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Ease of Learning and the Emergence of Equivalence Class Formation: A Comparison of Topography-Based and Selection-Based Paradigms

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EASE OF LEARNING AND THE EMERGENCE OF EQUIVALENCE CLASS FORMATION: A COMPARISON OF TOPOGRAPHY-BASED AND SELECTION-BASED PARADIGMS

by

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CHAPTER I

INTRODUCTION

In the last decade the area of augmentative methods of communication within the field of speech pathology has witnessed increased attention (Mirenda, 1985; Sundberg & Sundberg, 1990). A number of articles have been published in related journals (e.g., *Augmentative and Alternative Communication*) describing the various types of communication systems (e.g., Musselwhite & St. Louis, 1982); specifying proper guidelines for selecting systems for individual users (e.g., Alpert, 1980; Shane & Bashir, 1980) and describing communication processes involved in utilizing various augmentation systems (Beukelman & Yorkston, 1982; Harris, 1982). As a result, speech pathologists and some school districts have become more aware of the possibility of nonvocal developmentally disabled individuals acquiring a substantial verbal repertoire utilizing other response forms than the vocal one. Specialists in the various alternative response forms (e.g., sign language, symbol boards, voice synthesizer, and computers) are now becoming more common and different agencies that host language deficient individuals have started to put more demands upon these specialists, especially with respect to the appropriateness of each augmentative system for individual users. The preferred systems at present are the selection-based type, for example symbol boards (selection-based versus topography-based language systems are distinguished in some detail below). However, this has not proven to be the system of choice for all individuals (e.g, Aiello, 1980; Schuler, 1979).

The present study is a further investigation of the differences between the most frequently employed augmentative communication systems, the selection-based symbol

board, and topography-based sign language. This research is based on a behavioral analysis of language as learned behavior, as proposed by Skinner (1957) and more specifically by Michael (1985). A brief description of Skinner's definition of verbal behavior and Michael's classification of Skinner's verbal relationships will be provided first. Next is a presentation of Michael's (1985) classification of language acquisition systems as topography-based versus stimulus-selection-based as well as the empirical research related to this distinction. The remainder of this chapter will briefly examine selected literature on the formation of equivalence classes in humans and conclude with the research questions of this study.

Skinner's Approach to Verbal Behavior

Definition

Skinner used *verbal behavior* to denote "behavior which is effective only through the mediation of other persons" (Skinner, 1957, p. 2). He selected this term to distinguish his functional approach from the traditional structural approach. He identified the functional unit of verbal behavior as consisting of four elements: (1) prior stimulus conditions, (2) establishing operations[1] (deprivation and aversive stimulation), (3) behavior, and (4) consequences.

From a behavioral perspective the definition of language must include the four-term contingency (establishing operation, prior stimulus, response and consequence). For example, a complete account of an individual's saying *coffee* should include a

[1]*Establishing operation* is not a term that was used by Skinner. It was first used by Keller and Schoenfeld (1950) to refer to variables that were responsible for *drives*, which in turn altered the reinforcing effectiveness of other events or stimuli, and also altered the momentary frequency of behavior that had been reinforced by those events or stimuli. The term was reintroduced by Michael (1982a) to refer to the variables responsible for alterations in the reinforcing effectiveness of various events or stimuli, and for alterations in the momentary frequency of behavior that had been reinforced by those events or stimuli, without any reference to drives.

description of the stimuli and/or the establishing operations that preceded the response and the consequences that followed it. The functional verbal unit is similar to nonverbal units except in the way that the last component of the four-term contingency, the consequence, is delivered. For verbal behavior the reinforcement is indirect, that is it is mediated through the behavior of a trained listener. For example, a person can walk to the kitchen and drink a cup of water, which is directly reinforced by water. Or, she may emit the verbal response *water* in the presence of an appropriately trained listener and also be reinforced by water. It is this mediated reinforcement that distinguishes verbal from nonverbal behavior. Some behavior analysts (e.g., Catania, 1986; Sidman, Rauzin, Lazar & Cunningham, 1982) have recently attempted to define the domain of verbal behavior in such a way as to relate the definition to the topic of stimulus equivalence.

Skinner's view of verbal behavior as behavior controlled by discriminative stimuli, establishing operations, and consequences, is substantially different from the traditional treatments of language. These approaches view verbal behavior as inherited and/or controlled by hypothetical cognitive processes which themselves need explanation. Skinner provides a new working approach to the verbal problems of many people including the developmentally disabled. The next section of this chapter is a brief description of Skinner's elementary verbal relations.

Basic Verbal Relations

One of the contributions of Skinner's (1957) *Verbal Behavior* is a classification system that allows for the identification of functionally different types of verbal behavior. This classification according to Peterson (1978) relies on three factors: the type of controlling variables (i.e., verbal stimulus, nonverbal stimulus, or establishing

operation); the musculature involved in the behavior; and finally, the nature of the controlling relationship (point-to-point correspondence, formal similarity or neither). Point-to-point correspondence "is a relationship where subdivisions or parts of the stimulus control subdivisions or parts of the response (or response product) but the relation need not be physical resemblance" (Michael, 1982b, p. 2). For example, when we say *vegetable* as result of seeing the written word *tomato* there is no point-to-point correspondence because no part of the stimulus controls any part of the response. However, when someone says *vegetable* as a result of seeing the written word *vegetable*, there is point-to-point correspondence in that the *ve* part of the stimulus controls the *ve* part of the response and the *ge* part of the stimulus controls the *ge* part of the response, and so on. Formal similarity is a relationship in which "the controlling stimulus and the response product are (1) in the same sense mode (both are visual, auditory, tactile), and (2) resemble each other in the physical sense of resemblance" (Michael, 1982b, p. 2). For example, when an individual says *dog*, as a result of hearing someone else saying *dog* there is formal similarity in that both the stimulus *dog* and the response product of saying *dog* are auditory stimuli and resemble each other.

Skinner (1957) identified seven types of relations between controlling variables and verbal responses (mand, tact, echoic, textual, intraverbal, taking dictation and copying a text). Michael (1982b) reorganized Skinner's verbal relations into five general categories, some of which have subcategories. According to Michael (1982b) these additions do not identify new or previously overlooked relations, but simply result in useful category names for all elementary forms and thus prevent potentially confusing extensions. For example, he refers to Braille reading as a form of codic behavior, or sign imitation as a form of duplic behavior. Following is a brief description of the five categories as arranged by Michael (1982b).

Mand

Skinner (1957) defines 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 specified relation to a prior stimulus" (pp. 35-36). Michael (1982a, 1987, 1988) maintains that Skinner's definition of the mand, in terms of deprivation and aversive stimulation, is not broad enough to include all the variables that control the mand. As described above, Michael has termed these motivational variables *establishing operations* (EOs), and has identified two types, unconditioned establishing operations (UEOs), and conditioned establishing operations (CEOs).[2] Applying the concept of the establishing operation to the analysis of verbal behavior 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" (Michael, 1988, p. 7).

Tact

Skinner (1957) proposed the term *tact* for the type of verbal relationship where the form of the response (e.g., what is said or signed) is controlled by a prior non-verbal stimulus. He defines tact as "a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event or property of an object or event" (Skinner, 1957, pp. 81-82). There are numerous nonverbal stimuli in the environment and these can affect any one of the different sensory systems. The common nonverbal stimuli are objects (*car, book, TV*), actions (*talk, run, go*),

[2]A detailed treatment of different kinds of conditioned establishing operations (CEOs) can be found in Michael, 1988.

properties of objects and actions (*sweet, red, fast, hot*), and relationships (*above, beneath, large, open*). Visual stimuli probably are the most common controlling stimuli for the tact but any nonverbal stimulus can function as a part of the tact relation. Saying *Sarah* when hearing Sarah talking even though she is not seen is a tact. To say *coffee* as a result of smelling coffee is a tact, as well as saying *coffee* upon seeing it.

Intraverbal

According to Skinner (1957), the intraverbal is a type of verbal relation where the form of the response (what is said or signed) is controlled primarily by an immediately prior verbal stimulus, and it is a stimulus that lacks point-to-point correspondence with the response. The consequences that shape and maintain the intraverbal relation usually consist of some form of generalized conditioned reinforcement (social approval, educational reinforcement), but the intraverbal is eventually related to its facilitative effect on the speaker's own verbal behavior as well as the actions of the listener (Sundberg, 1980). An example of the intraverbal would be the tendency to say *congress* when someone mentions *government*. This type of verbal relationship plays an important role in normal language development. For example, it is important that verbal responses such as *red, blue, green, yellow*, etc. be readily available in a child's repertoire when asked about colors. In a child's early educational (preschool) training a considerable amount of intraverbal behavior is developed in this manner. For example, the child is taught such skills as saying the alphabet, counting, singing songs, and playing word games. In later aspects of education intraverbal relations become important as definitions of terms, classification systems, historical information, scientific information, etc. (Sundberg, 1987). In a selection-based language system--described below--pointing at a verbal symbol as a result of seeing a

different symbol is intraverbal behavior, as is pointing at a verbal symbol as a result of hearing someone give the English word for the same nonverbal stimulus relevant to that symbol.

Codic Behavior

Codic behavior is defined by Michael (1982b) as a type of behavior in which

> the response form is controlled by 1) a verbal stimulus, 2) with which it has point-to-point correspondence, but 3) where there is no formal similarity between stimulus and response product. *Formal similarity* is Skinner's term for the case where the controlling stimulus and the response product are 1) in the same sense mode (both are visual, or both are auditory, or both are tactile, etc.) and 2) resemble each other in the physical sense of resemblance (p. 2).

The consequences for codic behavior are usually some kind of generalized conditioned reinforcement, as with the tact and the intraverbal relation. Michael (1982b) classified as codic behavior two of Skinner's relations, textual behavior and taking dictation, both of which have point-to-point correspondence with the response, but no formal similarity between stimulus and response product. In textual behavior the stimulus is visual (written or printed words) and the response consists of speaking (without the implication that the reader necessarily understands what is being read). In taking dictation the stimulus is auditory and the response is of writing what is heard.

Duplic Behavior

Michael (1982b) introduced the term *duplic* to identify verbal relations which meet the following criteria: (a) the response form is controlled by a verbal stimulus, and (b) the response product has formal similarity with the controlling stimulus. There are several types of duplic behavior. For example, Skinner's *echoic* behavior where the sense mode is auditory and the response is vocal. If the sense mode is visual (the result of someone else making a sign) and the response is signing, the relation is termed

mimetic, and if the sense mode is visual and the response consists of writing, the relation is called *copying a text* (Michael, 1982b), or *identigraphic* (Vargas, 1986).

