle, 1989).
The linguistic model suggests that once the child learns the meaning of a word (e.g., learns to say the word under tact conditions), he or she will then use that word under all conditions.

The advantages of Skinner's analysis is clear when language fails to develop for a particular individual. Sundberg (1987) states:

If language is a product of a cognitive processing system, then its failure to develop indicates defective internal mechanisms which are not accessible through any direct means. If language is learned and controlled by historical and environmental variables, then its failure to develop indicates a defective environment, a situation which can be altered much easier than biological composition or a hypothesized cognitive processing system (p.5).

Topography-based and Selection-based Verbal Behavior

When vocal verbal behavior fails, or is slow to develop in a developmentally disabled person, some form of augmentative communication is often sought. Sundberg (1993) points out that a critical element in establishing an intervention program for those who exhibit no or only limited verbal behavior is the selection of a response form. Typical response forms in augmentative communication systems consist either of sign language or the use of a symbol board. Often times, the decision on which form to use is based upon the personal preference of the trainer, rather than on the needs of the student, or any empirical evidence supporting a specific system.

From the traditional linguistic or cognitive perspective, the type of response form selected may not be an important issue. Michael (1985), however, makes a convincing argument for considering different response forms as separate types of verbal behavior. He
calls one topography-based (TB) verbal behavior and the other stimulus-selection based (or simply selection-based) (SB).

In TB verbal behavior, the operant unit consists of "an increased strength of a distinguishable topography given some specific controlling variable" (P.1). For example, the vocal response "cat" in the presence of a cat or a signed response "dog" in the presence of a dog are examples of TB verbal behavior. In saying "cat" and signing "dog," there are clear differences in topography in terms of the movements of the musculature and clear differences in the auditory and visual response products.

In SB verbal behavior, the operant unit consists of an "increased control of a pointing response by a particular stimulus as the result of the presence of a different stimulus (or the strength of a particular establishing operation)" (Michael, 1985, p.1). In this response form, there are no important differences in the topographies of the different pointing responses. For example, in an SB tact, one tacts "cat" and "dog" by pointing to the corresponding symbols on a communication board in the presence of the appropriate objects; but the pointing response topography is roughly the same for each object. It is the object or symbol being pointed at that distinguishes one response from another, not the form of the response itself.

The current trend in the field of speech pathology is to favor SB systems such as symbol boards over TB systems such as sign language.
Ostensibly, this makes sense. Pointing to a symbol board does not require the client to learn any new topographies. Also, the stimulus provided to the viewer is more easily interpretable than the manual sign. Moreover, it seems intuitively easier to learn to point at pictures than to learn hand positions and movements.

Michael (1985), points out several variables that could be of significance when SB verbal behavior is compared to TB verbal behavior. These variables seem to be relevant when discussing the issues of ease of acquisition, effectiveness of control by motivative variables and ease of interference by similar functional relations. Differences between SB and TB verbal behavior are likely to be overlooked by those who are primarily interested in the effect of verbal behavior on the listener. Schools, group homes, and parents of those who have a language deficit, often focus on the effect of verbal behavior on the listener. Differences between TB and SB verbal behavior are also likely to be overlooked by cognitivists who consider TB verbal behavior to be merely the selection of words from memory (and therefore, is actually SB). Also, the traditional view asserts that both SB and TB verbal behavior represent the same underlying linguistic process. This traditional view treats language similarly from both the perspective of the speaker and listener. The behaviors of the speaker and listener are treated as conceptually equivalent because it is believed they both are manifestations of the same underlying cognitive process. Thus, from the traditional
perspective, it is irrelevant whether the verbal stimulus for the listener is a spoken word, a sign, a symbol pointed to, etc. Therefore, the traditional view tends to focus on the effects of verbal behavior on the listener, de-emphasizing the role of the speaker. A discussion of the differences between SB and TB verbal behavior can be divided into conceptual and practical aspects.

**Conceptual Differences**

Michael (1985) points out that SB verbal behavior involves a conditional discrimination incorporating two primary controlling variables. For example, in tact training, a stimulus such as an apple, alters the controlling strength of another stimulus, the symbol or picture for apple, over a non-distinctive pointing (or indicating) response. TB verbal behavior, however, involves only one primary controlling variable. For example, the stimulus of an apple directly controls the response "apple", rather than altering the strength of another stimulus.

In addition to the more complicated controlling variables, SB verbal behavior involves a two-component response form as opposed to the single component response form of TB verbal behavior. In SB responding, the person who points at the verbal stimulus must first scan the options, then point to the appropriate one. Typically, scanning is not a problem for normal adults because they usually develop a good scanning repertoire without additional training. It may, however, take special training to develop an effective scanning
repertoire for those who lack this repertoire. Most normal adults, when scanning an array to make a selection use a systematic method. For example, when looking for a particular brand of cereal at the supermarket, the normal adult may start at the top shelf on the left side, moving all the way to the right, then down one shelf, moving all the way to the left, etc. A person who does not have this scanning repertoire may look up to the left, then in the center, and then up to the left again, etc. With no systematic method of scanning, it may take a long time to find the appropriate selection. If and when the person comes across the appropriate selection, it may have taken so long that the effectiveness of the original controlling variable may have been lost.

Another conceptual difference between the two language systems is that TB verbal behavior always involves point-to-point correspondence between the response form and the response product, while SB verbal behavior does not. Michael (1985) elaborates on this issue by stating:

When one speaks there is a correspondence between the details of the vocal muscle action and the relevant details of the auditory stimulus that results, and likewise with writing and the use of signs and their respective visual response products. When one points at a word, picture or symbol, however, the muscle action of the pointing response has no correspondence with the important features of the selected stimulus. Again, this difference would not seem to be irrelevant to such factors as ease of acquisition, precision of control, susceptibility to interference, etc. (p.3)

In addition to these differences, Cresson (1994) has pointed out several other differences between TB and SB verbal behavior.

For example, SB procedures allow for an overt response as the
incorrect comparison stimuli are excluded (holding a finger against them, moving them, and so on). In the TB case the exclusion is done covertly.

In addition, TB languages have an advantage when the task involves a long delay between the presentation of the first stimulus and the second stimulus (in SB) or characteristic response (in TB). This is because the TB response can be used to mediate the delay interval, an option not available in the SB case.

Furthermore, SB languages have an advantage when computers are used in education, because it is difficult for a computer to respond to a person's speech, writing, or signing.

These distinctions are important for several reasons. Cresson (1994) suggests that there are many variables that can interfere with language performance. Since the two basic classes of verbal behavior are very different, it is reasonable to expect that one or the other might have an advantage. This issue may be of particular importance for those whose verbal repertoire is not well developed and those who have trouble learning (e.g., a non vocal Down's syndrome boy who is just learning to communicate with a symbol board or through sign language).

These distinctions are also relevant to the discussion of language involving one underlying process (represented by the cognitive position). A cognitive psychologist might say that TB verbal behavior involves selection from memory, and is therefore not different from SB.
Practical Differences

One practical problem with SB verbal behavior is the obvious necessity of auxiliary equipment; it is not always possible to have the symbol board immediately accessible to the speaker. This is an obvious problem with respect to the mand repertoire. When an EO is present in the natural environment, it is important that the speaker be able to mand. If there is not a response form readily available, then the mand can not be made, and the speaker can not make his or her needs known. In this case, it could be more likely that the absence of a response form (pointing to a symbol board) could result in maladaptive behaviors. This is the case with a non verbal person with developmental disabilities who may scream, hit, or tantrum when hungry; a verbal person with developmental disabilities who relies on a symbol board is, in essence, non verbal when the board is absent. In this case, the person may be likely to resort back to the maladaptive behaviors that were successful before any verbal training was done. Unlike pointing systems, an important facilitating feature of speech (and sign) is that it is free from any environmental support (Skinner, 1974) and can be carried with the speaker at all times (e.g., we don't need a bicycle or a picture of a bicycle, to talk about a bicycle. SB mand training would also be restricted mostly to contrived EOs unless the symbol board is with the student at all times. Of course, the student could easily learn to retrieve the symbol board when an EO is in effect, but this adds another response component, and can make the whole process more difficult.
Also, it may be easier for the student to emit a maladaptive behavior that, in essence, is equivalent to "bring me my symbol board" than it is for the student to get the symbol board him-or herself.

A second practical problem with an SB system is that many words (such as verbs, prepositions, pronouns) are hard to portray in symbol form because of the abstractness of symbols beyond simple objects. In a TB verbal system hand movements and configurations can be arranged to depict some of these abstract notions (e.g., you can move your hands fast, slow, up down, in circles etc.).

A third practical problem with an SB system is that the listener must always be in close proximity to the speaker. In a TB verbal behavior system, one can carry on a conversation in sign language from across the room. Communication with a symbol board cannot be conducted unless the listener is positioned close enough to interpret the responses. This adds an additional requirement of the teacher, which may ultimately lead to less use by the student.

Another problem with an SB system is the absence of a community of speakers that use a pointing system to communicate. Although it could be arranged, a student learning how to use a symbol board typically does so without the benefit of observing communication between two competent speakers using a symbol board. Typically it is not the case that two people will communicate with both people using symbol boards. More likely, a student uses a symbol board, and a teacher (or a member of the community) asks questions complying with the student's mands, or reinforcer
the student's tacts, intraverbals, etc. In a TB system it is not hard to imagine two students communicating with each other using signs. Also, when the student is interacting with the teacher (care giver, staff, parent etc.) they are both typically using sign language. Furthermore, Skinner (1957) notes that exposure to a fluent verbal community is essential for the development of a verbal repertoire.

When verbal operants are simple, the tact is probably not as sensitive to the differences between SB and TB verbal behavior as the mand. As verbal exchanges become more complex, however, it becomes increasingly difficult to portray them in an SB system. Complexity of verbal behavior may require more training trials in an SB system than would similar verbal operants using a TB system. In addition, as words are chained together, (for example, in the tact "large green ball") additional scanning and additional conditional discriminations are required in an SB verbal system. Furthermore, as the response chain increases, the odds decrease that all of the stimuli will be on the same page of the symbol board system. If the symbol board is large enough to include a vast array of symbols, then the scan required would be more difficult.

Another problem with an SB system is the effect that learning to point can have on vocal behavior (Sundberg 1993). In their review of the literature, Sisson and Barrett (1983) note that none of the studies on SB systems mention vocal behavior or vocal improvement. Speech should always be the primary goal, and there
are several advantages of a TB system over an SB system when trying to develop or improve vocal behavior.

Speech as the Primary Goal

When working with a person who lacks an effective language repertoire, speech is often the most desired response form. Sundberg, (1993) points out several advantages of speech. Speaking does not require special skills from the audience. In addition, this large audience produces constant vocal models which are often paired with strong forms of reinforcement, resulting in speech sound and patterns becoming conditioned reinforcers. Vocalizations then can become automatically reinforcing, thereby naturally strengthening vocal behavior. As a result of all this, vocal behavior can be the easiest form of verbal behavior to acquire. Normal children can rapidly learn to talk even though the parents have no special training in teaching these skills. Vocal behavior is also portable and responses can be emitted quickly and efficiently.

If speech fails to develop in the typical manner, however, it may become a difficult response form to establish (Sundberg, 1993). Trainers who try to teach speech and find it difficult, may find that they are more successful using sign language. Sundberg (1987) describes several reasons for this.

First, many DD persons can already emit a motor response under imitative control. If the person does not readily imitate, it is much easier to physically prompt or teach a motor response involving
actions than it is to prompt or teach a vocal response. The student's hands can be physically manipulated by the teacher, and these prompts can then be faded out. It is impossible to physically guide or prompt the vocal musculature.

Another factor that can lead to easier acquisition of signing is that many signs are iconic. That is, the response form often resembles the controlling referent in the environment. For example, the sign for "cup" actually resembles a cup.

A final point involves the student's negative history with attempts to speak. Sundberg (1987) explains:

Such histories typically involved frequent failure to communicate vocally and often there has been considerable urging on the part of others to continue attempting to speak. Due to the high response effort of speaking and low probability of reinforcement, this situation can produce various negative emotional reactions (e.g., withdrawal, aggression). Effective instruction in signing may, to some extent, avoid involvement with this negative history. Especially since the hands are a set of muscles which often have a very positive interactional history with the environment (p.10).

Sundberg (1987) points out several advantages of sign language when trying to develop speech.

First, if trainers speak as they sign, they can require and reinforce approximations of the spoken word emitted by the student. Once the person begins to sign to gain reinforcers (builds a mand repertoire) and engages in successfully communication (builds an intraverbal repertoire), the motivation to speak may be altered. Many people with developmental disabilities have a long history of trying to speak, but these attempts typically fail to gain the
reinforcers that typically accompany successful speech.

Second, many nonvocal people attempt to vocalize, but their vocalizations can not be recognized by the listener, and thus go unreinforced. If the student signs along with an attempt to vocalize, the trainer may then know what the attempted vocalization is, and be able to do a correction trial on the articulation error. Closer approximations of the word can then be reinforced. These training trials take advantage of a situation where the motivation to speak is high.

A third advantage to sign language noted by Sundberg (1987) is that sign language can allow a person to be much more articulate in the absence of specific objects or actions because many signs contain an iconic relation to the referent. For example, the sign for "eat" consists of putting your hand up to your mouth as if you were eating. This can allow for more successful verbal interactions which result in more practice for the speaker and more chances to train speech.

Topography-based and Selection-based Studies

A number of studies have been conducted comparing the ease of learning to communicate using the two systems, but many of the studies have conflicting results. Most have found that signing was easier for subjects to learn as measured by number of trials to criterion, percentage of correct responses achieved, and the development of equivalence classes (Hodges & Schwethelm, 1984;
Sundberg & Sundberg, 1990; Wraikat, 1991; Wraikat, et al., 1991). One study found that pointing was easier to learn (Stratton 1992). Three found no significant difference between a TB system and a SB system (Bristow & Fristoe, 1984; Potter, et al., 1997; Tan, et al., 1995).

So far, the data seem to indicate that the lower functioning subjects perform better with signing systems (the developmentally disabled subjects in the studies by Hodges & Schwethelm, 1984; Sundberg & Sundberg, 1990; Wraikat, 1991, Wraikat et al., 1991; and the bottom half of the subjects in the Cresson, 1994 study), and that the higher functioning subjects perform better or show no difference with the pointing systems (Bristow & Fristoe, 1984; Potter, et al., 1997; Stratton, 1992; Tan et al., 1995; and the top performers in the Cresson 1994 study).

Bristow and Fristoe (1984) were among the first to design a study explicitly for the purpose of comparing the two types of language. They compared the use of manual signs with the use of idiographic symbols (blissymbols) using 20 normal children with a mean age of 8.2. Their results indicated that, although acquisition was slightly faster for the sign training, the difference was not statistically significant.

In contrast, Hodges and Schwethelm (1984) found that their subjects clearly learned more signs, and learned those signs faster than they learned a matching to sample SB task. In both SB and TB trials the subjects were shown common objects as sample stimuli (e.g., candy, ball). The results were obtained using 52 profoundly
retarded nonverbal children. It should be noted however, that the researchers used nonspecific reinforcers when training the SB task (praise and food) and specific reinforcers for the TB task. Therefore, they actually conducted training of mand responses for the TB task.

Sundberg and Sundberg (1990), using four adults with mild to moderate developmental disabilities, compared acquisition of the following four tasks: signing in response to an object, signing in response to a nonsense word (e.g., "Zug"), pointing to a symbol in the presence of an object, and pointing to a symbol in response to a nonsense word. The two TB tasks and the two SB tasks were then combined to test for the emergence of stimulus equivalence. For example, a subject would be presented with three objects and the experimenter would ask him to point to one of the objects when given the nonsense name (e.g., "which one is Zug"). Although the subject was trained to emit the sign or select the symbol when presented with the object and when presented with the nonsense word, matching the object with the nonsense name was an untrained relation. Thus, selection of the correct object would have demonstrated the transitive relation of stimulus equivalence. The authors found that the TB tasks were easier to learn as measured by trials to criterion and percentage of correct responses. Stimulus equivalence was also demonstrated by some of the subjects with the TB tasks but it did not emerge with the SB tasks.
Wriakat, (1991) replicated the results of Sundberg and Sundberg (1990) using five adults with mild to moderate developmental disabilities. Wriakat presented the subjects with either an object or a nonsense syllable (e.g., "Ki"). Subjects were then required to either select the corresponding symbol or emit the corresponding sign. No equivalence test was conducted in this study.

Wriakat, et al., (1991) addressed the problem of ambiguous data created by tasks that were either too easy or too difficult. This was accomplished by adjusting the task difficulty according to the performance of the subject. Seven subjects diagnosed as developmentally disabled and exhibiting moderate to severe learning disabilities, were used in this study. The procedures were similar to those of Sundberg and Sundberg (1990) and Wriakat (1991), and an equivalence test was added in which the subjects were required to select an object (from an array) when presented with the name of the object. This was an untrained relation because the object was paired with either a symbol or a sign, and the symbol or the sign was paired with a nonsense name. Thus identifying an object by name would demonstrate transitivity. Results indicated faster acquisition and more accurate responding when the subjects were trained with the TB system. Accuracy was also better in the equivalence test after TB training.

Stratton (1992) used 28 college students to examine stimulus set size (5 vs. 20) and language paradigm (SB vs TB). In the presence
of an English auditory word, subjects were asked to either point to a Kanji symbol (SB) or say the matching Japanese word (TB). Stratton used a between-subjects design, consisting of seven subjects for each of the groups: SB with five relations; SB with twenty relations; TB with five relations and TB with twenty relations. Results indicated that there was little difference between the two groups where five relations were used. However, when 20 relations were trained, the SB group performed significantly better than the TB group.

Wallander (1993) speculated that the SB task in Stratton's study was made easier because many of the visual Kanji symbols could be construed to look like the objects represented by the English words used as samples. In the TB case, however, no mediating association was possible between the auditory English and vocal Japanese sounds.

Wallander (1993) examined the effect of familiarity (familiar vs. unfamiliar) with sample stimulus on matching-to-sample. 20 college students were used as subjects. Subjects were asked to select the appropriate Japanese Kanji characters when presented with either an English animal name (familiar group) or a Japanese Katakana character (unfamiliar group). Results indicated that when English words were used the subjects learned the relations in half as many trials than when Japanese Katakana symbols were used as samples.

Cresson (1994) used nonsense sounds or nonsense visual patterns as sample stimuli, while Japanese Katakana characters were used as choices. 16 college students served as subjects. In the TB
conditions the subjects were asked to write the Katakana character which matched the visual pattern or sound. In the SB condition subjects were asked to select the correct Katakana character from an array, in the presence of either the visual pattern or the sound. Results indicated that pointing to a pattern (SB) was acquired more easily by subjects who demonstrated an overall faster rate of acquisition. But writing a symbol (TB) was acquired more easily by subjects who demonstrated an overall slower rate of acquisition. This was discovered by a division of the subjects into the top eight and the bottom eight, based on overall performance. In all other measures, however, (e.g., generalization, testing for equivalence etc.) there did not seem to be a difference.

Tan et al., (1985) used English words and their French counterparts to explore the emergence of symmetry under all four possible combinations of SB and TB training and testing. Using eight college students, the researchers arranged for a computerized task in which the participants saw French words as sample stimuli and then selected English words from an array (SB) or typed English words (TB). Results indicated all training conditions were learned equally well. They found that symmetry emerged easily when a relation was selection-trained (see French, select English) and selection tested (see English, select French). They also found that symmetry emerged when relations were topography-trained (see French, type English) and selection-tested (see English, select French). However, poorer performance was demonstrated when the relations were topography-
tested (see English, type French), regardless of whether the items were selection-trained or topography-trained. The authors noted, "For the behavior analyst this should come as no surprise: seeing the stimulus word, whether during selection-training or topography-training, no matter how often, does not guarantee that one will later be able to produce it, especially if the word is unfamiliar" (p.2). The TB testing involved emitting a new response (typing a French word for the first time), whereas the SB testing involved pointing to a word already seen.

Potter et al., (1997) designed a study to investigate the role that response produced kinesthetic stimulation might have in the acquisition of conditional relations. In one condition (point-to-point), participants were asked to select comparison stimuli on a computer by clicking the mouse on each of four dots in the selected comparison. The experimenters suggested that this was a SB condition with an added TB component (the point-to-point responding of clicking on all of the dots that form the comparison pattern). In the second condition (non point-to-point), the participants were required to select the appropriate comparison stimulus by clicking twice in the upper-left corner and twice in the lower-right corner of the pattern. Thus the same number of clicks were required across conditions but only the point-to-point condition had unique response-produced kinesthetic stimulation. Results showed no consistent difference between the point-to-point and non point-to-point conditions in acquisition (number of trials/blocks to acquisition) or in accuracy
(the number of correct responses in each condition).

Perhaps the most significant findings in this study stem from the exit interviews and protocol analysis. This analysis showed consistent vocal verbal behavior by the participants, indicating that this may have obscured any true difference, as well as implicating the use of TB verbal behavior in SB tasks, especially with highly vocal-verbal participants. This notion will be discussed further in the next section.

Factors Affecting the Acquisition of Verbal Behavior

There are several variables that can contribute to the difficulty in establishing an effective verbal repertoire in persons with developmental disabilities. These variables, which may be relevant in the analysis of the distinction between SB and TB verbal behavior, will be considered below.

Formation of Conditional Discriminations

One prerequisite for acquiring a SB repertoire is the learner's ability to form conditional discriminations (Shafer, 1993). A number of studies, however, have indicated that persons with developmental disabilities have trouble doing so (McIlvane, Dube, Klederas, Iennaco, & Stoddard, 1990). For most normal children, simple exposure to a stimulating environment is enough for them to develop perceptual and cognitive competence which then typically leads to effective communication. However, with difficult-to-teach children (e.g., those with severe
developmental disabilities) a normal stimulating environment may be inadequate (Keogh and Reichle, 1985). In these cases, the environment needs to be modified. In addition, for most normally developing children the potential exists for heavy doses of novelty or stimulus change. Most normal children are quite ambulatory and dexterous. This allows them to manipulate and experiment with the environment, creating many novel stimulus changes that can lead to perceptual and cognitive development. There is an obvious disadvantage for children who cannot walk, touch, or mouth things, or who are unable to interact with their environment in other ways.

**Concept Formation**

The establishment of concepts is also relevant in the formation of conditional discriminations and equivalence classes. Becker, Engleman, and Thomas (1972) describe conceptual behavior as a special case of operant conditioning brought under the control of discriminative stimuli through differential reinforcement. Ferster, Culbertson, andPerrott-Baren (1975) qualified the Becker and Engleman (1972) description by suggesting that the process is best described as abstract stimulus control:

> When we say that a man has a concept, it implies that the concept resides in him and is a means by which he performs differentially to stimuli. In contrast, the term abstract property of a stimulus emphasizes that the control of behavior by a stimulus depends upon how reinforcement contingencies are arranged in respect to a particular property of a stimulus. Thus, we use abstract stimulus control because it refers to the environmental events responsible for the behavior (p. 75).
Often it can be difficult to obtain abstract stimulus control with people with severe developmental disabilities and language deficits, and many SB systems rely on abstract stimulus control.

**Discrimination Learning**

Zeaman and House (1963) propose that subjects with mental retardation are particularly slow to develop some simple visual habits. These visual habit deficiencies may result in the failure of the subject to attend to the relevant cues that define the stimulus. They suggest that discrimination learning requires a chain of two responses. The first one is the central mediating response that defines the relevant stimulus dimensions that separate the correct choice from the incorrect choice. The second one is an overt response to the relevant dimensions. An example is offered by Reese and Lipsitt (1973):

On Trial 1 the subject sees a red square and a green triangle, with red square the positive pattern. On Trial 2 he sees a green square and a red triangle and now choice of the green square is reinforced. On successive trials the two arrays are randomly alternated, and the left-right position of the positive stimulus also varies at random. It is obvious that form is the relevant dimension, since one of the forms, the square, is consistently positive and the other, the triangle is consistently negative. Dimensions are defined as "broad classes of cues having a common discriminative property" Zeeman & House, (1963, p. 168). There are two cue values on each of the irrelevant dimensions, red and green and left and right, and each of these values is reinforced 50 percent of the time on a random basis. Learning is considered to have occurred when the subject consistently selects the stimuli pattern that contains the square, whether it is on the right or left and whether it is red or green. How this consistent selection or learning occurs is the substance of attention theory. (p. 288).
Stimulus Overselectivity

Many children with mental retardation (especially those with autism) typically respond to a more restricted part of their environment than do normal children (Lovaas, Litrownik, and Mann, 1971), a phenomenon called stimulus overselectivity. Thus, if a complex stimulus is presented, the child may respond to only one dimension of that stimulus. For example, suppose there is an object called a "podink" and it is defined by three stimulus properties. Furthermore, suppose that one of these defining features is color—all podinks are green. Another defining feature is the shape—all podinks are round. And a third defining feature is texture—all podinks are rough like sand paper. If a child’s response is only controlled by one dimension of a podink, for example, shape, the child may then call all round objects podinks.