To summarize, what has been described so far are the elementary verbal relations (shown as Figure 1 below). These elements can constitute a large part of an individual's repertoire. Verbal behavior becomes more complicated when it comes to be controlled by private stimuli, or by more than one variable at the same time. Further complexity results from the development of secondary verbal behavior which is controlled by other aspects of ongoing verbal behavior by the same speaker (Sundberg, 1980). Skinner (1957) termed these relations *autoclitic* behavior. Such behavior involves the self-manipulation of verbal behavior and its controlling variables.

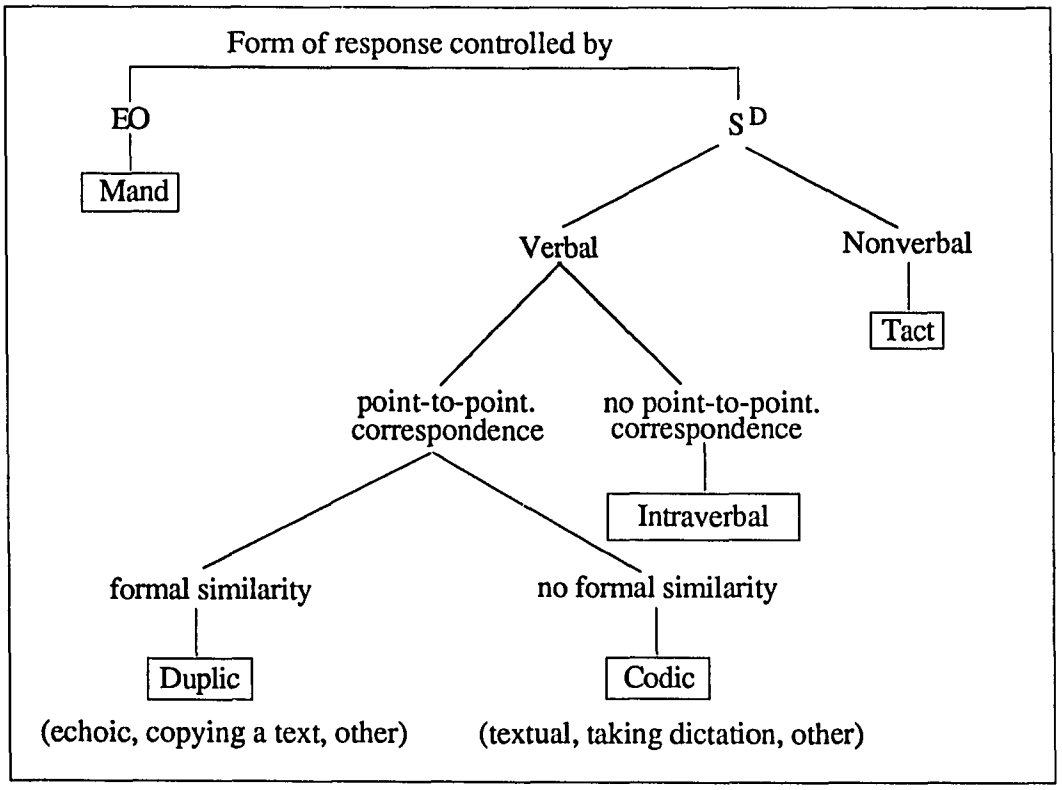


Figure 1. Michael's Classification of Skinner's Verbal Relationships.

Topography-Based and Selection-Based Verbal Behavior

The Basic Distinction

Independent of whether an instance of a verbal behavior is categorized as one of the elementary verbal operants (e.g., tact, mand, intraverbal, etc.), it can be further classified in terms of the nature of the unit of behavior. In topography-based verbal behavior the unit consists of "an increased strength of a distinguishable topography given some specific controlling variable" (Michael, 1985, p. 1). For example, in the case of the tact, the vocal response *refrigerator* in the presence of a refrigerator or *telephone* in the presence of a telephone are examples of topography-based verbal behavior. Saying *refrigerator* differs from saying *telephone* in terms of the movements of the relevant vocal musculature, that is in terms of response topography. Signing (as in the sign language of the deaf) is similar in that the different signs consist of different response topographies (hand and arm movements). Writing is also a topography-based form of language.

In addition to being the main forms of human communication, topography-based verbal behavior has been used in various ape language projects interested in the development of signing repertoires (e.g., Gardner and Gardner, 1969; Patterson & Linden, 1981; Terrace, 1979) and also by Pepperberg (1981) in training an African Grey parrot to make vocal tacts.

In stimulus-selection-based verbal behavior (or simply *selection-based*), "the unit of verbal behavior can be described as an increased control of a pointing response by a particular stimulus as a result of the presence of a different stimulus (or the strength of a particular establishing operation)" (Michael, 1985, p.1). To continue with the previous example, in a selection-based system of verbal behavior, one tacts a

telephone and a refrigerator by pointing to a corresponding symbol (e.g., on a communication board) in the presence of the appropriate object; but the pointing topography is approximately the same irrespective of which symbol is pointed at. Thus, the different tacts in a selection-based system are not distinctive with regard to the topographies of the responses involved, because essentially the same form of response is common to all tact relations in the repertoire. This is not the case with topography-based verbal behavior where the topography of the response is a distinguishing part of the verbal relation.

Rumbaugh's (1977) work on teaching language to a chimpanzee (Lana project) provides a good example of selection-based verbal behavior. Rumbaugh used a graphic system in which abstract symbols were embossed on a large type of computer key. When Lana (the chimpanzee) keyed a sequence of symbols on her keyboard, the same symbols were displayed on a screen that the experimenter could see. Replies from the experimenter were displayed on the chimpanzee's screen. The Blissymbolics system (Bliss, 1965), or one of its more recent forms using iconic pictures (Hurlbut, Iwata, & Green, 1982) commonly used with some nonvocal humans, is another example of selection-based verbal behavior.

Important Differences

Because both selection-based and topography-based verbal behavior result in distinguishable stimuli, they do not differ much from the listener's perspective. Michael (1985) suggests, however, that there are a number of differences between the two kinds of verbal behavior from the perspective of the person providing these stimuli (the speaker, signer, pointer, etc.), and that these differences may be quite important

when verbal behavior is being taught to individuals with seriously deficient verbal repertoires.

In the first place, selection-based verbal behavior consists of a conditional discrimination, one involving two discriminative stimuli, whereas topography-based verbal behavior involves only one (Michael, 1985). In a selection-based tact, for example, the nonverbal discriminative stimulus consisting of a cup alters the controlling strength of a verbal discriminative stimulus, the symbol for the cup, over a non-distinctive pointing or indicating response . In the topography-based system consisting of vocal behavior or speaking, the cup directly controls the vocal response *cup*.

Another difference is that selection-based behavior involves two response components as opposed to the single component in topography-based behavior (Michael, 1985). In a selection-based system, the person who points at the verbal stimulus must first scan the options, then point to the appropriate one. Normal adults usually develop a good scanning repertoire, but it may take special training to develop effective scanning with those who lack this repertoire (Sundberg & Sundberg, 1990). Mirenda (1985), for example, noted that students with severe handicaps usually have difficulty scanning an array of pictures that are too broad (i.e., more than one picture on a page) and some may exhibit very fleeting visual fixation and/or attention skills. Yet other individuals often have difficulty (require more training time) in picture/background discrimination. If the various visual stimuli are not all presented at the same time, the speaker must *remember* which ones were previously seen, and this constitutes an additional complexity. If the scanning takes a long time (e.g., too many pictures on the communication board, or too many pages to shuffle through), the effectiveness of the original controlling variable may become too weak to evoke the correct response (Sundberg & Sundberg, 1990).

Michael (1985) also points out that topography-based language systems, in contrast to selection-based ones, always involve point-to-point correspondence between the response form and the response product.

> When one speaks there is 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).

Some additional practical limitations of selection-based systems have been noted by Sundberg (1987). One is the necessity of depending on auxiliary equipment. It is not always possible to have a picture board or a computer synthesizer by your side. As pointed out by Trefler and Crislip (1985), this type of equipment requires frequent maintenance, is costly, and there are environments in which the client would not have access to such equipment. An important practical feature of speech (Skinner, 1974) is that it does not require any form of environmental support, and the same could be said about signing.

Current Language Training

Despite the previously mentioned conceptual and practical disadvantages of stimulus-selection-based language systems, the current trend in the field of speech pathology when vocal behavior does not seem possible is to favor a pointing system over sign-language (Sundberg & Sundberg, 1990). The reasons are many (Moores, 1978; Sundberg & Fuqua, 1980) but probably the main difficulty with signs is that parents, care givers, and staff must learn some sign language to participate in the communication program. A selection-based system does not require any special training on the part of the listener (or more appropriately the *viewer*). Most programs

have the English word printed beneath each symbol or picture and the synthesized sound of the word is emitted in the case of a computer augmentative system. Furthermore, sign-language requires teaching relatively complex motor skills, whereas the pointing response is often already strong in many client's repertoires, or if not can be taught more easily than the several different sign responses (Sundberg & Sundberg, 1990).

What is ordinarily referred to as receptive language training is a third type of verbal relation. Here the subject is presented with a set of objects or pictures of objects and asked to point to a particular item in the set. For example, a trainer may present a set consisting of a comb, doll, spoon, and nickel, and say "show me the nickel." The subject's correct pointing response is jointly controlled by the auditory verbal stimulus produced by the trainer's saying "nickel" and the nonverbal stimulus consisting of the nickel. Michael (1985) labeled this type of relation *mand compliance with respect to a stimulus* or just *mand compliance*, and pointed out that it is a sort of mirror image of the selection-based tact relation. In the latter, the subject would be shown a single object (for example a nickel) and asked to point to the verbal symbol for that object among the set of symbols for the comb, doll, spoon and nickel. The two relations are similar in that both involve a conditional discrimination (joint control by a nonverbal and a verbal stimulus), and both require an effective scanning repertoire.

The mand-compliance procedure is even more popular in work with the developmentally disabled population than selection-based tact training. This is probably because according to traditional theories, language acquisition consists of the subject's learning the meanings of words which would seem to be accomplished by this training; and because, as Michael (1985) noted, it requires only a pointing response by the subject, rather than the shaping of vocal responses or of the arm and hand

topographies used in signing. There is no question that mand compliance with respect to a stimulus is an important part of a listener's repertoire, and the transfer of such training to selection-based tacting may well occur rather easily, but there is considerable evidence that such training does not result in topography-based verbal repertoires (Guess, 1969; Lee, 1981).

Speech pathologists and psycholinguists usually treat topography-based verbal behavior, selection-based verbal behavior, and mand compliance as equivalent forms of the same underlying language processes (Michael, 1985; Sundberg & Sundberg, 1990). Therefore, it is not surprising that the differences between the behavior of the listener and the behavior of the speaker are minimized.