In Lovaas et al. (1971), three groups of children (normal children, retarded children, and autistic children) were taught to respond to a stimulus complex involving auditory, visual, and tactile components. All children learned to respond to this complex (at least 90% of the trials were correct) by pressing a bar. Each stimulus was then presented alone. It was found that each of the normal children responded uniformly to all three cues, and that the autistic children responded to only one of these cues. The retarded children also demonstrated stimulus overselectivity but not to the same extreme of the autistic children (i.e., one retarded child responded to all three cues, one child to one cue, and three children to two cues).
The implications for language instruction are obvious when you consider the possibility of a subject over-selecting an irrelevant stimulus property. Over selection is likely to interfere with the formation of conditional discriminations if the task requires responding on the basis of more than one component (Cook, Anderson, & Rincover, 1982). For example, suppose an individual has learned to select a picture of a hair brush when presented with an actual hair brush. If the individual then responds on the basis of a restricted aspect of the sample stimulus, such as the color of the brush, stimulus overselectivity has occurred. When another brush that looks like the first except for the color is presented, the subject may not be affected by the relevant stimulus properties.

It is likely that the lower verbal skilled subjects who perform poorly in the selection-based training and testing also have trouble in some or all of the above areas. It is also feasible that there is a correlation between the subject's performance in those areas and the subject's ability to engage in mediating verbal behavior.

The role of mediating verbal behavior in the formation of conditional discriminations and stimulus equivalent classes will be considered further.

Verbal Mediation

Sidman, Cresson and Wilson-Morris (1974) concluded that verbal mediation (naming) was not a necessary component in the emergence
of visual auditory matching. However, the results of Potter et al.,
(1997) along with other studies, (Sundberg and Sundberg 1990; Stratton,
that regardless of the issue of necessity, there is evidence to suggest
that mediating responses may help in the acquisition of matching to
sample responses.

In a series of studies by Lowenkron (1984, 1988, and 1989),
subjects were taught overt responses capable of mediating generalized
matching, and the dependence of generalized matching on these media­
tors was thus demonstrated.

Lowenkron (1984) taught subjects to code the orientation of
sample shapes by placing an arrow on the shapes' axis of symmetry.
Next, the subjects were taught to rotate the arrow 90 degrees clockwise.
They were then taught to select the comparison figure that was oriented
90 degrees clockwise to the sample. This was done by picking the
comparison that matched the orientation of the rotated arrow.

When untrained sample and comparison shapes were interspersed
with those of the training set, generalization tended to occur only with
the shapes that were symmetrical. The subjects could not reliably pick
the correct comparison orientation of the asymmetrical transfer shapes
until they were taught how to code the sample asymmetrical shapes.

Lowenkron (1984) concluded that the "the generalization of
matching varied directly with the availability of appropriate mediating
responses....The dependence of matching on stable coding responses suggests that generalization could not be readily accounted for in terms of general states of knowledge or cognition acquired merely through successful performance on the training set" (p.10). It appeared that the feature of symmetry acquired the control over the generalization of responding. This feature readily allowed for generalization of the mediating response and the generalization of accurate comparison coding depended on stable sample coding.

Lowenkron (1988) taught four children with developmental disabilities to use a particular handsign to tact a sample shape. Subjects were then taught to maintain that handsign over a delay interval, to correctly tact one of the comparison stimuli without changing the handsign, and to select the comparison shape that allowed a repetition of the sample handsign. Subjects were then presented with four novel stimuli and generalization did not occur until the subjects were trained to code (make the handsign for) the shapes of the transfer set.

Lowenkron concluded that training of this sort preserves the identity relation during generalization to novel stimuli. "This preservation seems to depend on the interaction between stimulus-specific components common to all trials of the task. In the present task, stimulus coding was the sole specific behavior. The components common to all trials includes retention of handsigns over the delay interval and use of handsigns to select comparisons." (p. 170). It
would appear that differential responding to samples must be a key part of the current behavior for a successful response to occur.

This requirement was demonstrated in the Sundberg and Sundberg study (1990). Two subjects were trained in a TB behavior. They learned to make a hand sign when presented with an object and to make the same hand sign when presented with a nonsense word (three sets of object\sign\word relations). In addition, two subjects were trained in an SB behavior. These subjects learned to select a symbol when presented with an object and to select the same symbol when presented with a nonsense word (three sets). The emergence of manded stimulus selection (receptive language) within each word-object pair was then measured on unreinforced test trials interspersed among reinforced intraverbal and tact trials. Only the subjects who were trained with the TB system could appropriately select the object when presented with the object name (the untrained relation), demonstrating transitivity.

During the second phase of the experiment subjects who were trained in the TB behavior were trained with three new word-object pairs in the SB behavior, and then retested for the emergence of transitivity (manded stimulus selection). It did not appear. Even with a history of successful demonstration of transitivity, subjects could not reproduce the behavior if TB responses were not available.

The two subjects who were first trained in the SB behavior were then trained with three new word-object pairs in the TB behavior, and then retested for the emergence of transitivity. It did occur. Even
with their unsuccessful history in the selection test for transfer. Of interest here is that with the SB behavior a mediating response was not readily available.

Perhaps the importance of the mediating response was made most apparent in the following observation by Sundberg and Sundberg (1990):

During topography-based training Mary would be asked to point to an object (e.g., "which one is zug?"). She would then vocally repeat the name and make the sign. As a result she was correct on 56% of her testing trials. Gary, on the other hand, made no overt mediating response at all. He was correct on 59% of his topography-based test trials. This is only a difference 3%, yet for the topography-based tact Gary was correct 96% of the trials while Mary was correct 48% of the trials—a difference of 48%. For the topography-based intraverbal Gary was correct 76% of the time while Mary was correct 53% of the time—a difference of 23%. Gary's obvious superior performance with the tact and intraverbal relations would lead one to believe that his test percentages would similarly be higher than Mary's test percentages. This was not the case, however. Perhaps this was due to Gary's lack of a mediating response (p. 40).

In Sundberg and Sundberg (1990) subjects were not explicitly taught to make the overt mediating response during testing (as they were in the Lowenkron studies). It was possible (and somewhat likely) for subjects to make such responses for the TB behavior, but such responses were not possible during the SB behavior (during the test for transitivity the symbols were not available to mediate any responding).

Sundberg and Sundberg (1990) also lent further evidence in support of Lowenkron's analysis of joint control and the general notion of the mediating response. During testing, one subject, Dan,
would make the corresponding sign when asked to select an object (e.g., "which one is poe") before he would select the object. He was correct on 55% of the TB testing trials and only 29% of the SB testing trials (where an overt mediating response was not possible). An interesting feature of Dan's behavior was that almost all of the testing trials that he missed involved an incorrect mediating response. For example, if he was asked to identify the poe object, and he made the sign for zig as a mediating response, he would then select the zig object.

Is Verbal Mediation Necessary?

Sidman et al. (1974) suggested that oral naming need not mediate the emergence of visual-auditory matching. This was demonstrated when subjects who had learned to match printed words to pictures and pictures to their auditory names, showed a substantial ability to match printed to dictated words and almost no ability to read words aloud.

Lazar, Davis-Lang, and Sanchez (1984) also demonstrated stimulus class formation in normal children without the use of auditory stimuli, and concluded that stimulus class formation can be formed in the absence of mediating names. This corroborates the view of Sidman and Tailby (1982) who noted that a differential response to each stimulus is not required to form a conditional discrimination. Lazar et al. (1984) summarized by stating "Inasmuch as it has now
been demonstrated that naming is not a prerequisite to equivalence formation, we can take the position that human matching is governed by a relation between the sample and its corresponding correct comparison." (This is a stimulus-stimulus relation as opposed to the stimulus-response relation suggested by giving causal status to the mediating response.)

It is not impossible, however, that the subjects in these studies may have devised their own codes for the stimuli. For example, Lazar et al., (1984) reported that subjects' oral naming of each stimulus showed that they had not assigned a common label to stimuli in the same class. This indicates that the subjects were engaging in precursory verbal behavior.

It is yet to be unequivocally demonstrated that nonhumans can form stimulus equivalence classes. It is clear that nonhumans do not possess verbal behavior in the same sense that humans possess verbal behavior. It has been demonstrated that equivalence class formation can be established with humans who are considered nonverbal. In humans with deficient verbal skills, the extent of the role of verbal behavior in class formation is not as clear. One can assume that a nonhuman is not engaging in any type of coding response, but one cannot make the same assumption about a human who is lacking in verbal behavior but who has the ability to form stimulus classes without the benefit of an overt mediating response.

McIntire, Cleary, and Thompson (1987) claimed to demonstrate
the properties of stimulus equivalence in monkeys. The researchers taught monkeys to categorize six colors into two groups of three. Each group of colors was related to a characteristic pattern of responding. In the presence of one set of colors (described as the odd set 1-3-5, for ease of description) a duration key press was required (holding the key for 3.5 seconds). In the presence of the other set of colors (described as the even set 2-4-6), a frequency key press was required (eight key presses).

The monkeys were required to emit the correct response in the presence of the sample. A correct response resulted in the presentation of two comparison stimuli. The monkeys then had to select the correct comparison (odd or even to match the sample). When this selection was made, the final step was to emit the corresponding response topography of duration or frequency.

After discrimination training each subject was tested with 10 additional color combinations, all of which differed from the training combinations. The experimenters concluded that the conditional relations established between test combinations could be characterized as stimulus equivalence.

This study is analogous to those of Lowenkron (1984, 1988) in that a discrimination that could not be made initially was facilitated by the teaching of a mediating response.

Some researchers have questioned these results, suggesting that McIntire et al. (1987) did not demonstrate true stimulus equivalence in their subjects. Saunders (1989) rejects the stimulus
equivalence claim, suggesting instead that the monkey's behavior in selecting the comparison was not under the control of the sample stimulus but under the control of the differential response.

Similarly, Hayes (1989) rejects the notion, stating that the relations were not really derived. "The characteristic response always precedes selection of the correct comparisons. Thus, the animal has been directly trained in name-stimulus relations as well as stimulus-name relations" (p. 386). Thus, the comparison stimulus selection was a function of the naming response, an S-R mechanism. This is central to the question of whether stimulus equivalence is a function of stimulus-response or stimulus-stimulus principles. That is, is verbal behavior necessary for equivalence or the result of equivalence. It cannot be conclusively demonstrated that a mediating response is occurring in all instances of stimulus equivalence or conditional discriminations. It also cannot be conclusively demonstrated that a mediating response is not occurring in all instances of stimulus equivalence and conditional discriminations (on the covert level). It can, however, be demonstrated that by training a mediating response, conditional discriminations and behavior that may at least be analogous to stimulus equivalence may emerge in humans and non-humans where it was previously unobserved.

The Relation of Stimulus Equivalence to Verbal Behavior

The debate continues today over the relevance of stimulus equivalence research to verbal behavior. The evidence currently
available is inconclusive as to whether verbal mediation is necessary for equivalence. Sidman (1994), for example, argues that stimulus equivalence is an innate linguistic prerequisite which accounts for such things as meaning, symbol, referent, and rule-governed behavior. Hayes and colleagues (e.g., Hayes, & Hayes, 1992; Wulfert & Hayes, 1988) maintain that stimulus equivalence transforms nonlinguistic into linguistic behavior. Other researchers (e.g., Dugdale & Lowe 1990; Lowe, Horne, & Higson, 1987; Horne & Lowe 1996) suggest that equivalence is a function of verbal behavior. Success with matching to sample, which leads to stimulus equivalence, is attributable in large part to subjects' naming and other verbal behavior. This may explain the lack of success of nonverbal organisms on these tests.