In summary, there are possibly important conceptual differences between topography-based and selection-based behavior, including the additional conditionality of selection-based behavior, its lack of point-to-point correspondence to the response product, and its partial dependence on an effective scanning repertoire (Michael, 1985). These differences when added to the practical limitations mentioned by Sundberg (1987), would suggest that selection-based verbal behavior should be harder to acquire, less likely to be controlled effectively by motivational variables, and more vulnerable to interference than topography-based verbal behavior.

Previous Studies

To date only two studies have directly compared selection-based and topography-based verbal behavior with respect to ease of acquisition. Sundberg and Sundberg (1990) taught four developmentally disabled adults to name objects (the tact relation) by either pointing to the corresponding symbols (the selection-based procedure) or by making an appropriate sign-language response (the topography-based

procedure). They were also taught either to select the appropriate symbol (selection-based) or to make the appropriate sign (topography-based) when the experimenter stated the name of the object (an intraverbal relation). For three of the four subjects, acquisition of the selection-based relations were more difficult (more trials to criterion). The other subject was sufficiently high functioning that both kinds of relations were so rapidly acquired that no comparison between them could be made.

In a systematic replication of Sundberg and Sundberg, Wraikat (1991) used a very similar procedure and obtained similar results. Three of the five subjects demonstrated faster acquisition for most of the relations when they were trained with the topography-based procedure. The remaining two performed equally well with both procedures.

Stimulus Class Formation and Class Expansion

The establishment of stimulus class formation has recently become the focus of much behavior analytic research (e.g., Haring, Breen, & Laitinen, 1989; Saunders, Wachter, & Spradlin, 1988). A stimulus class can be defined as a generic class of interchangeable stimulus events that are related to a common response (Skinner, 1935). More specifically, the concept of stimulus class membership is appropriate when a variable applied to one class member affects other members without explicit conditioning (e.g., Silverman, Anderson, Marshall & Baer, 1986). There are several bases for substitutability or interchangeablity of stimuli. One is simple physical similarity, or generalization of stimulus control across common stimulus features. Stimuli can also become substitutable if they occasion an equivalent functional effect or control a common response topography (Haring et al., 1989). It has also been shown

that stimulus classes can be extended via stimulus-reinforcer relations (Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989).

The Stimulus Equivalence Training Procedure

The recent trend of research in stimulus class formation has focused on stimulus-stimulus relations involving conditional discriminations in the matching-to-sample procedure (e.g., Sidman, 1971; Sidman, Cresson, & Willson-Morris, 1974; Sidman & Tailby, 1982). In these procedures, called stimulus equivalence training, the subjects are first probed to show that two sets of stimuli (for example, let the letters *d*, *r*, and *y* be the members of one set, and the numbers 1, 2, and 3 the members of the other set) bear no particular relation to one another. In other words, when shown the letter *d* there is no greater tendency to choose one of the three numerals over the others, and so on. Next, in reinforced training phases, subjects are taught to choose particular letters and particular numerals when shown particular members of a third set, for example, the abstract shapes consisting of a square, an asterisk, and a pound sign. The task would thus consist of learning to choose the letter *d* out of the three letters when shown the square; the letter *r* when shown the asterisk; and the letter *y* when shown the pound sign. In a separate but similar training phase the subjects learn to choose the numerals 1, 2, and 3 when shown the square, asterisk and pound sign, respectively. Finally, in an unreinforced test phase, they may choose the letters *d*, *r*, and *y* when shown, respectively, the numerals 1, 2, and 3, and vice versa, even though they have never been reinforced for making these choices. If this happens a new form of stimulus class relation has emerged. The relation is widely referred to as *stimulus equivalence*, although this term is now defined in a more restrictive way (Hayes, 1989; O'Mara, 1991).

Stimulus Equivalence and Language

Equivalence class formation may play a fundamental role in language acquisition and competence. It enables words to mediate new, emergent behaviors that have never been taught directly (Sidman, 1977). For example, if a child is taught to label cars, trucks, and buses as "vehicles" and then taught that cars and trucks require gas to run, he may, without further training, correctly say that buses also require gas to run. He may also conclude that if cars and trucks have tires, buses also have tires and so on. If a child or a developmentally disabled individual can't make such derived relations, prerequisite skills, as discussed by Sidman (1977), may be needed in order to enable these individuals to benefit from the formation of stimulus classes (Sundberg, 1990). A number of authors have suggested that further study of the stimulus equivalence phenomenon may well contribute to a sound functional analysis of various complex language phenomena (e.g., Fields, Verhave, & Fath, 1984; Sidman, 1986; Wulfert & Hayes, 1988).

Sidman (1977) proposed that the formation of equivalence classes works as a mediated variable in the development of reading skills. He demonstrated (Sidman, 1971) that certain learned visual-auditory equivalences were sufficient prerequisites for the emergence of reading comprehension, even without teaching comprehension directly. In that study he separately taught a subject to match visual pictures and printed picture names to their auditory names. It was then found that the subject, without further training, could match the visual pictures to their corresponding printed names and vice versa, which was considered a demonstration of a form of reading comprehension.

Equivalence Relations in Nonhumans

In the 20 years since Sidman first demonstrated stimulus equivalency, the formation of equivalence classes has been shown in a variety of human populations. It has been demonstrated readily in normal children (Lazar, Davis-Lang, & Sanchez, 1984; Sidman & Tailby, 1982). It was demonstrated in retarded children and adolescents (Sidman et al., 1974; Spradlin, Cotter, & Baxley, 1973), and normal adults (Lazar, 1977; Wulfert & Hayes, 1988). However, until 1987, stimulus equivalency had not been demonstrated with nonhuman organisms. Unsuccessful attempts had been reported with pigeons (D'Amato, Salmon, Loukas, & Tomie, 1985; Lipkens, Kop, & Matthijs, 1988) and monkeys, baboons, and other primates (D'Amato et al., 1985; Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982).

The unsuccessful attempts to demonstrate stimulus equivalence in nonhumans, as well as all of the successful demonstrations with humans, used some variation of the matching-to-sample procedure. Vaughan (1988), using a quite different procedure, was able to demonstrate what he described as a form of stimulus equivalence in pigeons. He divided a set of slides of various scenes into two sets randomly. One set was arbitrarily labeled as positive discriminative stimuli and the other as negative discriminative stimuli. He then reinforced the pigeons for pecking a disk when the positive stimuli were present and not when the negative stimuli were present. When they had acquired this performance to a high degree of accuracy he then reversed the relation between the two sets and reinforcement, with the positive stimuli becoming negative and vice versa. After performance stabilized, he reversed the sets again, and so on several times. Eventually, when the conditions were reversed, exposure to only a few slides in one set led to appropriate performance with all the remaining set

members. Although this performance by the birds would seem to be a form of equivalence, because of the uniqueness of his procedure Vaughan's results are still considered controversial with respect to the issue of nonhuman equivalence.

The Possible Relevance of Response Topography

McIntire, Cleary and Thompson (1987) proposed that humans can readily engage in behavior with a characteristic topography in the presence of stimuli in a matching-to-sample task (i.e., make distinctive vocal responses consisting of saying the names of the stimuli). Thus, "it is possible that the discriminated emission of differential response topographies is itself of functional significance in the establishment of stimulus equivalence" (McIntire et al., 1987, p. 280). These researchers devised an experimental procedure that tested this hypothesis with nonhumans. Monkeys were trained to press and hold a response key for 3.5 sec when any one of three different colors (red, yellow, or blue) appeared on the key; and to press and release the key eight times when any one of three other colors (orange, green or violet) appeared on the key. These topographically different responses were considered analogous to a person's applying the same name to three stimuli that differed from each other, and a different name to three other stimuli. For explanatory purposes McIntire et al. (1987) termed one set of colors odd and labeled the stimulus elements 1, 3, and 5; and the other set even and labeled them 2, 4, and 6. In the next phase of the experiment, involving a three-key matching-to-sample procedure, when an odd color appeared on the sample key the animals had to press the comparison key that had an odd rather than an even color, and similarly with the even colors. In each case the animal was required to emit the appropriate response topography to the sample and the same response again to the appropriate comparison. For example, when the sample

was illuminated with color 1, the correct response consisted of pressing and holding the sample key, which then caused illumination of the two comparison keys, one with color 3 and the other with color 4. Reinforcement was provided when the animal then pressed and held the comparison key illuminated with color 3, the odd color, rather than color 4, an even color. Six combinations of 2 colors (3 combinations from the odd set and 3 from the even set) were trained directly. Testing trials consisted of 10 different color combinations that had not been trained directly. For example, in the presence of color 1 as sample, they were trained to pick 3 rather than 4, and 1 rather than 2. In the presence of color 3 as sample they were trained to pick 5 rather than 6. In all cases, the subject had to respond with the appropriate distinctive topography on the sample key and then on the correct comparison key. Without further training, they were then found to behave appropriately when the sample was color 1 and the comparisons were 5 and 6, even though this combination of sample and comparisons had not been seen before. The conditional relations that emerged between set combinations were characterized as a demonstration of stimulus equivalence. The procedures were considered as an analogue to the human use of category names.

The McIntire et al. (1987) study demonstrated that the formation of equivalence classes may be facilitated by the use of topographically distinct *naming* responses. The role of verbal behavior in the development of equivalent class formation was further demonstrated in a recent study with humans by Barnes, McCullagh, and Keenan (1990). In this study the relationship between level of verbal functioning and the capacity to form equivalence classes was examined. In a typical stimulus equivalence training procedure six children differing in their chronological age and verbal ability were divided into three groups (two for each group) based on their verbal age (measured by Reynal Developmental Language Scale combined with their IQ scores) as

follows: (1) normally developing preschoolers (chronological ages 4,7 and 3,4 and verbal ages 4-5 and 3-4); (2) normally developing but severely to profoundly deaf children (chronological ages 8,1 and 7,11 and verbal ages 2-2.5 and 2-2.5); and (3) normally developing but severely to profoundly deaf children (chronological ages 4,10 and 5,10 and verbal ages 1.5-2 and 1-1.5). The subjects were taught a series of four conditional discriminations utilizing unfamiliar stimuli. An unreinforced test for the formation of equivalence classes showed that, while all children were able to learn the conditional discriminations equally well, all of the verbally able subjects, groups 1 (normal) and 2 (partially hearing) did form equivalence classes, but only one of the verbally impaired children demonstrated stimulus equivalency. The results are interpreted to demonstrate that stimulus equivalency and verbal behavior are highly correlated.

Type of Verbal Relation and Stimulus Equivalence

As was previously mentioned, the ability to form equivalence classes may play an important role in language development, and as is shown by the literature considered immediately above, verbal behavior (i.e., tacting) may play an important role in the development of stimulus class formation. It is thus of considerable importance to determine whether there is any relation between equivalence class formation and whether a learner's verbal relationships are topography or selection based. Such a relation would clearly have implications for programs concerned with teaching language to language-deficient individuals. Addressing this specific question was the main purpose of the previously mentioned Sundberg and Sundberg (1990) study, although the generally inadequate performance of some of the subjects on the selection-based tact and especially the selection-based intraverbal relation resulted in the study's having

very little data relevant to this question. One of the four subjects met criterion with all verbal relations in both paradigms, and demonstrated mand compliance as a form of equivalence with the topography-based paradigm only. Another demonstrated mand compliance with the topography-based paradigm but did not reach criterion for the selection-based tact and was not trained with the selection-based intraverbal, thus no test for equivalence with the selection-based paradigm was possible. A third subject did not meet criterion for either topography or selection-based tacts or intraverbals, but did show partial stimulus equivalence (mand compliance) in both systems with a higher percentage of correct responses in the topography-based paradigm. The fourth subject was so high functioning that he performed almost perfectly with both paradigms and showed the maximum performance possible on both equivalence tests.

Purpose of the Present Study

The possibility that selection-based verbal behavior is more difficult to establish is reason enough for a more definitive comparison of the two systems, especially considering its possible relevance to training language deficient individuals. The established role of stimulus class formation in language development and elaboration, and the possible importance of verbal naming, the tact relation, in the establishment of stimulus equivalence constitute a further reason to compare the two language systems. Two previous studies dealt with ease of acquisition (Sundberg & Sundberg, 1990; Wraikat, 1991), and one of them attempted to provide a comparison with respect to the formation of equivalence relations (Sundberg & Sundberg, 1990). The present study is an effort to modify the procedures of these two earlier studies so as to obtain more extensive comparison data.

Methodological Improvements

Both of the preceding efforts to compare the two paradigms with respect to ease of acquisition and the development of stimulus equivalence obtained useful comparative data from only a few of the subjects tested. Unfortunately, it is not easy to accurately predict how subjects classified as profoundly to mildly retarded will function on the verbal training tasks. Both of the previous relevant studies used a standard procedure with all subjects and attempted to select subjects who would be appropriate for that procedure, then used the procedure without modification. In some cases the subjects were too low functioning, and failed to learn the procedure sufficiently to permit comparative data (a sort of *floor effect*); and in some cases they were so high functioning with respect to the experimental task (in spite of appearing less effective on previous assessment instruments or in everyday activities) that both paradigms were acquired too rapidly to permit any useful comparisons (a *ceiling effect*). The present study attempted to improve on the previous methodologies in two ways.

In the first place, two versions of the testing procedure were developed, one using two objects for each relation and one using three, and subjects were assigned to a procedure on the basis of all prior information relevant to their general verbal effectiveness.

Secondly, both the two-object and the three-object procedures were elaborated by including the interspersal of already learned relations with the training of new relations. This meant that if the subject's level of function had been overestimated, and s/he was not reaching criterion with one or more relations, interspersal data which could contribute to the comparison were still being collected on all relations, and the increased exposure to the various relations might facilitate the equivalence comparison.

On the other hand, if the subject's level of function had been underestimated, and s/he was acquiring both kinds of relation too quickly to permit much of a comparison, interspersal data were still being collected throughout the experiment, and could be the basis for further comparisons. In other words, even though the subject might have acquired both kinds of relation rapidly it was still possible that throughout the remainder of the experiment, performance differences would show up with the already-learned relations as they were being tested during the learning of new relations.

The interspersal of old with new tasks has been found to facilitate some kinds of task acquisition (e.g., Neef, Iwata, & Page, 1977; Neef, Iwata, & Page, 1980), which might work against the present use of interspersal to obtain better comparison data from subjects whose function level had been underestimated. However, it was decided to risk this possibility on the hope that the increase in available comparison data would more than compensate for any facilitative effect on the learning of the new relations.

During the experiment an adjustment of the interspersal procedure, called *retention training*, was used with two of the subjects for which the regular interspersal was at first believed to be too difficult. This adjustment, like the regular interspersal, also resulted in the collection of more data for comparison purposes than the training procedures of the two preceding studies, and is described in detail in Chapter II.

In summary, the main research questions for this study are: (1) With which paradigm (topography-based or selection-based) will tact and intraverbal relations be easier to learn (number of trials to mastery criterion), (2) With which paradigm will tact and intraverbal relations be learned more accurately (percentage of correct responses), and (3) Will there be any differences between the two paradigms in the spontaneous

development of a form of stimulus equivalence relation, the mand compliance (receptive language) task?

CHAPTER II

METHOD

Subjects

Seven developmentally disabled adults served as subjects in the experiment. All seven attended the day-treatment Center for Developmentally Disabled Adults, Douglass Site, Kalamazoo, Michigan. There were three males and four females, ranging in age from 26 to 50 years. Inclusion criteria were: (a) a moderate to severe language deficit (as documented in the subject's files), (b) the exhibition of manual dexterity allowing for the formation of manual signs, (c) the ability to imitate, (d) the ability to follow instructions (as determined by prestudy probes), (e) a criterion level of previous performance in related programs reflecting that the subject might benefit from the type of activities involved in this study, and (f) no special dietary requirements that might restrict the client from going out weekly to a local restaurant.

The subject selection process was conducted by a group of professionals including: (a) a speech-language pathologist, (b) the site coordinator, (c) the assistant therapist of the client, and (d) the principal investigator. Consent was obtained from guardians, Western Michigan University Human Subjects Institutional Review Board (HSIRB), Center for Developmentally Disabled Adults (CDDA), and Human Services Department (HSD) prior to each subject participation. The outcome of each client's participation was placed in the client's clinical record to indicate the client's potential for future language training programs. Subjects' characteristics are presented in Table 1 on the next page. (The names shown are not the subject's real names.)

Table 1

Subject Characteristics

Pseudonym	Age	Primary Diagnosis	Secondary Diag.
Amelia	40	cerebral palsy	mild ment.retard.
Jesse	26	moderate ment.retard.	spas. quadriplegia & cere. pal.
Kathleen	33	severe ment. retard.	microcephalic
Karen	29	moderate ment. retard.	epilepsy
Troy	33	moderate ment. retard.	epilepsy
Jessica	50	profound ment. retard.	none
Jordan	46	profound ment. retard.	none

Setting

The study was conducted in a room (14 m by 12 m) at Douglass Community Center. The Center for Developmentally Disabled Adults (CDDA) occupies only three rooms from Douglass Community Center. One is used as an administrative office and a storage area, another as a staff working area, and a third as a classroom. This study was conducted in an adjacent room which is part of the Douglass Community Center but not the CDDA. The room was empty except for two chairs and a card table. A third chair was brought in on days when reliability data were taken.

The experimental sessions were conducted five days a week, Monday through Friday from 9:00 to 11:00 a.m. Each session usually consisted of 48 trials and lasted

about 15 to 20 minutes per subject. Occasional schedule changes occurred due to participants' sickness or similar conditions.

Apparatus/Materials

All subjects were taught the following verbal relations between: (a) unknown objects and symbols, the selection-based tact; (b) unknown spoken names and symbols, the selection-based intraverbal; (c) unknown objects and manual signs, the topography-based tact; and (d) unknown spoken names and manual signs, the topograpy-based intraverbal. The objects, symbols, and signs were chosen so as to control for the differential ease of acquisition due to iconicity and other factors. Common objects, names, signs, etc. were not used because it was essential to guard against the possible influence of previous history with any of the signs, symbols, names, or objects. One-syllable words that were judged easily distinguished from one another by the subjects of the experiment were selected.

The following procedures were used in selecting symbols, signs, and names.

1. A list of symbols, names, and signs was provided to four experts (people who have a B.A. in psychology or related fields and a minimum of two years of experience with developmentally disabled adults). They were asked individually to rate these symbols, names, and signs on a scale of 1 to 10 in term of difficulty level for developmentally disabled adults (1 = not at all difficult, 10= very difficult).

2. From the above ratings, a list of signs, symbols and names which obtained low difficulty ratings was developed (the signs and the names were demonstrated by the experimenter).

3. Combinations of least difficult signs, names and symbols was also provided to these experts to account for difficulty when the items were combined together in sets.

The sets used in this study were the ones that were agreed upon as least difficult by these judges (see Appendix E).

The objects were made of various materials, were of various shapes, and had no obvious function. For example, the metal object was symmetrical and approximately 12 cm. long. It had a hole in the middle with two sliding joints connected by screws. In each end of the object there were hooks on opposite sides. The polystyrene object was a white cylinder approximately 12 cm. long. The bottom portion of the object was about .5 cm. in diameter and the top portion was approximately 2.5 cm. in diameter. Each object was assigned a nonsense name to be spoken by the experimenter, an arbitrary symbol drawn in black ink on a 10 cm. by 10 cm. piece of white poster board for the selection-based paradigm; and a manual sign for the topography-based paradigm. The symbols resemble the Greek letters omega, sigma, phi, psi and the Arabic letters "B" and "D." The names, objects, symbols and signs for each set of relationships are described in Table 2 on the next page. The signs did not involve touching a part of the body so to avoid the possibility of suggesting to the subject that s/he is naming a body part with a nonsense name. All signs involved only one arm and either one was acceptable. Each set was assigned an unknown name to be spoken by the experimenter; "puck" for example was the name that went with the polystyrene object, the phi symbol (when the selection-based paradigm was used), and an open hand sign (when the topography-based paradigm was used) and so on.

For three of the subjects, a total of four objects were used. For example, the verbal sets "nack" and "teef" in the selection-based paradigm ; "dil" and "koob" with the topography-based paradigm were used with Jessica. This order was reversed for

Table 2

Set Contents

Name	Object	Symbol	Sign
puck	polystyrene	phi	displaying an open hand
nack	plastic	Arabic D	waving a hand over the head back and forth
teef	sponge	psi	holding up a fist
dil	metal	Arabic B	making a circle in the air
koob	wood	omega	moving arm several times in a horizontal plane
doof	cloth	sigma	pointing down with an open hand

Amelia and Kathleen. For the remaining subjects a total of six objects were used. The verbal sets "puck," "nack" and "teef" in the selection-based paradigm and "dil," "koob" and "doof" with the topography-based paradigm were used with Karen and Troy. This order was reversed with Jesse and Jordan.

The real name of each object or its made up name was written on a prepared randomization sheet which determined which set was to be used for each trial. The number of times each object appeared on the sheet was predetermined; however, the order of each object was random (see Appendix D).