Protocol Analyses

Regardless of the "necessity" of verbal mediation, there are a number of experiments that suggest that verbal mediation can at least facilitate acquisition of stimulus equivalence and conditional discriminations (e.g., Lowenkron, 1984, 1988; Potter et al., 1997; Sundberg & Sundberg, 1990; Stratton, 1992; Wulfert, Dougher, & Greenway, 1991).

Wulfert et al., (1991) recorded participant's verbal responses during matching to sample, using a "think aloud procedure" modeled after Ericsson and Simon's (1993) protocol analysis. The purpose was to identify variables that might explain individuals' differences in
equivalence class formation. They found that subjects who formed equivalence classes described the relations among stimuli, whereas those not showing equivalence described sample and comparison stimuli as unitary compounds. In a second experiment, the experimenters manipulated the types of training given to participants. Subjects were taught to name stimulus compounds or to name relations between stimuli. In general, those in the "relations" group demonstrated stimulus equivalence and the other group did not. These results offer more evidence of the role of covert mediating events as an independent variable. (These were actually overt responses that were observed. To accept this position, one must assume that the overt mediating responses were representative of the covert responses.)

Potter et al., (1997) conducted a protocol analysis to determine the possibility that SB responding may in some cases be composed of both TB and SB components (as suggested by Dugdale & Lowe, 1990 and Lowenkron, 1991). The vocal verbal behavior of participants was examined while they engaged in the arranged task. From the exit interviews it became apparent that subjects were developing skills in generating TB responses to the sample and choice stimuli. Typical verbal statements consistently preceded selection of correct and incorrect choice stimuli. A final session was conducted in which less discriminable sample stimuli were used. He found that not only were these stimuli harder to name, but performance decreased as well.
Purpose

The primary purpose of the present study is to compare the results of various matching-to-sample tasks to a signing-to-sample task in two populations. One population of subjects consisted of highly verbal college subjects, and the other consists of developmentally disabled subjects with very low verbal abilities. It is proposed that one, or some, of the differences between these TB and SB systems influences performance when there is a deficit in the language of the subject (e.g., the subject is not highly verbal, or has some learning disability). For example, if it were the scan, the conditional discrimination requirement, or the ability to engage in mediated verbal behavior, these variables may not affect a normal adult (such as the college students in the Stratton 1992 study) who have a well-established scanning repertoire and have an extensive (successful) history dealing with conditional discriminations. This question is addressed by varying some of the aspects of the selection based task such as the location of the comparison symbols (always in the same position for each trial vs. in various locations around the board for each trial).

Of particular interest to this experimenter is the investigation of the role of mediating verbal behavior in the SB and TB tasks. To help isolate the effects of verbal mediation, one of the SB tasks involves comparison stimuli that are differentiated, not by appearance, but by location only. That is, all of the symbols on the board are the same. If verbal mediation is indeed a key component in a
matching to sample task, then the mediations should be facilitated by symbols that are vastly different and inhibited by symbols that are the same. Furthermore, if increasing the difficulty of creating verbally mediated responses interferes with the performance of the highly verbal group (the college students) but does not interfere with the performance of the low verbal subjects, then we must consider the importance of the role of verbal mediation. To further isolate the effects of verbal mediation on the acquisition of conditional discriminations, a protocol analysis is conducted with the college subjects at the conclusion of the study.

A second purpose is to make a comparison of these various systems with a sign language system. This methodology will allow comparison of a TB system (signing to sample) with various degrees of a SB system: symbols are fixed in position; symbols vary in position; symbols are identical.

A third purpose of this study is to use a repeated acquisition procedure to permit the study of ease of learning within the same subject (Boren & Devine, 1968). One of the concerns in the interpretation of earlier studies is that of a sequence effect. Typically it is difficult to study ease of learning within the same subject because, as subjects learn new response patterns or new discriminations, their behavior is continually in transition. If a second series of different but similar discriminations is required, then the subject is likely to learn it more quickly. For this reason a subject's initial learning does not serve as a good control for later learning. A repeated
acquisition procedure is designed to produce a steady state of learning. This steady state of repeated acquisitions for one learning procedure can then be compared to the steady state of responding during a different learning procedure.

The repeated acquisitions procedure has not been used in this line of research. Therefore, methodologically, it may provide for a more reliable form of comparison. In a review of the literature of empirical studies comparing TB and SB verbal behavior, Potter et al., (1997), noted that the variations in subjects' pretraining offer an additional confounding variable. The repeated acquisitions design will eliminate this problem by ensuring the pretraining in all cases is conducted until the data series stabilize.
METHODS

Overview

To facilitate the reader's understanding of the methods, a clarification of some of the terminology and a brief overview of the procedures will be provided. In essence, this study involved two separate experiments. The methodology was virtually identical but the populations differed dramatically as did the difficulty of the tasks. For purpose of description, one group will be called the college subjects, the other group will be called the DD subjects (subjects with developmental disabilities).

The following descriptions of the procedures will be clarified here: A trial represents one stimulus presentation. A block represents one presentation of each stimulus in a set. A round consists of a number of trials and blocks until criterion is met. A session represents one training period. A phase represents the type of symbol system or signs used. A relation refers to the relation between a sign, and a word\object or a symbol and a word\object. A set refers to the number of relations used per subject.

Each of the subjects from both groups were exposed to four phases in various orders. Since each subject started at a different phase, the phases will be referred to by name rather than number. Three of the phases involved matching-to-sample training on a
symbol board and one involved training in a sign system. In one phase, the symbols were fixed in position throughout the phase; this will be referred to as the fixed phase. In another phase, the symbols changed positions after every correct response; this will be referred to as the random phase. Another phase consisted of symbols that were identical and remained so throughout the phase (thus, the subjects had to rely on the location of the symbol); this will be referred to as the same phase. Another phase involved tact or intraverbal training using signs; this will be referred to as the sign phase.

Repeated Acquisition

To help guard against possible sequence effects and to allow pretraining to mastery, a repeated acquisition design was used (Boren & Devine, 1968). Each phase was divided into several rounds. During each round a specific word or object corresponded to a symbol or sign. Trials were run until the subject mastered the relation or a predetermined number of stimulus blocks were presented without meeting criteria. When criterion was met, a new round started. The new round was conducted in the same way except that the words or objects corresponded to different symbols. Again, trials were run until criterion was met or the predetermined number of stimulus blocks were presented without the subject meeting criterion. This sequence was repeated until the number of errors made before criterion was stable. At this point the next phase
would begin (e.g., fixed location phase).

Subjects

Four subjects, functioning in the severe to moderate range of mental retardation, served as one half of the subjects. These subjects resided in a group home operated by Residential Opportunities, Inc. (ROI). Two females and two males participated in this experiment with ages ranging from 24 to 52. In addition to the severe to moderate range of mental retardation, the subjects met the following criteria: (a) displayed moderate to severe deficits in language behaviors, (b) possessed manual dexterity sufficient for the adequate formation of signs, (c) demonstrated the ability to imitate, (d) demonstrated the ability to follow simple instructions, and (e) had no prior experience with either sign language or a symbolic communication board. Prior to any subject's participation, legal guardian and official ROI consent was obtained as well as approval from the Human Subjects Institutional Review Board of Western Michigan University. Initially each subject was paid $5.00 per one half hour session. Later in the experiment it was determined that the sessions were too long for the subjects and they were shortened to 5-15 minutes. The pay was then adjusted to $1.00 per six minutes. Subjects were given nickels for each correct response. At the end of the session any additional money owed to a subject was put into his or her house account.

The other four subjects were normal adults between the ages of 21 and 25 with no language deficits. All subjects were female. To
be considered for inclusion in this study the subjects met the following criteria: (a) at least 18 years of age, (b) were literate, (c) had sufficient time to participate in the study, (d) had not been exposed to sign language training, nor had any extensive symbol board use. All subjects signed an informed consent form. Each subject was paid $5.00 per session.

Setting

Sessions for the DD subjects were conducted in a food storage room inside the group home. The room contained a table, two chairs, a filing cabinet and shelves (where food was stored). The room was well ventilated and well lit. There was no traffic during the sessions and because the experimental room was in the basement, the noise was at a minimum.

For the college subjects, sessions were conducted in a room at Western Michigan University. The room contained a large table, several modular office spaces and filing cabinets. The room is used as the main office for the Psychology 100 class at Western Michigan University but was empty during all of the sessions (the experiment was done in the summer while the office was not in use).

Sessions were conducted five or six days a week between the hours of 3:00 p.m. and 9:00 p.m. Each session lasted approximately 30 minutes for each college subject, and 10 to 20 minutes for each DD subject.
Apparatus and Materials

All college subjects were taught relations between nonsense two-syllable words (e.g., "Miba") and meaningless visual patterns and signs. Two DD subjects were taught relations between nonsense one syllable words (e.g., "Poe") and meaningless visual patterns and signs. One DD subject was taught relations between four-piece lego configurations and meaningless visual patterns and signs. One DD subject was taught relations between two objects (with more distinct features), and meaningless visual patterns and signs. One object was a brown cardboard cylinder the other was a circular wood piece. See Appendix A for a list of the nonsense words, and signs used.

The patterns were 4" X 4" in size, printed on paper, and pasted on an 18" X 24" piece of poster board placed approximately 2" apart from each other. For ease of description, the experimenter named each of the symbols according to their features; for example, "window," "stairs," and "square." See Appendix A for complete list of symbol names.

Each subject progressed through three phases that required a symbol board. During the random phase the symbol position was altered after each correct response. To make the changing of the symbols easier and systematic, six poster boards with the same patterns but in different locations were used. The six were stacked in front of the subjects. After every correct response in this phase the experimenter removed the posterboard and put it on the bottom
of the stack, leaving a new one in front of the subject (thus, the symbol positions would repeat after every sixth correct response).

Since all four college subjects were trained with 12 sets, the same six boards were used for all college subjects. All DD subjects, however, were trained with a different number of sets. Therefore, six unique symbol boards were used for each subject for this phase.

For the fixed phase one board with distinct symbols was used throughout all rounds. The same 12-symbol board was used for all college subjects. Each DD subject had his/her own board corresponding to the number of sets used for that subject.

For the same phase, one board was used throughout all 12 rounds. The symbols on this board, however, were nondistinct (i.e., all symbols looked the same).

Because a repeated-acquisitions design was used, the relation was changed after each round (each time after criterion had been met). The relations for each round were predetermined and listed on the data sheets. For the college subjects, packs of 10 data sheets were used, designed for use for 30 rounds. For each round, the symbol code or the sign code (depending on the phase) was constant on the data sheet for all 30 rounds. Each new round, however had eight words from the previous round (four from the last and four from the one before) and four new words. This arrangement would accommodate 30 rounds before repeating.

For DD subject JW, since there were only two sets, the relations simply alternated for each round. For example, if for round
one "Rook" was related with symbol 1 and "Poe" was related with symbol 2, then for round two "Rook" would be related with symbol 2 and Poe would be related to symbol 1. For subject AS, three sets were used. A table that listed all of the possible word\symbol and word\object relations was used to determine the relations for each round. This arrangement would accommodate 6 rounds before repeating. For DD subject JI (four sets), data sheets similar to the college subjects were used. For each round, the symbol code or the sign code (depending on the phase) was constant. Each new round, however, had two new one- syllable nonsense words. This arrangement would accommodate 12 rounds before repeating. For DD subject TP (six sets) data sheets similar to the college subjects were used but only two new words were introduced for each round. This arrangement would accommodate eight rounds before repeating. See Table 1 for summary of relations for DD subjects.

Pilot Sessions

A particular relationship between a pattern and its corresponding word or object only held for one round (a round consisted of trials of sample stimuli presentations until the criterion was met). The relations were then changed for the next round.

This repeated-acquisitions design made it possible to expose the subjects to the stimulus materials in an attempt to determine an appropriate level of difficulty without confounding the results.
Several pilot sessions were run with the subjects using various non-sense words, objects and symbols.

For the college subjects, the initial pilot sessions consisted of two subjects matching eight distinctive objects to eight symbols. This relation was too easy (so few errors were recorded that a ceiling effect was imminent). The objects were then replaced with objects consisting of four-piece lego configurations. These objects were much less distinctive. This initially made the task more difficult but as errors stabilized, they were still too few to make a comparison between phases. The next materials change involved
using eight one-syllable words instead of objects (e.g., "Clo," "Rook,"). Again, this task did not create enough errors for the subjects. The next materials change involved creating four more symbols, nonsense words, and signs. Once again this was initially difficult, but after a few days the subjects were performing almost perfectly. The words were then altered so that they were less distinctive (e.g., "Che," "De," "Cha," "Da,"). This change created many errors during the first three sessions, but by the sixth sessions errors stabilized at a rate too low to make any meaningful comparisons. The words were altered again (more alliteration was added). This did not seem to make a difference. Finally, it was determined that once the words became familiar to the subjects the task became easier. Because of the repeated acquisitions nature of the design, the subjects would have ample opportunity to become familiar with the words, reducing errors in the process.

The final materials change involved creating an almost exhaustive list of words so that each subject would receive four new words after each round. See Appendix A for the six word lists and the sign descriptions.

The adjustments were somewhat easier for the DD subjects but they were idiosyncratic to each subject. Subject JW started with three sets of relations (three objects, and three symbols). This turned out to be too difficult so one object, one symbol and one sign was dropped resulting in two sets (two symbols, two objects, and two signs). Subject AS started with four objects with distinguishing
features (small cardboard cylinder, a circular wood piece, a metal cylinder, and a hard plastic piece) and four symbols. This subject quickly mastered the relations. The objects were then substituted with four four-piece lego configurations. This proved too difficult for the subject. Finally, one set was dropped resulting in three sets (three symbols, three lego configurations and three signs). Subject JI started out with four sets consisting of symbols and lego configurations, and signs, and she was performing errorlessly by the fourth round. There was only one change in materials for subject three—the lego configurations were replaced with one-syllable words, two new words were substituted after each round. Subject TP started with six sets of relations consisting of six signs six symbols and six words from a pool of eight—that is, for each new round two words were replaced.

Measurement

For the college subjects, responses were recorded as correct by simply marking in the column under the corresponding stimulus presentation, with a standard dash. Incorrect responses were indicated by writing the code for the response that was emitted or a zero for no response. The first sign made or the first symbol indicated was the response recorded. Mastery criterion for a round was met when the subject either responded correctly on all 12 stimulus presentations in a block or responded correctly on 11 out of 12 for two consecutive blocks.
Each DD subject had separate mastery criterion. For subject JW, mastery criterion was met when she responded correctly on 15 consecutive blocks or 19 out of 20 blocks. If she did not meet criterion after 60 blocks the session was terminated and the errors recorded. For subject AS, mastery criterion was met when he responded correctly on five consecutive blocks. For subjects JW and AS (since the set size was small) all possible responses were listed on the data sheet. The experimenter would simply circle the response made by the subject (see sample data sheet in appendix A). For DD subjects JI and ET data collection was done in the same way as with the college subjects. For subject JI, mastery criterion was met when she responded correctly for four out of five stimulus presentations across all four relations. In other words, she could make up to one error per relation over five blocks, but could not make two errors in one relation even if she made no errors for another relation. Mastery criterion for subject TP was met by making no more than one error over two blocks of six presentations (11 out of 12 trials).

Independent Variables

The independent variable in study was the type response system used for responding to a sample stimulus (one of three various symbol boards or a signed response).
Dependent Variable

For three of the phases a selection-based tact (i.e., pointing to a symbol when presented with an object) was trained. In one phase a topography-based tact (i.e., making a sign when presented with an object) was trained.

For a response to be recorded as correct, it must have been a close enough approximation to the desired response that it was easily distinguishable by the experimenter from the other responses in the subject's repertoire.

The four phases were compared by looking at the number of errors made, per round, before criterion had been reached. Comparisons were made after errors had stabilized using a repeated-acquisition design.

Response Definitions

**Topography-based Tact**

When shown a certain object or presented with a word and asked "What's the sign for this?" (or "What is the sign for ____") the subject made the corresponding sign within ten seconds of its presentation (e.g., when shown the plastic piece and asked "What's this?" the subject pulled her left ear within ten seconds).

**Selection-based Tact**

When shown a certain object or presented with a word and
asked "Which one is this?" (or "Which one is ____") the subject pointed to the correct symbol (out of an array of at least two, no more than 12) within ten seconds of its presentation (e.g., when presented with the stimulus "Which one is mojam?" the subject pointed to the corresponding symbol within ten seconds.

**Exit Interview**

At the conclusion of the study, an exit interview was conducted with three of the four college students. Each subject was asked a series of questions designed to identify strategies used and the extent of mediating verbal behavior. Also of interest was the extent to which mediated verbal behavior was correlated with differential performance across phases; or if any particular type of verbal behavior was correlated with differential performance across conditions. The subjects were asked to talk aloud as they were presented a block of stimulus presentations. They were instructed to try to overtly vocalize any tacts or intraverbals that they may have emitted on the covert level during the actual experiment (e.g., "Bebah, that sounds like baby, there's a baby in the window"). They were also instructed to report any relations in which they did not engage in any consistent verbal behavior (e.g., "Bocam, huh, I wonder where that goes").

**Interobserver Agreement**

Reliability data on each subject's responses were collected by a
trained observer on approximately 30 percent of the total trials. The observer used the same data collection sheets as the experimenter and scored each subject's responses according to the above-stated criteria. Interobserver agreement was calculated by dividing the trials scored in agreement by the summation of trials scored in agreement and trials scored in disagreement, and then multiplying that figure by 100.

The observer for the college subjects was a graduate student in psychology at Western Michigan University who was interested in this line of research. The observer practiced scoring approximately twice per week for four weeks during the pilot studies.

The observer for the DD subjects was the home coordinator of the group home where the subjects resided. He also practiced scoring approximately twice per week for four weeks during the pilot studies. Both observers were paid $10.00 per hour. See Appendix B for Table of reliability scores.

Procedure

Overview

In general the subjects were exposed to matching-to-sample tasks with three different arrangements of symbols and one signing-to-sample task. Two DD subjects started with the fixed phase, then progressed through the random, same, and sign phases. Two DD subjects started with the sign phase, then progressed through the fixed, random, same phases, then the sign phase again. Two college
subjects went through the phases in the following order: fixed, random, same, and sign. Two subjects started with the sign phase, then progressed through the fixed, random, and same phase. One of these subjects then went through the sign phase again.

Some of the subjects who started with the sign phase repeated this phase at the end because it was determined by the experimenter that the phase shift may have occurred before the errors stabilized. The signs may have taken longer to stabilize because there was an extra step involved in the initial sets involving sign. Not only did the subjects have to emit a sign when presented with a nonsense word, but in order to do this they had to learn all of the signs. There was nothing special to learn about the symbols. That is, the pointing response was already in the subject's repertoire. See Table 2 for an example, of relations for three rounds of repeated acquisition training.

**Pretraining**

Relations within a SB phase started with a symbol board being placed in front of the subject. If objects were used, the experimenter placed all of the objects on the symbols one at a time while saying "this goes with this." Objects were left on the board for five seconds. If words were used, the experimenter pointed to each symbol (at a rate of one every two seconds) while saying "This is __________." The subject was then told that the experimenter would hold up an object or present a word and the subject would have
for DD Subject JI

<table>
<thead>
<tr>
<th>ROUND</th>
<th>- RELATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAMPLE WORD</td>
</tr>
<tr>
<td>1</td>
<td>Mook</td>
</tr>
<tr>
<td></td>
<td>Rac</td>
</tr>
<tr>
<td></td>
<td>Mig</td>
</tr>
<tr>
<td></td>
<td>Doe</td>
</tr>
<tr>
<td>2</td>
<td>Mig</td>
</tr>
<tr>
<td></td>
<td>Doe</td>
</tr>
<tr>
<td></td>
<td>Jib</td>
</tr>
<tr>
<td></td>
<td>Dro</td>
</tr>
<tr>
<td>3</td>
<td>Jib</td>
</tr>
<tr>
<td></td>
<td>Dro</td>
</tr>
<tr>
<td></td>
<td>Slo</td>
</tr>
<tr>
<td></td>
<td>Rook</td>
</tr>
</tbody>
</table>

five seconds to point to the pattern that goes with that object.

Relations with the TB phase started with a demonstration of all of the signs. The subject was then asked to imitate the signs as the experimenter emitted them. This was done five times. Next, if objects were used the experimenter would lay them on the table, point to each one while making the corresponding sign and say "This is this." If words were used, the experimenter would make the sign for each word while saying "This is ____ (e.g., Biba)."

**Fixed Phase**

The subjects were shown the objects or presented with the words one at a time and their corresponding symbols (as described in pretraining). Next, the experimenter randomly selected one of the
words or objects and presented it to the subject while saying "Which one is this" (object) or "Which one is ___" (word). For the college subjects, if the correct symbol was selected, the experimenter simply said "yes" and presented the next stimulus. For the DD subjects, if the correct symbol was selected, the experimenter praised the subjects (e.g., "Yeah, good job") and presented the subject with a nickel. If the response was incorrect, the experimenter said "No, this goes here," or "No, this is ___" while pointing to the correct symbol.

For the college students all 12 words were presented once, and then repeated in a different order. This was repeated until mastery criterion was met. When criterion had been met the round ended and either the session ended or a new round began with 12 new word-symbol relations. Again, when mastery criterion was met a new round with 12 new relations would begin. Four rounds were conducted for each subject each session. This process was repeated until it appeared by analyzing the data (number of errors) that the subjects performance had stopped improving (i.e., the number of errors had stabilized).

For the DD subjects, the above procedures were the same, all objects or words were presented (two, three, four, or six, depending on the subject) once and repeated until criterion was met, etc. Only one round per day was conducted with these subjects, however.

In this phase the subject's response was prompted by the distinct features of each symbol and by the fixed location of each symbol.
Random Phase

The random phase was conducted in the same way as the fixed phase except that a correct response produced a new symbol board. This new board had the same symbols but the symbols were in different locations. No symbol's location was the same as on the previous board. Six boards were used and the symbol location repeated after every six correct responses. In this phase, the subject's response was prompted by the distinct features of each symbol only.

Same Phase

The same phase was also conducted in the same way as the fixed phase except that the same symbol was used in each location on the board. In this phase, the subject's response was prompted by location of the symbols only (see Appendix A for examples symbol boards).

Sign Phase

The sign phase started with the pretraining on the signs (described above). After pretraining the subjects were presented with one object or one word and asked "what is the sign for this," or "what is the sign for ___" (e.g., "Pog"). As with the previous phases, all of the objects or words were then presented one at a time and then repeated. This continued until criterion was met. When criterion had been met the round ended and either the session ended or a new round would begin with new word-sign or
object-sign relations. This process was repeated until it appeared by analyzing the data (number of errors) that the subjects performance had stopped improving (i.e., the number of errors had stabilized). As with the previous phases one round per day was conducted with the DD subjects. For the college subjects, only two or three rounds were conducted during the first couple of sessions because of the excessive time requirement for early sign training. Many more errors were made initially while the subjects were acquiring the sign topographies. After the initial sessions, four rounds per day were conducted.

Experimental Design

This study utilized an alternating treatments design (Barlow & Hayes, 1979), in which the four conditions were compared within each subject in an A-B-C-D or A-B-C-D-A fashion. The possible confounding effects of sequence of the phases, on the dependent variable were minimized by the use of the repeated acquisition design (Boren & Devine, 1968).
RESULTS

The results showed a fairly consistent pattern of errors between subjects within each group, but there were many differences between groups. The college subjects will be discussed first.