Reinforcement Selection

The reinforcers utilized in this study were similar to those commonly used at CDDA (Douglass site) and included: (a) social reinforcement, (b) achievement certification, (c) stickers, (d) cards and (e) individualized reinforcers such as a sports magazine. Money or edibles were not used as reinforcers in this study. However, weekly noncontingent outings to a local restaurant were provided to help insure that subjects remained interested in the study. The principal investigator accompanied the subjects to the restaurant.

Measurement

Responses were recorded as correct or incorrect on a specially prepared data sheet by marking a plus (+) or a minus (-) sign in one of the squares for the 48 trials for one of the two or three sets corresponding with each object, name, symbol or sign (see Appendix C). For example, if a subject was being trained in the selection-based tact relation, the three sets were "puck," "nack," and "teef." If the subject failed to select the phi symbol when shown the polystyrene object, the response was recorded as a minus sign in the cell appropriate for that trial under the set named "polystyrene." The first symbol/sign emitted by the subject, depending on the paradigm in use, was the one recorded on the data sheet. Mastery criterion was defined as 11 out of 12 successive correct responses for the test trials in the case of two objects, and 7 out of 8 in the case of three objects. Interspersed verbal relations were recorded as correct or incorrect but were not included in determining the mastery criterion. When the retention-training procedure, described below, was used, the training was continued until the subject reached criterion or until the cut-off or stopping point was reached. This meant that

retention-training sometimes ended in a session before 48 trials had been completed, and sometimes more than one session was required.

Dependent Variables

For each subject, two verbal relations for each paradigm were directly taught and tested: (1) the tact (pointing to a symbol or making a sign, depending on the paradigm in use, when shown an object), and (2) the intraverbal (pointing to a symbol or making a sign, depending on the paradigm in use, when an object name was spoken by the experimenter). The two paradigms were compared with respect to the number of trials to the mastery criterion, and with respect to the overall percent correct. This latter value was calculated by dividing total correct trials during test trials by total trials and multiplying by 100. For individual sessions, percent correct was calculated by dividing total number of correct trials by total trials for each verbal relation in that session. Average trials to criterion for all subjects in each verbal relation was calculated by dividing the total number of trials to criterion for each subject by the number of subjects. The same procedure was followed with the average percent correct.

After tacts and intraverbals were either mastered or the cut-off or stopping point (an arbitrary 144 trials for five of the subjects and 72 for Kathleen and Jesse with the intraverbals only) was reached, an unreinforced mand-compliance (receptive language) test was conducted. For example, after the subject went through training with all verbal relations, s/he was then shown all of the objects and told "Show me teef." If s/he then pointed at the appropriate object within the next twenty seconds the mand compliance response was scored as correct.

For a response to be scored as correct it must be a close enough approximation to the desired response to be easily distinguished by the experimenter from the other responses in the subject's repertoire.

Experimental Design

The experiment involved a within-subject comparison where each subject was trained on four verbal relations, two topography based and two selection based. Three subjects were trained in the order topography-based tact (call it condition A), selection-based tact (B), selection-based intraverbal (C) and topography-based intraverbal (D). The other four were trained in the order selection-based tact, topography-based tact, topography based intraverbal, selection based intraverbal. This arrangement was used to balance the topography- and selection-based training so that neither had both of its verbal relations taught first or both taught last.

In a sense this is a sort of ABCD design for some of the subjects and BADC for the others, with none of the four conditions being a baseline condition. Possible confounding of changes in uncontrolled variables with the independent variable is not controlled for, except in the sense that the subjects were not generally starting and finishing in the same independent variable condition at the same time. That is, an uncontrolled variable such as a condition at the facility where the research was taking place (for example, some unusually disturbing event such as a fire drill, or an inspection by some government agency) would not systematically affect topography-based relations versus selection-based relations across subjects, since the different subjects would have been in various phases of their experiment depending on their progress through the phases, and depending upon which phases were a part of their experiment. It was, of course, possible for an uncontrolled variable, such as an

undetected illness, to affect any particular subject and influence his or her performance during that phase of his or her experiment.

Response Definitions

Topography-based Tact. When presented with a certain object and asked "What's this?" the subject makes the correct sign within 20 seconds of the presentation of the object. For example, when presented with the sponge object and asked "What's this?" the subject makes the hold-up-a-fist sign within 20 seconds.

Topography-based Intraverbal. When the experimenter speaks the name of an object the subject makes the corresponding sign within 20 seconds of its presentation. For example, when the experimenter says "What's teef?" the subject holds up his fist within 20 seconds.

Selection-based Tact. When presented with a certain object and asked "What's this?" the subject points to the correct symbol (out of an array of two or three) within 20 seconds of its presentation. For example, when presented with the polystyrene object and asked "What's this?" the subject points to the phi symbol within 20 seconds. The first symbol pointed to is recorded.

Selection-based Intraverbal. When the experimenter speaks the name of an object the subject points to the corresponding symbol (out of an array of two or three) within 20 seconds of its presentation. For example, when the experimenter says "What's puck?" the subject points to the phi symbol within 20 seconds.

Receptive Language or Mand Compliance Test for Equivalency. When asked to identify an object (out of an array of four or six) the subject correctly points at the object within 20 seconds. For example, when asked "Which one is koob?" the subject points to the wood object within 20 seconds.

Data Collection and Reliability Checks

Each trial was recorded as correct or incorrect under the corresponding relation. Reliability data on each subject's responses were collected by a trained observer who was a senior undergraduate student in psychology at Western Michigan University. The observer used the same type of data sheet as the experimenter and was seated at a nearby desk so that he could see the participant's responses but not the experimenter's data. Reliability was calculated for each observed session utilizing the following formula:

$$\frac{\text{Number of Agreements}}{\text{Number of Agreements + Disagreements}} \quad \text{X } 100$$

For a trial to be recorded as an agreement the observer and the experimenter must have agreed on a recorded response as correct or incorrect under one of the two or three sets (e.g., "puck," "nack," or "teef"). Reliability data were obtained for two sessions for Amelia (96 trials); two sessions for Jesse (102 trials); three sessions for Kathleen (144 trials); seven sessions for Jessica (336 trials); eight sessions for Troy (402 trials); seven sessions for Karen (354 trials) and six sessions for Jordan (288 trials).

Procedure

General

The general procedure consisted of approximately five demonstrations with corrections of newly trained verbal relations. This includes training to imitate signs, to make the sign when presented with an object or with the vocal name of the object, and to point to one of two or one of three symbols when presented with an object or the vocal name of the object. Sessions were conducted once a day, five days a week, for

each subject. Each session lasted approximately 20 minutes, usually consisted of 48 trials, and was run at the same time every day for each subject.

As shown in Table 3 (below) four of the subjects (Jesse, Troy, Karen

Table 3

Number of Objects and Order of Training

Subject and No. of Objects	Order of Training
Amelia: 2 Objects Only	Phase I, TB-Tact only; Phase II, SB-Tact interspersed with TB-Tact; Phase III, SB-INV interspersed with the tacts; Phase IV, TB-INV interspersed with all; Phase V, Mand Compliance.
Jesse, Troy, and Karen, 3 Objects	Phase I, SB-Tact only; Phase II, TB-Tact interspersed with SB-Tact; Phase III, TB-INV interspersed with the tacts; Phase IV, SB-INV interspersed with all; Phase V, Mand Compliance.
Kathleen: 2 Objects[3]	Phase I, TB-Tact only; Phase II, SB-Tact only; Phase III, Tacts retention; Phase IV, SB-INV interspersed with the tacts; Phase V, TB-INV interspersed with all.; Phase VI, Mand Compliance.
Jessica: 2 Objects[3]	Phase I, SB-Tact only; Phase II, TB-Tact only; Phase III, Tacts retention; Phase IV, TB-INV only; Phase V, SB-INV only; Phase VI, Intraverbals retention; Phase VII, mand compliance.
Jordan: 3 Objects[4]	Phase I, TB-Tact only; Phase II, SB-Tact interspersed with the TB-tact; Phase III, SB-INV only; Phase IV, TB-INV only; Phase V, mand compliance.

[3]Due to an inaccuracy in the assessment of this subject's level of function, the procedure was changed somewhat during the process of the experiment by adding a retention-training phase, as described at the end of this chapter.

[4]Jordan's procedure also varied from what was originally planned but the variation did not involve retention training and will be described in Chapter III.

and Jordan) utilized three objects in each verbal training set. The remaining subjects (Amelia, Kathleen, and Jessica) used two objects only with each verbal relation set. The order and number of objects utilized with each subject are also shown in the table.

For all sessions with interspersal training, half of the trials were assigned to the newly trained verbal relations (test trials). These were alternated with the verbal relations previously known. For example, Amelia's Phase II consisted of 24 selection-based tact trials (test trials) alternated with 24 trials from the already learned topography-based tact; her Phase IV consisted of 24 topography-based intraverbal trials (test trials) and the other 24 trials were divided evenly among the previously trained verbal relations (four trials for each of the two objects with the topography-based tact, selection-based tact and selection-based intraverbal). In the case of three objects, the last session involving interspersal usually consisted of 54 trials instead of 48 trials, with 27 assigned to the new relation being taught (test trials) and three sets of nine trials (three for each object) for each of the three verbal relations that had been previously taught.

Training Verbal Relations

Topography-Based Tact and/or Interspersal Training

The experimenter held up an object, made the corresponding sign, and said "This" (holding up the object) "is this" (making the sign). The subjects were then asked to imitate the sign. If the subject made the correct sign, verbal praise was given ("Good job, you got it."). If the subject did not make a sign, the proper sign was demonstrated along with the verbal prompt "This" (pointing to the object) "is this" (making the sign). If the subject made the wrong sign s/he was informed of the error, and this was followed by a demonstration of the correct sign along with the verbal

prompt. This procedure was then repeated for the other object(s) until the subject began to imitate some of the signs displayed by the experimenter. Approximately five demonstrations were given to each newly trained verbal relation and two reminders at the beginning of each session. Data collection began with the experimenter looking up a name on a pre-arranged randomization sheet and holding up the corresponding object and saying "What is this, _____?"(participant's name). The consequences of a correct sign, no sign, or an incorrect sign were as indicated above. This sequence was usually repeated 48 times (ending the session for that day) until criterion was met or until the cut-off point for terminating training was reached for this verbal relation. When the criterion or the cut-off point was reached, the next phase of training was initiated.

If the topography-based tact session involved interspersal or a retention test, the session consisted of 48 trials, 24 topography-based tact trials alternated with 24 trials for the selection-based tact. Correct and incorrect interspersal selection-based tact responses were recorded, but no criterion was required (see Appendix D for details about the topography-based tact interspersal sessions).

Selection-Based Tact and/or Interspersal Training.