College Subjects

Although data from all of the rounds will be presented in the individual graphs, only the last 10 rounds for each subject will be included in the analysis (after the errors had stabilized). The college subjects' performance was typically invariable between the random phase and the fixed phase. Two subjects made fewer errors during the random phase (subjects MA and ET) but the difference was not significant. Subject GP made slightly fewer errors during the fixed phase and subject MJ made significantly fewer errors during the random phase. Subject MJ reported that she "figured it out" about the time the phase shifted from fixed to random. She reported that she came up with a strategy that helped her significantly. Subject MJ also reported that she was highly distracted during the last two sessions of the fixed phase. These last two session inflated her error rate significantly. Therefore, her data will be displayed with and without those last two sessions. Also, her error rate had become fairly stable, before the last two rounds and a phase shift at that time would have been reasonable.
In general, it appeared that changing the location of every symbol after each correct response did not affect the performance of the college subjects.

Responding in signs took longer to stabilize but once they did the performance was about the same as in the fixed and random phase. Perhaps the signs took longer to stabilize because there was an extra step involved in the initial sets involving sign. Not only did the subjects have to emit a sign when presented with a nonsense word, but in order to do this they had to learn all 12 of the signs. There was nothing special to learn about the symbols. If the subject did not know she would guess. In the initial stages with the sign the subject would often respond by saying "I don't know." All four subjects performed better in the sign phase than the same phase. Subjects GP and MA made the fewest errors of any phase during the sign phase. Subjects MJ and ET made more errors during the sign phase than during the symbol phases (fixed and random).

The only clear difference between the phases with the college subjects was shown during the phase when all symbols were the same. Subjects MA and ET demonstrated significantly more errors during this phase than any other phase. Subject MJ made significantly more errors during the same phase than during the random phase and slightly more errors than the sign phase. She also made more errors in the same phase than the fixed phase if the last 10 rounds are discarded (her reported distracted sessions). Subject GP made slightly fewer errors during the same phase than during the
symbol phases (fixed and random). However, she later stated that she had to pay attention and concentrate much harder during this phase. Subject GP showed the least variance between phases but she showed considerable variance within phases. This subject missed many sessions and was often gone for long periods of time between sessions. Some phases were cut shorter than ideal in fear that the subject was losing interest. She was also the only subject that went through all of the pilot testing. Therefore, she was involved in the experiment longer than the experimenter estimated.

All subjects indicated that they were having problems with the same phase. They reported that it was too difficult to come up with strategies without the symbol differentiation. See Table 3 for the errors made on the last 10 rounds for each subject for each phase.

Group Results

When the combined average number of errors of all college subjects are examined the same phase proved to be the most difficult. If the second set of data from subject MJ’s fixed phase are used (prior 10 rounds), then the same phase is clearly separate from the others (see Figures 1 and 2 for grouped mean errors with subject MJ’s prior 10 and subject MJ’S last 10 rounds). These results indicate that the college subjects relied on the visual distinctness of the symbols more than on the fixed location of the symbols. This was demonstrated when the subjects’ performance was not hindered
Table 3
Errors for Each of the Last 10 Rounds per Phase
for College Subjects

<table>
<thead>
<tr>
<th>PHASE</th>
<th>SUBJECT MJ*</th>
<th>SUBJECT GP</th>
<th>SUBJECT MA</th>
<th>SUBJECT ET</th>
<th>GRAND MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIXED</td>
<td>LAST 10 PRIOR 10</td>
<td>LAST 10</td>
<td>LAST 10</td>
<td>LAST 10</td>
<td>Subject MJ last 10</td>
</tr>
<tr>
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<td>7</td>
<td>13</td>
<td>8</td>
<td>2</td>
<td>( \bar{X} = 9.5 )</td>
</tr>
<tr>
<td>22</td>
<td>19</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>( \bar{X} = 7.5 )</td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>6</td>
<td>( \bar{X} = 18 )</td>
</tr>
<tr>
<td>21</td>
<td>16</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>( \bar{X} = 11.9 )</td>
</tr>
<tr>
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<td>1</td>
<td>3</td>
<td>5</td>
<td>( \bar{X} = 3.4 )</td>
</tr>
<tr>
<td>39</td>
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<td>8</td>
<td>4</td>
<td>0</td>
<td>( \bar{X} = 5.1 )</td>
</tr>
<tr>
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<td>4</td>
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</tr>
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<td>33</td>
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<td>5</td>
<td>( \bar{X} = 3.4 )</td>
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<td>( \bar{X} = 3.4 )</td>
<td>( \bar{X} = 5.1 )</td>
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<td>5 2</td>
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<td>0 2</td>
<td>6 1</td>
<td></td>
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<tr>
<td>16 7</td>
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<td>6 6</td>
<td>0 5</td>
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</tr>
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<td>8 7</td>
<td>8 1</td>
<td>7 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{X} = 8.7 )</td>
<td>( \bar{X} = 10.7 )</td>
<td>( \bar{X} = 2.2 )</td>
<td>( \bar{X} = 4.3 )</td>
<td>( \bar{X} = 6.1 )</td>
<td></td>
</tr>
<tr>
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<td>10 6</td>
<td>13 6</td>
<td>14 2</td>
<td>34 17</td>
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<td>13 6</td>
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<td>15 11</td>
<td>23 12</td>
<td>18 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 17</td>
<td>19 1</td>
<td>7 4</td>
<td>23 19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{X} = 12.7 )</td>
<td>( \bar{X} = 9.5 )</td>
<td>( \bar{X} = 7.5 )</td>
<td>( \bar{X} = 18 )</td>
<td>( \bar{X} = 11.9 )</td>
<td></td>
</tr>
</tbody>
</table>
when the location cues were taken away. When the visual distinct
cues were taken away, however, the general performance of the
subjects regressed. Subjects MA and ET were particularly adversely
affected by the removal of the distinct features of the symbols in the
same phase. Perhaps of significance here is that these two subjects
made almost two-thirds fewer errors during the random phase than
subjects MJ and GP (mean of 3.3 vs. mean of 9.5). In other words,
the subjects who performed best on the distinct symbol phases were
affected more by the removal of the distinct visual cues than the
subjects who performed worse. Examination of Figures 3 and 4 will
show that the subjects who made the most errors across all phases
were affected less by the removal of the distinct symbols.

**DD Subjects**

Several comparisons can be made between the phases within this
Figure 1. Graphic Representation of the Grand Mean Presented in Table 3. Figure 1 Includes Data from Subject MJ's Last 10 Rounds.

Figure 2. Graphic Representation of the Grand Mean Presented in Table 3. Figure 2 Includes Data from Subject MJ's Best 10 Rounds.
COMBINED AVERAGE -- MA AND ET

Figure 3. Graphic Representation of the Combined Mean Errors per Round for Subjects MA and ET.

COMBINED AVERAGE -- MJ AND GP

Figure 4. Graphic Representation of the Combined Mean Errors per Round for Subjects MJ and GP.
group. Three of the four subjects made significantly more errors during the random phase than the fixed phase. In most cases the subjects did not master the relation of the random phase. One subject (JW) did not show a difference but there was a peculiarity in her performance in that during the fixed and random phases she would master the relation every other session (for DD subjects one round = one session). In other words, she typically was not reversing the discrimination from one round to the next (see Figure 10). She was the only subject whose selection response came under the control of the distinct symbols (she only had two sets of relations to master, however), but only for every other round. It was not the case that she had mastered one relation and not the other (e.g., mastered "wood object goes with vertical symbol," but did not master "cylinder object goes with window symbol"). This was apparent when she had two good rounds in a row (fifth and sixth) during the fixed phase. After this, she reverted back to meeting criterion for every other round except that the relation she had mastered and the one she had not switched. This pattern continued for seven more rounds until the phase shifted from fixed to random. At this point the mastered and unmastered relation switched again. See Table 4 for errors for the last four rounds of each phase for each subject.

The same three subject's who could not master the relations of the random phase (AS, JI, TP) quite easily mastered the relations of the same phase. Subjects AS and TP made fewer errors in same
Table 4
Errors for Each of the Last Four Rounds per Phase
for DD Subjects

<table>
<thead>
<tr>
<th>PHASE</th>
<th>SUBJECT</th>
<th>SUBJECT</th>
<th>SUBJECT</th>
<th>SUBJECT</th>
<th>GRAND</th>
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<tr>
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<td>JW</td>
<td>AS</td>
<td>JI</td>
<td>TP</td>
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<tr>
<td>Fixed</td>
<td>16</td>
<td>16</td>
<td>9</td>
<td>11</td>
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</tr>
<tr>
<td></td>
<td>69</td>
<td>11</td>
<td>25</td>
<td>59</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>X=39.5</td>
<td>X=26.1</td>
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<td>RANDOM</td>
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<td>SAME</td>
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<tr>
<td>SIGN (PHASE 1)</td>
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<tr>
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<td>X=12.3</td>
<td>X=29.5</td>
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<td>X=20.9</td>
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<tr>
<td>SIGN (PHASE 5)</td>
<td>18</td>
<td>5</td>
<td>61</td>
<td>11</td>
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<td>X=9</td>
<td>X=30.5</td>
<td>X=45</td>
<td>X=30.5</td>
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</table>

phase than they did in the fixed phase. Subject JI made slightly more errors than she did in the fixed phase. JW, however, did the poorest during this phase. While she tended to master every-other
round during the previous phases, she did not master any of the rounds during the same phase. This was surprising in that her performance was the poorest of the four subjects and she only had a two-symbol to two-object relation. This indicated that the symbols themselves exerted control over her selection (at least one half the time) while the position (without the symbols) did not. The other three subjects did very well with the position only cues even though they had more positions (3, 4, and 6) yet they could not master the relation without the location cues.

Three of the four subjects did significantly better during the sign phase than they did during the random phase. JW who started and finished with the sign phase made significantly fewer errors in the first sign phase than the random phase. During the second sign phase however, her mastery performance alternated by rounds as it did in the fixed and random phase. JW's second sign phase was slightly better than the random phase.

When comparing the sign phase with the random phase, the results replicate the early findings of the Sundberg and Sundberg (1990) and Wraikat et al., (1991) studies done with low verbal developmentally disabled subjects. In these experiments TB tacts and intraverbals (signs) were compared to SB tacts and intraverbals, where symbols were randomized after every correct response.

When the sign phase is compared to the fixed and same phase, however, the difference is not consistent. JI made one-third more errors in the sign phase than the fixed phase and one-fifth more
than the same phase. TP made only slightly more errors in the sign phase than in the fixed phase but twice as many than the same phase. These two were the highest functioning subjects. TP had six sign-word relations, or six symbol-word relations to learn each round, and Ji had four. These were intraverbal relations which some studies suggest are harder to acquire than tacts (Sundberg & Sundberg 1990; Wraikat et al., 1991).

Subject AS clearly performed better during the second sign phase than any other phase. JW clearly performed better during the first sign phase than during any other phase. Her second sign phase was also better, but her performance was more varied.

**Group Results**

Although the performance across phases was not consistent between subjects, when the mean errors are grouped an obvious pattern emerges. See Table 4 and Figure 5. There is an overall consistency between the fixed, same, and sign, phases. The mean errors ranged from 30.5 to 32.5. The mean error range for the random phase, however, was 59.9. See Figure 5.

**Summary Between Groups**

The college subjects did not increase their number of errors per round when the location cues of the symbols was removed. The DD subjects, however, were significantly affected by this change.
The college subjects were significantly affected when the symbol differentiation was eliminated. The DD subjects, however, were not.

(Compare Figure 2 with Figure 5.)

Exit Interview

Three of the college subjects (GP, MA, and ET) were available for post experimental interviews. Each subject was asked a series of questions designed to identify strategies used and the extent of mediating verbal behavior. The subjects were then asked to talk aloud as they were presented a block of stimulus presentations.

The subjects were first asked which phase they found to be the easiest. MA reported that the fixed phase was overall easiest throughout, but the sign phase was the easiest by the end, after she had mastered all of the signs. She reported that she had developed
strong intraverbal relationships by the time the fixed phase turned into the random phase. The scan requirement of the random phase made it harder, but it was mainly "more 'work,' not any harder to find the right symbol." ET also reported that the fixed phase was easier. She added that she did rely on the fixed location of the symbols (her errors were fewer in the random phase, however). GP reported that the sign phase was easier because it was "easier to associate body parts with the words." For example, during one round, the relation involved the word "Viba" corresponding to a sign that involved the fist. GP reported that she would covertly alter the word to "beat up" which then easily matched the fist. She indicated that it was easier to do this with the signs than with the symbols. This corresponds to her performance. She was the only college subject whose best performance was with the signs.

Next, the subjects were asked which phase they found the hardest. All three subjects reported that the same phase was the hardest. MA reported that she could not use her "intraverbal strategies" that were effective in the preceding phases. It took longer to come up with a strategy, and when she did it was not as effective. She relied more on repetition. ET stated that she could not come up with names for the symbols as she did with the previous phases. For example during the symbol phases "if the word 'Buba' went with the symbol that looked like a window then it was 'bye bye, out the window.' But during the same phase, 'Buba' was just Buba.'" She also reported that she had trouble with the signs that could not
easily be converted into words to describe them. GP reported that she could not use her strategy for the same phase because she could not easily name the symbols or make up stories about the relation between the symbols and the word. Her performance did not indicate much of a difference between the symbol phases and the same phase but she indicated that she had to work much harder and pay more attention during the same phase.

All subjects were asked if they had any problem distinguishing visually, one position from another on the board during the same phase. All subjects reported that the positions were clearly distinct from one another and that was not a problem. The problem was that they were unable to engage in effective verbal behavior with respect to relations between the symbols and the words.

All three subjects reported using similar strategies. As indicated above, the basic strategy for all subjects during the differentiated symbol phases and the sign phase was to create a name or action for the symbols and signs, and then alter the word to something more familiar that would more easily match the sign or symbol. All three also indicated that much of the variance in errors between rounds was a result of the extent to which they could come up with some good intraverbals. What follows are some examples of this process along with some selected comments from subjects.
Subjects reported that they had a name for most of the symbols and signs but some they did not. For these they could usually come up with a description of some sort depending on the word. For example, one symbol was an empty square. If the corresponding word was "Biba," then the word was converted to "Bebop" and the square was thought of as a dance floor. If the word was "Luba" then it was converted to "Love life" and the square represented "empty." The connection was then "my love life is empty." One symbol was a square with a line though it. If the word was "Quba" then it was converted to "Club" and the line was thought of as a stick. If the word was "Heba" then it was related to Israeli politics and the line represented a division. MA reported that she could typically come up with something immediately. Each nonsense word could be converted to a multitude of more meaningful words and each symbol could be converted to a multitude of real things. For example, the symbol with squiggly lines could be stairs, brain waves, a bad hair day, crooked teeth, etc. Between the numerous options of the symbol and the numerous options of the words, a match is highly probable. ET reported that for some relations she would simply change the word and put it with the prenamed symbol. For example, this was often done with the symbols that she called "Window" and "Stairs." If the corresponding word was "Biba" then the conversion was "there's a baby in the window" or "there's a baby on the stairs." If the word was Miba, then the conversion was "Maybe I'll look out the window" or Maybe I'll go up stairs." This subject had
a name for all symbols but the tacts for the symbols could be
changed if a better match presented itself. For example, the "Box"
symbol could be changed to "Empty" if a good intraverbal presented
itself. For example if "Gata" corresponded to the "Box", it may be
converted to "Gas tank is empty."

During the same phase, subjects reported simply repeating the
word over and over while looking at the location. MA reported that
sometimes she could use some intraverbals but that they were not
as reliable. For example, "Puba" might be converted to the "Corner
Bar" if the correct comparison was one of the corners.

Subjects reported that the signs were difficult at first because
they had to remember what they were along with the matching to the
word. Eventually, though, it was easy to come up with names and
descriptions of each sign.

Improvelement Over Rounds

The DD subjects did not tend to perform better within each
phase as a result of repeated exposure. That is, their performance
at the end of a phase was typically the same as at the beginning.
The college subjects, however generally decreased the number of
errors over the rounds. See Figures 6-13.

Elimination of Symbols

The DD subjects did not eliminate signs or symbols as they
proceeded though a set. The college students would never select a
Figure 6. Number of Errors per Round for Subject MJ.

Figure 7. Number of Errors per Round for Subject GP.
Figure 8. Number of Errors per Round for Subject MA.

Figure 9. Number of Errors per Round for Subject ET.
Figure 10. Number of Errors per Round for Subject JW.

Figure 11. Number of Errors per Round for Subject AS.
Errors (JI)

Figure 12. Number of Errors per Round for Subject JI.

Errors (TP)

Figure 13. Number of Errors per Round for Subject TP.

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symbol or emit a sign during a set of 12 presentations (all relations) that they had already selected. Also they would sometimes select the same symbol twice in a row if the first selection was wrong. Following would often be a statement such as "I knew it was one of those two." The post experiment interview revealed that often times they could keep track of what symbols had been correct (whether they selected them or the experimenter corrected their selection) and narrow down their choices on the remaining. The DD subjects would often pick the same symbol or make the same sign twice in a row even when the first one was correct. If the first one was correct (e.g., "Moe" goes with the square) then the next presentation can not be the same symbol because a different word or object would be used. Also during a round the subjects would often pick the same symbol consistently for two words or objects. For example, a subject may consistently select the window symbol when presented with "Bo" and select the window when presented with "Zig." Often the other relations would be correct. TP for example, might respond correctly on five of the six presentations during a set but the sixth would consistently be a repeat of a symbol already selected. In this example, the fact that the presentation of the word "Bo" evoked the selection of the window, the selection of the window was not suppressed by the presentation of the word "Zig." All DD subjects responded similarly in this fashion.
Rules\mediated Responses

It did not appear that the DD subjects were forming any rules or using mnemonics. Given their verbal repertoire it is doubtful that they were capable of forming rules and there was no evidence of any mediated responding.

The college subjects were clearly engaging in rule-governed behavior and making use of mediated responses. This was observed during the sessions and was clearly revealed in the post-experiment interviews.
DISCUSSION

All of the DD subjects performed significantly better during the sign phase than during the random symbol phase. This replicates the findings of all similar studies using subjects with developmental disabilities (in all of the earlier studies, the symbols were randomized in location rather than fixed). All college subjects showed no significant difference between the sign phase and the random symbol phase. These results are in general agreement with previous studies using normal adults.

The results of this study clearly indicate that the verbal ability of the subject is a critical variable to be considered in the analysis of various SB tasks and TB tasks. The findings of this study may also help explain the differing results obtained in previous studies, where results were mixed (Bristow & Fristoe, 1984; Cresson, 1994; Hodges & Schwethelm, 1984; Potter et al., 1997; Sundberg & Sundberg, 1990; Stratton, 1992; Tan et al., 1995; Wraikat, 1991; Wraikat et al., 1991). That is, these findings may explain why DD subjects perform better with the TB systems and why normal subjects typically show no difference between TB and SB systems.

The use of verbal behavior as a mediating response seems to be an important issue. Evidence for the role of verbal behavior in matching to sample tasks was provided by comparing the three symbol phases. There was a correlation between the verbal behavior
of the college students during the sessions, along with their post experimental post experimental interviews, and performance. There was no evidence for mediating verbal behavior emitted by the DD subjects and their relative performance varied significantly from the college students.

The results of the exit interview replicate the Potter et al., (1997) protocol analysis findings in which the exit interviews indicated that subjects were developing skills in generating TB responses to the sample and choice stimuli. Typical verbal statements consistently preceded selection of correct and incorrect choice stimuli. When less discriminable sample stimuli were used, Potter et al., (1997) found that the stimuli were not only harder to name, but that performance decreased as well.

Based on the subject's descriptions, their verbal behavior could be a form of coding. This code is then repeated as a self-echoic while scanning, until a comparison evokes a response that is under the joint control of the sample and the comparison. This analysis, with some modification, is analogous to Lowenkron's (e.g., 1988; 1991) notion of joint control.

Each subject reported that, after a few sessions, it became easy to generate a code that would fit both the sample and the correct comparison for most of the relations (about 7-9 out of 12). For example, when presented with the word "Heba" with the correct comparison being a symbol that looked like a maze, one subject coded the sample by saying, "He be hiding in the maze." She then selected the symbol that looked like the maze, presumable because it was the
only one that controlled the pointing response under the joint control of the self-echoic "He be hiding in the maze" and the codic response "maze" produced by the symbol. The comparison selected thus bore a constant relation to the sample after the transformational coding response.

With this strategy in place, the subjects did not perform differently when the symbols became randomized during the next phase, even though the subjects had to thoroughly scan the board until they came upon the correct comparison. This, again, was not the case for the subjects with developmental disabilities, who could master the relations when positions were fixed but not when they were random.

When the symbols were all the same, the performance of the college subjects deteriorated significantly. In this phase, the joint control that Lowenkron (1991) spoke of is lacking. When presented with a word such as "Biba," the subject simply repeats "Biba" as a self-echoic. When scanning the selections for the correct comparison, there is no comparison that will evoke a selection response that is both an echoic with respect to the sample and codic with respect to the comparison. Thus, the mediating response of simply repeating the word as a self-echoic was not as effective as the response topographies created to mediate the selection during the other phases with the distinct symbols. The following is a verbal behavior analysis of this coding response, taken from a sample of one of the subjects during the exit interview.
The experimenter says, "This is Biba," and points to the symbol that consists of a big cross inside a box. This symbol becomes an SD for the tact "Window" by the subject. The nonsense word "Biba" becomes an SD for the tact "Baby." The subject's transformations of these two nonverbal stimuli into familiar verbal stimuli, combine to create an SD for the intraverbal "There's a baby in the window." The experimenter's presentation of the sample stimulus ("Biba") under test conditions ("Which one is 'Biba'?") becomes an SD for the intraverbal "There's a baby in the window." This intraverbal is then repeated by the subject as a self echoic while scanning the selections until one of the comparison symbols matches the self echoic. This match evokes the pointing response.

The differential response emitted in the presence of the sample need not match the response emitted in the presence of the comparison. For example, "Baby" does not match "Window." But the key here seems to be the intraverbal that "connects" the sample tact with the comparison tact, "There's a baby in the window." This is a modification of Lowenkron's notion of joint control.

Two subjects, MA and ET, became especially adept at this quick transformation. These two subjects, who seemed to have the most consistent method of coding and transforming samples and comparisons, performed significantly better during the fixed and random phases, than the other subjects. They also had the most trouble with the same phase. See Figures 3 and 4.
It appears that the better the performance with the differentiated symbols, the more likely the disruption when the symbols are taken away. Furthermore, one could speculate that those with the most consistent methods of coding use the symbols more effectively as tools. Perhaps the subjects who did not emit the more sophisticated mediation response were not as affected when the symbols were taken away. The DD subjects, who probably did not emit any coding responses, did not appear to be able to use the distinct symbols as tools at all.

These results are consistent with the findings of Cresson (1994), who compared the performance of the top eight subjects with that of the bottom eight subjects. The task was to write the Katakana character which matched either a nonsense sound or the visual pattern (TB) or to select the correct Katakana character from an array when presented with the sample. Cresson (1994) found that those who made few errors did better with SB instruction, and those who made many errors did better with TB instruction.

The current results are reflective of the analysis suggested by Lowenkron (1991) and others (Dugdale & Lowe, 1990; Horne & Lowe, 1996; Lowenkron & Colvin, 1995) who have suggested that SB responding may consist of both TB and SB responding (e.g., Lowenkron's issue of joint control).
Is Verbal Mediation Necessary?

The data from this study and others (Sundberg and Sundberg 1990; Lowenkron, 1984, 1988) suggest two things. First, when a mediating response is taught or when the subjects are taught to accurately tact a sample, correct matching to sample and/or the formation of stimulus equivalence, which did not occur prior to training, occurs. Also, for low-verbal subjects, stimulus equivalence occurs more readily with those who are making the mediated response (e.g., Sundberg and Sundberg, 1990). Second, for the college subjects in the current study, it appears that response mediation, occurring on the covert level, facilitated matching to sample.