The experimenter held up an object and said "This" (holding up the object) "is this" (pointing to the corresponding symbol). The experimenter then asked "What is this,_____?"(participant's name). If the subject pointed to the correct symbol s/he was given verbal praise just as in the previous relation. If the subject did not point to a symbol within twenty seconds, the experimenter pointed to the correct symbol while giving the verbal prompt. If the subject pointed to the wrong symbol s/he was informed of the error. This was followed with a demonstration in which the

experimenter held up the object and pointed to the correct symbol along with a verbal prompt. This procedure was repeated for the other object(s) until the subject began to point to some of the symbols displayed by the experimenter. Approximately five demonstrations were given of each newly trained verbal relation and two reminders at the beginning of each session.

Data collection began by the experimenter looking up a name of an object in the randomization sheet, holding up the corresponding object and saying "What is this,_____?"(participant's name), with the response consequated as above.

If the selection-based tact session involved interspersal, the session consisted of 48 trials, 24 selection-based tact trials alternated with 24 trials for the topography-based tact. Correct and incorrect interspersal topography-based tact responses were recorded, but no criterion was required (see Appendix D for details about selection-based tact interspersal sessions).

Selection-Based Intraverbal and/or Interspersal Training:

Training began with the experimenter saying the spoken name (that relates to the object and symbol while pointing to the corresponding symbol, out of two or three). The experimenter then would say "_____," (subject's name) "which one is _____?" (saying the corresponding name). If the subject pointed to the correct symbol s/he was given verbal praise just as in the previous relations. If the subject did not point to a symbol within twenty seconds, the experimenter would say "_____,"(subject's name) "this,"(while pointing to the symbol) "is _____"(saying the name). If the subject pointed to the wrong symbol s/he was informed of the error while being shown the symbol that corresponded to the name (e.g., "No, _____"(subject's name). "That was nack. This is puck." This procedure was then repeated for the other

name(s) until the subject began to point to some of the symbols displayed by the experimenter.

Data collection began by the experimenter looking up a corresponding name to object and symbol in the randomization sheet, and saying "_____,"(subject's name) "which one is _____?" (saying the corresponding name), with the response consequated as above.

If the selection-based intraverbal session involved interspersal, the session consisted of 48 trials, and 24 selection-based trials were assigned to newly trained selection-based intraverbal while the remaining trials were divided evenly among all other interspersed verbal relations (see Appendix D for details about selection-based intraverbal interspersal sessions).

Topography-Based Intraverbal and/or Interspersal Training

The experimenter said the name (that relates to a sign and object) and made the corresponding sign. The subjects were then asked to imitate the sign. If the subject made the appropriate sign, verbal praise was given just as in the previous relations. If the subject did not make the sign, the experimenter would say "____(subject's name), this _____(making the sign) is _____(saying the name)." If the subject made the wrong sign s/he was informed of the error, followed by a demonstration of the correct sign along with the verbal prompt. This procedure was repeated for the other name(s) until the subject began to imitate some of the signs displayed by the experimenter. Approximately five demonstrations were given of each newly trained verbal relation and two reminders at the beginning of each session.

Data collection began with the experimenter looking up a name that related to an object and a sign in the randomization sheet, and asking the subject to make the

corresponding sign (e.g., "_____,"(subject's name) "show me _____" (corresponding name), with the response consequated as above.

After this point the same procedures as with the selection-based intraverbal and/or interspersal sessions were followed (see Appendix D for details about topography-based intraverbal interspersal sessions).

Topography-Based and Selection-based Test for Mand Compliance

When mastery criterion was met for most or all verbal relations, testing for the emergence of mand compliance (the untrained relation) was conducted. An unreinforced mand-compliance probe was conducted after a few practice trials on all of the trained verbal relations. For the mand-compliance probes the experimenter simply laid all four or all six objects on the table twice (each time in different order) and asked the subject to point to the one the experimenter mentioned by name. For example, the experimenter pointed to the objects (calling attention to them) and asked "Which one is nack"? Until this test, for instance, the subject had only learned to make a sign in the presence of the plastic object and to make the same sign when asked to sign "nack." Identifying the object named "nack" is a new relation and the extent to which this relation emerged was another basis for comparing the two paradigms. The same procedures were utilized for objects trained with the selection-based system. If in both trials s/he made the appropriate response the relation was considered to have been demonstrated. If an error appeared in one or both trials the relation was not shown.

Retention Training With Two Subjects

Although it was originally planned to use the two-object or three-object procedure either with interspersal or without interspersal depending on the level of

function of the subject, a modification was made in the case of two subjects because of problems arising during their performance. In all cases the modification consisted in part in the introduction of a procedure referred to as *retention training*. This occurred after training with two relations by themselves, and consisted in retraining with the two relations intermixed with each other.

Kathleen. This subject was trained using two objects with topography-based tact only and then with selection-based tact only (with no interspersal because she was assessed as sufficiently low functioning that the interspersal would not be useful). However, her performance on the two tact relations was sufficiently good that it was decided to use the retention-training review procedure as the next phase, and then go to the regular interspersal after the first training on an intraverbal relation.

Jessica. This subject, like Kathleen, was started with no interspersal, the retention-training was added after the tact training, but instead of going to interspersal with the intraverbal training (her performance on the selection-based tact was very poor) she was simply given a retention-training phase after the intraverbal training.

CHAPTER III

RESULTS

Interobserver Agreement

Interobserver agreement per subject ranged between 97 and 100 % (see Table 4 below). The two observers clearly had no difficulty in classifying the various responses.

Table 4

Interobserver Agreement

Subject	Trials	Agreements	Percentage
Amelia	96	96	100
Jesse	102	100	98
Kathleen	144	142	99
Jessica	336	327	97
Troy	402	397	99
Karen	354	348	98
Jordan	288	285	99

Overall Results

Trials to Criterion

Five of the seven subjects (Jesse, Jessica, Troy, Karen and Jordan) generally showed fewer trials to criterion for every verbal relation when trained with the topography-based system (see Table 5 below). The remaining two subjects demonstrated variations among the different verbal relations. Amelia did equally

Table 5

Trials to Criterion for Each Subject

Subject	T-B Tact	T-B Inv	S-B Tact	S-B Inv
Amelia	22	22	22	48
Jesse	22	22	48	81*
Kathleen	46	72	22	72*
Jessica	96	70	144*	144*
Troy	45	72	144	135
Karen	22	72	144*	96
Jordan	45	120	144*	144*
Average	43	64	95[5]	103[5]

* did not meet criterion.

[5]Averages are shown, but in those cases where the cut-off point was reached, that is, where training was terminated without the criterion being reached, such averages are relatively meaningless. All that can be said is that the true averages are larger than the values shown.

well with the tact in both paradigms but better on the topography-based intraverbal, and Kathleen did better on the selection-based than the topography-based tact but worse on the selection-based than topography-based intraverbal. Three of the seven subjects (Jessica, Karen and Jordan) did not reach criterion for the selection-based tact and four (Jesse, Kathleen, Jessica and Jordan) for the selection-based intraverbal, but all subjects reached criterion with the topography-based verbal relations. Average values are shown in the last row of Table 5, and it is clear that the averages for the topography-based relations are lower than for the selection-based relations, although the actual quantitative relation is not known because of the use of an arbitrary stopping point, which was reached with several of the selection-based values.

Overall Percent Correct for Each Subject

Three of the subjects (Jesse, Jessica and Jordan) had clearly higher accuracy in terms of percent correct for the topography-based relations than for selection-based relations (see Table 6 on the next page). Amelia did equally well with the tact in both paradigms, but better with the topography-based intraverbal. Kathleen did slightly better on the selection-based than the topography-based tact, but much worse on the selection-based than the topography-based intraverbal. Troy and Karen both did much better on the topography-based tact than the selection-based tact; but clearly somewhat better on the selection-based than the topography-based intraverbal. Average values are shown in the last row of Table 6, and although it is clear that the averages favor the topography-based relations, medians would be more appropriate measures of central tendency in this case, and would favor the selection-based paradigm for the intraverbal relation. As with the average trials to criterion, the actual quantitative relation is quite

Table 6

Percent Correct for Each Subject

Subject	T-B Tact	T-B Inv	S-B Tact	S-B Inv
Amelia	100	100	100	92
Jesse	100	100	90	81*
Kathleen	92	72	96	57*
Jessica	78	72	49*	51*
Troy	96	78	77	87
Karen	92	76	45*	88
Jordan	92	80	53*	42*
Average	93	83	73[6]	71[6]

* did not meet criterion.

unclear because of the use of an arbitrary stopping point, which was reached with several of the selection-based values.

Mand Compliance or Stimulus Equivalence

Table 7 (on the next page) shows each subject's performance on the test for spontaneous occurrence of the mand-compliance relation, which is taken here as a form of stimulus equivalence[7]. Six of the subjects showed more correct mand-compliance

[6]As with the average values of the trials-to-criterion across subjects, in those cases where the cut-off point was reached, the true averages can only be said to be larger than the values shown.

[7]The mathematical definition of equivalence requires reflexivity, symmetry and transitivity. No test of symmetry was involved in this research, only transitivity. For this reason the use of *equivalence* here might not be considered appropriate from this most stringent basis.

Table 7

Mand Compliance (Stimulus Equivalence)

Subject	Topography-based	Selection-based
Amelia	2 out of 2	1 out of 2
Jesse	3 out of 3	2 out of 3
Kathleen	1 out of 2	None out of 2
Jessica	None out of 2	None out of 2
Troy	3 out of 3	2 out of 3
Karen	2 out of 3	1 out of 3
Jordan	1 out of 3	None out of 3

with the topography-based than with the selection-based relations, and one subject (Jessica) had no correct mand compliance responses with either relation. It must be noted, however, that when there are only four objects (two with each paradigm), unless the subject fails to indicate either object, s/he has a 25% chance of making a correct identification just by guessing. With six objects (three with each paradigm) the probability of a correct response by chance is only 17%, but even so the present results with the equivalence test should not be considered very robust.

Individual Data

Correct trials per session for Amelia are shown in Table 8 on the next page. From this format it is possible to follow the subject's performance through the whole experiment. This subject's individual data do not reveal anything of importance that is

not available in the preceding overall tables, but working through the procedure provides further explanation of the general features of the experiment. Throughout Amelia's training only two objects were used for each relation. She was first trained and tested using the topography-based tact, and reached criterion after 22 trials in that session. Session two consisted of 22 trials on the selection-based tact with 22 topography-based trials interspersed. Her third relation involved the selection-based

Table 8

Amelia's Correct Trials Per Session

Session	T-B Tact	S-B Tact	S-B Inv	T-B Inv
1	22 out of 22	not trained	not trained	not trained
2	22 out of 22	22 out of 22	not trained	not trained
3	12 out of 12	12 out of 12	21 out of 24	not trained
4	12 out of 12	12 out of 12	23 out of 24	not trained
5	8 out of 8	8 out of 8	8 out of 8	24 out of 24

intraverbal and it took her two sessions to reach criterion with this relation. During these sessions (sessions three and four) trials with the two previously learned relations were interspersed with the 24 trials involving the new relation. Session 5 consisted of 24 trials with the new relation, the topography-based intraverbal, with eight trials of each of the three preceding relations interspersed. She met criterion on this new relation in one session and her participation in the experiment was terminated. Her performance on interspersal trials provides no information of comparative value, since

she made no errors irrespective of the relation trained. With respect to mand compliance, she was correct on both of the topography-based relations, and on one of the two selection-based relations (see Table 7).