These results may support the notion that success in matching to sample, which leads to stimulus equivalence, is attributable in large part to subjects' naming and other verbal behavior (e.g., Dugdale & Lowe, 1990; Lowe, Horne, & Higson, 1987). It was clear that the mediated response was a factor in the differentiated symbol phases. The explanation of the phenomenon is greater than simply the S-S model. It is less clear as to how the subjects mastered the discriminations in the "same symbol" phase. It could be that the subjects' performance in this phase, as with the performance for the low verbal subjects in all phases, was primarily the result of stimulus-stimulus relations; while the performance of the normal subjects in the "different symbol" phases and sign phase was primarily the result of stimulus-response relations.
Response Mediation

Most cognitive psychologists are interested in what happens between an environmental stimulus and an overt response. They call it "cognition," and give it names like "information processing," "thinking," "strategizing," "mapping," "problem solving," "perceiving," etc. This, however, is verbal behavior, consisting of tacts, intraverbals, self echoics, and probably some mands and autoclitics, which apparently help (prompt) the verbal subjects select the correct comparison or emit the correct sign. This raises an interesting question of the possible role of these mediating events as an independent variable. The behavioral analysis of such events is that both the verbal mediation and the selecting or signing behaviors are a result of the contingencies of reinforcement (Shimoff, 1984). The analysis does not fully explain the difference in results between the SB phases with differing symbols and the SB phase with the same symbols. Why did the contingencies of reinforcement lead to the mediating responses in the differing symbol phases and not in the same symbol phases?

The alternative is to agree somewhat with the cognitive position and suggest that perhaps these mediating responses could be given some causal status. However, there is evidence that mediating responses, whether covert or overt, may be acting as independent variables, and there is no need to attribute these variables to cognitive constructs. Lowenkron (1984) states, "Identity need not be viewed
as a cognitive concept residing within the subject but rather by cues originating in the sample-coding response and the correct comparison stimulus" (p.18).

Repeated Acquisitions

The repeated acquisitions design appeared to solve the problems of pretraining differences and sequence effects. Perhaps the biggest advantage of the repeated acquisition design was in the comparison of the sign phase with the symbol phases. Since there were two components to the sign training (learning the signs and learning the discriminations) there were more errors in the earlier sessions. Once the signs were mastered, however, the signs proved to be easier for the DD subjects, and just as easy for the college subjects. Perhaps, had Stratton (1992) used a repeated acquisition design, he may have found that saying the Japanese words would have been as easy as selecting them.

Conclusions

In the current study, it is possible that, for the college subjects, the same phase represented a baseline and that the symbols and signs provided tools (increased opportunity for verbal behavior) to help improve performances in other phases. It is also possible that, for the DD subjects, the random phase represented a baseline and that when the symbols then were in a fixed position (fixed or same) a tool was provided. (this tool, however was the fixed location
cues). The college subjects also had this fixed location cue, and it was implemented because all of the subjects eventually mastered all of the relations during the same phase. These location cues were not as helpful as the symbol and sign cues, which apparently facilitated more effective verbal behavior. Since the DD subjects could not rely on sophisticated verbal behavior, they had only the location cues to rely on. If this is the case, symbol differentiation is of no value to a subject who is unable to tact the difference between symbols. This could explain why normal subjects in the previous studies performed the same or better with the SB tasks, and DD subjects performed better with the TB tasks.

One likely conclusion to be drawn is that there are different processes working for the fully verbal and low verbal subjects. If this is the case, perhaps we ought not experiment on fully verbal subjects and generalize the proposed processes to other populations. As Saunders (1989) expounds, "... one wonders how much information that is relevant to fundamental issues of symbolization...can be gained from studying verbally sophisticated subjects" (p.308).
Appendix A

Stimulus Materials
Signs for all college subjects.

slide right hand down left arm from elbow to hand
raise left arm and point
touch nose with right finger
open one palm forward
pet imaginary animal
put right fist into left palm
slap table with right hand
lift right elbow (90 degrees from body)
hook index and middle fingers of both hands to each other
tap underneath chin with right hand
circle index fingers of both hands around each other
cover mouth with right hand

Signs for DD subject JW.

pat head with right hand
touch nose with right finger

Signs for DD subject AS.

pat head with right hand
touch nose with right finger
open one palm forward

Signs for DD subject JI.

pat head with right hand
touch nose with right finger
slap table with right hand
lift right elbow (90 degrees from body)

Signs for DD subject TP.

pat head with right hand
touch nose with right finger
slap table with right hand
lift right elbow (90 degrees from body)
open one palm forward
put right fist into left palm
Original 8 words for college subjects.

po   sac
rook  bo
flo   mo
clo   zig

First word amendment for college subjects.

po   sac
rook  bo
flo   mo
clo   zig
hig   kip
joz   rup

Second word amendment for college subjects.

che   da
zoe   cha
dee   zoo
cho   do
zee   chu
za    doe

Third word amendment for college subjects.

je    cha
cho   ju
chu   ji
chee  jah
jay   jo
chay  chi

Fourth word amendment for college subjects.

bac   dac
mac   nac
nab   pab
rab   sab
neb   peb
queb  reb
**Final word list for college subjects.**

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**Word list for DD subject ET.**

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<td>flo</td>
<td>mo</td>
</tr>
<tr>
<td>clo</td>
<td>zig</td>
</tr>
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</table>

**Word list for DD subject JI.**

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<tr>
<td>blo</td>
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<td>pig</td>
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</tr>
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<td>dro</td>
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Example of symbol board used for college subjects (fixed or random).
Example of symbol board used for college subjects (same).
Symbol names used by the experimenter.

Corresponding to symbols from left to right, top to bottom.

<table>
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<tr>
<th>stairs</th>
<th>window square 3</th>
<th>vertical square</th>
<th>check</th>
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</thead>
<tbody>
<tr>
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<td>window vertical</td>
<td>window cross</td>
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</tr>
<tr>
<td></td>
<td>vertical maze</td>
<td>window quarter</td>
<td></td>
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<tr>
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<td>check I</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>check H</td>
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</table>
Example of symbol board used for DD subject JW.

Example of symbol board used for DD subject AS.
Example of symbol board used for DD subject JI.
Example of symbol board used for DD subject TP.
### Sample data sheet for college subjects.

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<th>MZ</th>
<th>WN</th>
<th>S3</th>
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- Sample data sheet for college subjects.

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Sample data sheet for DD subject JW.

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Sample data sheet for DD subject AS.
Sample data sheet for DD subject JI.

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21 errors

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9 errors

- = Correct
Letter indicates selection made
Sample data sheet for DD subject TP.
Appendix B

Interobserver Agreement
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<th>% in Agreement</th>
<th>% of Trials Recorded</th>
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</table>
Appendix C

Informed Consent
I have been invited to participate in a research project entitled "A Further Analysis of the Differences Between Topography-based Verbal behavior and Selection-based Verbal Behavior". I understand that this research is intended to examine the differences in acquiring language when a sign is required for a response compared to when a point to a symbol board is required for a response. The overall purpose of this study is to examine which method leads to better or new language acquisition. I further understand that this project is Carl Sundberg's dissertation project.

My consent to participate in this project indicates that I will be asked to attend four to five private sessions per week for approximately two to four weeks. Each session will last approximately .5 hours. These sessions will take place in the residents home. The sessions will consist of learning to match an object with a symbol or a manual sign. I understand that I will receive $5.00 per session for participation.

As in all research there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me except as otherwise specified in this consent form. I understand that one potential risk of my participation in this project is that I may experience some stress when I will be asked to respond to a question. This stress should not be as intense as when taking an exam because there are no negative consequences for poor performance. If I want to stop working during a session, I will simply have to tell the experimenter (Carl Sundberg) that I do not wish to continue.

One way in which I may benefit from this activity is by receiving .5 hours per day of one on one attention. Even though the relations learned during this study are non functional there will be much practice learning how to follow instructions and participate in programming tasks.

I understand that the subjects were selected in terms of a number of criteria, including motor capacity to make a sign or point, ability and willingness to imitate, the ability to follow instructions, and that they have no prior experience with sign language or symbolic communication.

Willingness to imitate and follow instructions means that the subject will voluntarily come to the experimental area and participate in the study without repeated prompting. Subjects must also be capable of
expressing consent or refusal. Subjects will be asked if they want to participate and will respond with a yes\no or a head shake. Only subjects who are capable of sincere communication regarding consent and refusal were selected. The Home Operator will witness the interaction when a subject is asked to participate.

I understand that all information collected from my participation in this study is confidential. This means that my name will not appear on any papers on which this information is recorded. If the results of this study prove to be significant enough for publication the names of the subjects will be changed to protect confidentiality.

The only risk to the participants is the possible stress resulting from being asked to respond to a question. This stress should not be very intense, however, since there are no negative consequences for poor performance. All participants can stop a session for any reason at any time.

To prevent excess stress and to insure the subjects that they need not continue, they will be asked for consent at the beginning of each session. Also, during each session the subject will be asked every five minutes, if s\he wishes to continue. If the subject shows any signs of agitation, boredom, or slowness of responding s\he will be asked if s\he wishes to continue regardless of the time since that last inquiry.

All data will be kept in a file only to be reviewed by the principal and co-principal investigators. Participants will not have knowledge of other participants performance. Furthermore, real names will not be used in any documentation.

I understand that I may refuse to participate or quit at any time during the study without prejudice or penalty. If I have any question or concerns about this study I may contact either Carl Sundberg 372-6445 or Jack Michael 378-8325. I may also contact the chair of the Human Subjects Institutional Review Board at 387-8293 or the Vice President for Research at 387-8298 with any concerns that I have. My signature below indicates that I understand the purpose and requirement of the study and that I agree to participate.

Signature  Date

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Western Michigan University
Department of Psychology
Principal Investigator: Dr. Jack Michael
Co-Principal Investigator: Carl Sundberg
Informed Consent for Adult Subjects

I have been invited to participate in a research project entitled "A Further Analysis of the Differences Between Topography-based Verbal behavior and Selection-based Verbal Behavior". I understand that this research is intended to examine the differences in acquiring language when a sign is required for a response compared to when a point to a symbol board is required for a response. The overall purpose of this study is to examine which method leads to better or new language acquisition. I further understand that this project is Carl Sundberg's dissertation project.

My consent to participate in this project indicates that I will be asked to attend four to five private sessions per week for approximately two to four weeks. Each session will last approximately .5 hours. These sessions will take place in an office building in West Hall at Western Michigan University. The sessions will consist of learning to match an object with a symbol or a manual sign. I understand that I will receive $5.00 per session for participation.

As in all research there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me except as otherwise specified in this consent form. I understand that one potential risk of my participation in this project is that I may experience some stress when I will be asked to respond to a question. This stress should not be as intense as when taking an exam because there are no negative consequences for poor performance. If I want to stop working during a session, I will simply have to tell the experimenter (Carl Sundberg) that I do not wish to continue.

One way in which I may benefit from this activity is by having the chance to experience and talk about how psychologist study language. I also understand that others who study language may benefit from the knowledge gained from this research. In addition I will gain some insight into the dissertation process which Carl Sundberg is in the process of completing.

I understand that all information collected from my participation in this study is confidential. This means that my name will not appear on any papers on which this information is recorded. If the results of this study prove to be significant enough for publication the names of the subjects will be changed to protect confidentiality.

I understand that I may refuse to participate or quit at any time during the study without prejudice or penalty. If I have any question or concerns about this study I may contact either Carl
Sundberg 372-6445 or Jack Michael 378-8325. I may also contact the chair of the Human Subjects Institutional Review Board at 387-8293 or the Vice President for Research at 387-8298 with any concerns that I have. My signature below indicates that I understand the purpose and requirement of the study and that I agree to participate.

Signature    Date
Appendix D

Human Subjects Approval Forms
Date: April 15, 1996

To: Jack Michael, Psychology
    Carl Sundberg, Psychology

From: Richard Wright, Chair

Re: HSIRB Project Number 96-02-05

This letter will serve as confirmation that your research project entitled "A further analysis of the differences between topography-based verbal behavior and selection-based behavior" has been approved under the full board category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: April 15, 1997

Human Subjects Institutional Review Form.
March 20, 1996

Mr. Carl Sundberg
1915 Meadowview
Kalamazoo, MI 49008

Dear Carl:

This letter is to inform you that your research proposal has been accepted/approved by the ROI Research Review Committee. This approval is based upon your letter of March 1, 1996 which responded to questions of the Committee. At this point the Committee supports your research proposal, A Further Analysis of the Differences Between Topography-based Verbal Behavior and Selection-based Verbal Behavior, and you are approved to use individuals served by ROI as subjects for this research.

Good luck with the research. I hope you are able to obtain meaningful results.

Please contact me if you need further assistance or have any other questions.

Sincerely,

Scott Schrum
Executive Director
BIBLIOGRAPHY