Correct trials per session for Jesse, Kathleen, Jessica and Jordan are shown in Appendix F as Tables 11, 12, 13 and 14.

Interspersal Data

The correct trials per session data for Troy and Karen provide information that was not available in the overall data of Tables 5, 6 and 7, and only the data from these two subjects justify the use of interspersal as a way of obtaining more comparative information. First, with respect to Troy (see Table 9 on the next page), who worked with three objects, the first relation trained was the selection-based tact. It took three sessions, 144 trials for him to reach criterion with this relation. Next, he was trained on the topography-based tact as a new relation, with trials on the previously learned selection-based tact interspersed. He reached criterion on this new relation in two sessions (45 trials), and then was trained on the topography-based intraverbal, which required three sessions and 72 trials to reach criterion. During this training the two preceding relations were being interspersed, 12 trials with each. Finally, he was trained on the selection-based intraverbal, which took five sessions and 135 trials to reach criterion. This pattern of performance permits a comparison of topography-based and selection-based interspersal performance. During sessions 4 through 11 Troy continued to make quite a few errors on the selection-based tact. With the topography-based tact he made almost no errors after reaching criterion (sessions 6 through 13), and with the topography-based intraverbal his performance was quite good. In other

Table 9

Troy's Correct Trials Per Session

Session	S-B Tact	T-B Tact	T-B Inv	S-B Inv
1	33 out of 48	not trained	not trained	not trained
2	34 out of 48	not trained	not trained	not trained
3	44 out of 48	not trained	not trained	not trained
4	17 out of 24	22 out of 24	not trained	not trained
5	15 out of 24	24 out of 24	not trained	not trained
6	9 out of 12	12 out of 12	15 out of 24	not trained
7	9 out of 12	12 out of 12	20 out of 24	not trained
8	10 out of 12	12 out of 12	21 out of 24	not trained
9	6 out of 9	9 out of 9	7 out of 9	21 out of 27
10	6 out of 9	9 out of 9	9 out of 9	22 out of 27
11	7 out of 9	9 out of 9	9 out of 9	24 out of 27
12	8 out of 9	8 out of 9	8 out of 9	24 out of 27
13	8 out of 9	9 out of 9	9 out of 9	26 out of 27

words, the first learned relation, the selection-based tact, continued to be performed incorrectly even though criterion had been met, and even though it was practiced more than any other relation.

Karen's data (Table 10) are very similar to Troy's with respect to interspersal performance. She did not meet criterion with the first relation trained, the selection-based tact, and continued to make many errors on this relation throughout sessions 4 through 11. On the other hand, after reaching criterion on the next two relations which were topography based, she continued to perform perfectly on those relations when they were interspersed with new relations.

Table 10

Karen's Correct Trials Per Session

Session	S-B Tact	T-B Tact	T-B Inv	S-B Inv
1	17 out of 48	not trained	not trained	not trained
2	20 out of 48	not trained	not trained	not trained
3	27 out of 48	not trained	not trained	not trained
4	7 out of 24	22 out of 24	not trained	not trained
5	7 out of 12	11 out of 12	16 out of 24	not trained
6	5 out of 12	12 out of 12	18 out of 24	not trained
7	6 out of 12	12 out of 12	21 out of 24	not trained
8	5 out of 9	9 out of 9	9 out of 9	20 out of 27
9	6 out of 9	9 out of 9	9 out of 9	24 out of 27
10	4 out of 9	9 out of 9	9 out of 9	25 out of 27
11	3 out of 9	9 out of 9	9 out of 9	26 out of 27

Whether interspersal facilitates or hinders the learning of new relations cannot be determined from the present experiment because this type of comparison is completely confounded with the type of relation being trained.

Tacts Versus Intraverbals

From Tables 5 (on page 44) and 6 (on page 46), and from most of the individual data, it was clear that the topography-based intraverbal relation was more difficult for these subjects to learn than the topography-based tact. Two of the subjects (Amelia and Jesse) showed no differences, and four (Kathleen, Troy, Karen and Jordan) of the remaining five had considerably better performances on the tact than the intraverbal. With respect to the selection-based relations the results are not clear. Jessica and Jordan did not meet criterion with either tact or intraverbal, and of the remaining five subjects three (Amelia, Jesse and Kathleen) had better tact performances and two (Troy and Karen) had better intraverbal performances.

Informal Observations

As noted by previous researchers (Sundberg & Sundberg, 1990; Wraikat 1991), it was found that the subject's attitudes toward the experiment and the experimenter were more positive during phases involving the topography-based paradigm. For example, as soon as Jordan saw the experimenter he would greet him with a smile and attempt to leave his coffee unfinished to do the experiment. This was not the case when training involved the selection-based paradigm. The experimenter was forced to skip several sessions with Jordan because of his attitude toward training with the selection-based paradigm. Of course, these observations were made on a casual basis and should certainly be cautiously interpreted.

CHAPTER IV

DISCUSSION

General Conclusions

Success of the Task Difficulty Adjustment

The present study attempted to provide a more complete comparison of the topography-based and selection-based verbal behavior than previous research on this issue (Sundberg & Sundberg, 1990; Wraikat, 1991). The training sessions consisted of a sequence of procedures, first using only two objects, then adding progressively more complex task requirements if the subject acquired the repertoire too easily to permit useful comparisons of the two paradigms. These complications consisted of either a retention test where pairs of relations learned must be demonstrated together in an intermixed pattern before going on to the next pair of verbal relations, or if this proved too easy, then learned relations were interspersed with new ones as a procedure adopted from the study by Neef, et al., (1977). On the other hand, if interspersal training was begun and proved too difficult for a subject, then learned relations were trained separately as in the studies by Sundberg and Sundberg (1990) and by Wraikat (1991). Furthermore, for high functioning subjects a third object was added to the set.

These complications were added or subtracted in such a way as to make it possible to compare the two paradigms in terms of trials to criterion and percent correct responses, and also to test for spontaneous development or the mand-compliance task, a possible equivalence relation. In general, these efforts to adjust the task difficulty to

the level of function of the subject were somewhat successful, in that at least some useful comparison data were obtained from every subject.

Main Conclusions

The main research questions for this study were: (1) With which paradigm (topography-based or selection-based) will tact and intraverbal relations be easier to learn (number of trials to mastery criterion)?; (2) With which paradigm will tact and intraverbal relations be learned more accurately (percentage of correct responses)?; and (3) Will there be any differences between the two paradigms in the spontaneous development of a form of stimulus equivalence relation, the mand compliance task?

With respect to the first question the results clearly favor the topography-based language system. Trials-to-criterion were generally fewer for topography-based than selection-based relations. For the second question, the results are not so clear, although there would still seem to be somewhat more support for the topography-based than the selection-based system. In retrospect, the second research question is not well worded. It seems to be concerned with the asymptote of a learning curve, which is not really addressed by overall percent correct responses. Perhaps it would have been better to study percent correct for successive blocks of trials as the dependent variable, and then to compare the two paradigms with respect to both the rates of approach to the asymptote and the asymptotic values themselves. For the question concerning the spontaneous development of a new stimulus relationship, even though the probability of chance success was uncomfortably high, the question was still answered clearly in favor of the topography-based paradigm. In general, the results of this study constitute further support for the previous theoretical and empirical research in this area (e.g., Michael, 1985; Sundberg, 1987; Sundberg & Sundberg, 1990; Wraikat, 1991).

Although it was not a primary issue in this research, the results do bear on the general question regarding the relative ease of acquiring tact versus intraverbal relations. In the Sundberg and Sundberg (1990) study the intraverbal seemed in general more difficult to learn. The present data are somewhat similar, in that the tact was generally easier to learn for the topography-based relations; however, for the selection-based relations, two of the present subjects (Troy and Karen) had clearly more difficulty with the tact than with the intraverbal, and two subjects, Jessica and Jordan, found them about equally difficult. Although differing from the Sundberg and Sundberg results, the present data are consistent with the previous study by the present author (Wraikat, 1991). The differences may reflect the various procedural differences between the studies. For example, in the Wraikat studies even if a subject did not meet criterion for a verbal relation in one paradigm (e.g., topography-based tact) the other relation in that paradigm was still trained and tested. That was not the case with Sundberg and Sundberg (1990).

Theoretical Implications

The necessary and sufficient conditions required for the development of equivalent stimulus classes are not completely known and continue to be debated among researchers (e.g., D'Amato et al., 1985; Lazar et al., 1984; McIntire et al., 1987; Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982). McIntire et al. (1987) proposed that the important aspect of verbal behavior, as it relates to the formation of equivalence classes, is the occurrence of naming responses with different response topographies. The superior spontaneous stimulus class development of the topography-based behaviors in the present study can be considered a form of support for this analysis.

Practical Implications

The present results continue to support the notion that there are important advantages to a topography-based language system in terms of ease of learning, and now also ease of spontaneous stimulus class expansion. When these advantages are added to the practical advantages of such a system (i.e., freedom from environmental support) it becomes increasingly necessary for specialists in traditional psycholinguistics, speech pathologists, parents and teachers to reexamine their biases in favor of selection-based systems. If improved intellectual function by the developmentally disabled person results from the acquisition of a topography-based language such as signing, then the extra effort such a system imposes on parents, teachers, and other care givers may still be worth it. Of course, it would still be possible for a person with a signing repertoire to make use of a selection-based system for interacting with members of the community who are not familiar with the signs, much as is done by some deaf signers when they function in the nondeaf community.

Nor does the possible advent of selection-based computer devices that provide a familiar auditory stimuli for the listener eliminate the necessity of a topography-based language system for the language producer. In this connection Trefler and Crislip (1985) noted that "In spite of the availability of microcomputer-based systems, it is still proposed that clients should always maintain competency in the use of nontechnical augmentative systems. This is particularly important if electronically based equipment requires frequent maintenance, or if there are environments in which the client would not have access to the electronic system" (p. 151).

Another implication of the present results for language training programs with the developmentally disabled population concerns the intraverbal relation. With this population the intraverbal repertoire is frequently one of the weakest (Sundberg, 1987).

However, as shown by this study, if the developmentally disabled individual can develop a tact repertoire s/he might very well be able to develop intraverbal behavior if it was taught. The objection usually made to the teaching of intraverbal relations to a developmentally disabled learner is that "he won't understand it because it is beyond his cognitive level" (Sundberg 1987, p. 40). This point of view obviously reflects the traditional cognitive approach to language training which dominates speech pathology, special education, and psychology, and this approach may well have limited the development of the educational potential of a large number of developmentally disabled individuals.

Possible Sequencing Effects

For each subject if the topography-based tact was taught first, the selection-based was second. Similarly, if the selection-based intraverbal was third, the topography-based was fourth. It might have been easier to learn one of the relations if the other one had been previously learned--a sort of generalization in terms of features of the procedures that the two paradigms had in common--a sequence effect that could have been confounded with the results of the study. Note that in contrast to the design of the two previous studies (Sundberg & Sundberg, 1990; Wraikat, 1991) the present procedure was such that neither paradigm was systematically favored--that is, if the tact sequence favored the topography-based relation, then the intraverbal sequence favored the selection-based relation. For example, Jesse was trained with the selection-based tact first, but in his case, the selection-based intraverbal was the last task to be trained among the four verbal relations.

It will be helpful, nevertheless, to examine the individual data to see what evidence there might be for the notion that the second tact relation learned or the second

intraverbal learned was learned more easily. For the tact, four subjects started their training with the selection-based relation. As seen in Table 11, Appendix F, Jesse performed almost perfectly with both tacts and provides no useful information on this issue. Jessica's data (see Table 13 in Appendix F) support the notion of a sequence effect since she failed to meet criterion for the selection-based tact, but reached criterion with the topography-based tact in 96 trials. However, Jessica continued to do better on the topography-based tact during the subsequent retention sessions but continued to do very poorly on the selection-based tact relation which was now occurring after extensive exposure to further training. Troy, like Jessica (see Table 9 in the previous chapter) performed better on his second relation which was the topography-based tact. However, when topography-based and selection-based tacts were interspersed, Troy continued to perform perfectly with the topography-based tact but continued to make errors with the selection-based tact. Also, the abrupt improvement in his performance when he began the topography-based tact seems too large to be primarily a sequence effect. Karen was like Troy in showing an abrupt improvement when the topography-based task, the second task trained, began (see Table 10 in the previous chapter), and like Troy continued to show a very good performance throughout the study with the topography-based tact but continued to have great difficulty with the selection-based tact during its interspersal with all the other relations. In summary, then, it does not look like the superiority of the topography-based tact can be due entirely to a sequence effect.

These same four subjects had the selection-based intraverbal in the sequentially more favorable second position, but in all cases performed worse or no better with that relation than with the topography-based intraverbal which was the first intraverbal to be

trained. If there had been a sequence effect, the topography-based intraverbal would have shown even greater superiority.

Amelia, Kathleen and Jordan had the other sequence of relations, where with the tact the selection-based relation was in the more favored second position, but with the intraverbal the topography-based was in the second position. For Amelia (see Table 8 in the previous chapter) both tact relations were learned equally well. For Kathleen (see Table 12 in Appendix F) the selection-based was learned more easily, supporting the notion of a sequence effect. With Jordan, even though it was in the more favored second position, the selection-based tact was never performed well, whereas the topography-based tact was learned in one session and performed almost perfectly thereafter while it was interspersed with the selection-based tact training, another case where the topography-based superiority would have been even greater if there was no sequence effect.

With the intraverbal relation, for Amelia (Table 8 in the previous chapter) there was slight evidence for a sequence effect in that the first trained selection-based relation was less easily learned. For Kathleen (Table 12 in Appendix F) a sequence effect could be responsible for the inferior performance on the first trained selection-based relation, but this relation continued to be performed less well when it was being interspersed. For Jordan (Table 14 in Appendix F), the results could be explained as a sequence effect.

In conclusion, although it is not unreasonable to assume that the first learned relation will be at some disadvantage, it is not likely that the results favoring the topography-based relation can be accounted for in this way. It is just as likely or more so that if there was any sequence effect it worked against the topography-based relation.

Suggestions for Future Research

Better Subject Classification.

Although the process of subject selection and classification as to level of verbal function was carried out by a team of professionals, it relied basically on data in the subject's files which were not closely related to the experimental task, and on the casual observations of people who worked around these subjects. As a consequence the procedures had to be adapted throughout this study and in some instances (i.e., Jordan) this interfered with obtaining the comparative data that were targeted. More accurate classification of a subject's functioning level would not only facilitate further methodological refinements within subjects but would also allow between-subject comparisons to be made. It would probably be sufficient to present some experimental tasks prior to determining the final details of each subject's tasks.

Also in this connection, it is possible that some or all of the subjects had some sort of previous exposure to some kind of selection-based or/and topography-based language training. It is also possible that their past experiences would be such that they were familiar with some aspect of the made up objects, symbols, or names. A methodological design (i.e., group comparison) that equated for or cancelled out these possibilities is recommended.

Study of the Interspersal.

Although this study adapted its design primarily from Neef et al. (1980), no attempt was made in this study to determine the effects of interspersal on learning with these tasks. It would be a contribution to the interspersal literature if, in future

research, the design could provide a control for the factors that were confounded with the interspersal effects.

Retention.

In the present study not much time was given between learning the verbal relation and testing for retention, and responses during retention were consequated. This issue is of interest in itself as another type of comparison of topography- and selection-based verbal behavior, which would justify further experimental analysis. In addition, the effect of retention testing and/or the retention-training procedure of the present experiment on the learning of new relations, like the further study of interspersal could be of practical and theoretical interest.

Other Kinds of Subjects.

The current study also needs to be replicated with other subjects, especially with high functioning developmentally disabled individuals and normal children. These extensions might not be of great practical importance, but would have considerable theoretical significance in our efforts to understand the basic nature of verbal behavior. To extend the research to these populations, however, would require further refinement in the methodology in the direction of making the task more difficult, for example by considerably increasing the number of objects used.

As mentioned in the previous study by the same author (Wraikat, 1991) future research in this area should not only examine the fact that topography-based verbal behavior may be more beneficial for some categories of developmentally disabled individuals, but in addition try to isolate and identify the unique subject characteristics that would make him or her a potential candidate for each system.

Appendix A

Research Protocol Approval

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899

WESTERN MICHIGAN UNIVERSITY

Date: January 3, 1991

To: Riad Wraikat

From: Mary Anne Bunda, Chair Mary Anne Bunda

Re: HSIRB Project Number 91-01-09

The Human Subjects Institutional Review Board will consider your application for the approval of the research project entitled "Interspersal Training of Tact and Intraverbal: A Comparison of Topography-based and Selection-based Paradigms" at its next meeting on January 9, 1991. The review will be considered under expedited conditions.

Attendance is not required for consideration. If you decide to attend the meeting, you must contact Marjorie Kuipers in the HSIRB office, telephone number 387-5926 (24-hour voice mail available). The exact time of your review is not known, but you may arrive after 8:30 a.m. The meeting will be held in Room 3041 of the Seibert Administration Building.

Expedited reviews are initially considered by a subcommittee of the Board which makes a recommendation to the full Board regarding the approval of the application. While the subcommittee recommendation may be known prior to the full Board meeting, approval of the application cannot be made until the full Board has considered the recommendations. Immediately following the meeting of the full Board, you will receive information on the status of the application.

Thank you for the timely manner in which you made your submission.

xc: Jack Michael, Psychology

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899

WESTERN MICHIGAN UNIVERSITY

Date: January 9, 1991

To: Riad M. Wraikat

From: Mary Anne Bunda, Chair Mary Anne Bunda

Re: HSIRB Project Number 91-01-09

This letter will serve as confirmation that your research protocol, "Interspersal Training of Tact and Intraverbal: A Comparison of Topography-based and Selection-based Paradigms," was reviewed by the Board. The protocol cannot be approved until the following issue is addressed:

In the consent form you indicate the identifiable information will be published with authorization. Please specify the mechanism you will use for authorized disclosure of individuals, or remove that sentence altogether.

Please submit the above change in your protocol to the HSIRB, A-221 Ellsworth Hall. Approval may be granted after it has been received.

If you have any questions, please call Marjorie Kuipers in the HSIRB office, telephone number 387-5926.

xc: Jack Michael, Psychology

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899

WESTERN MICHIGAN UNIVERSITY

Date: January 23, 1991

To: Riad M. Wraikat

From: Mary Anne Bunda, Chair Mary Anne Bunda

Re: HSIRB Project Number 91-01-09

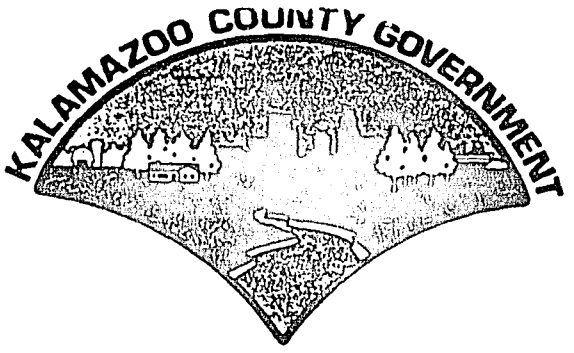
This letter will serve as confirmation that your research protocol, "Interspersal Training of Tact and Intraverbal: A Comparison of Topography-based and Selection-based Paradigms" (as revised), has been approved after expedited review by the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any change in this design. You must also seek reapproval if the project extends beyond the termination date.

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

xc: Jack Michael, Psychology

Approval Termination: January 23, 1992



HUMAN SERVICES DEPARTMENT

201 WEST KALAMAZOO AVENUE•KALAMAZOO, MICHIGAN 49007
PHONE (616) 384-8000

February 11, 1991

Mr. Riad M. Wraikat
1940 Howard Street, Apt. 484
Kalamazoo, MI 49008

Dear Riad:

Attached you will find a copy of the report letter sent to Dr. A. Roger Vander Schie concerning your recent research proposal.

I want to acknowledge your contributions to the Kalamazoo County Community Mental Health system through your work with developmentally disabled clients in the Center for Developmentally Disabled Adults. My interactions with you have been concerning your two research protocols. You have come before the Kalamazoo County Research Review Committee with worthy and professionally written research protocols. You have presented these proposals in a clear and concise manner. Your supervisor has advised us of your skill and professionalism with subjects and that your skills have caused the subjects to be reinforced by your very presence. This type of client response speaks to your bi-cultural abilities.

Riad, it has been a positive experience to work with you.

It is my understanding that you will be going home to your country, Jordan, soon. I want to express my compassion for the hardships the people of Jordan are currently experiencing. I wish you good luck with your study, your career and peace for us all.

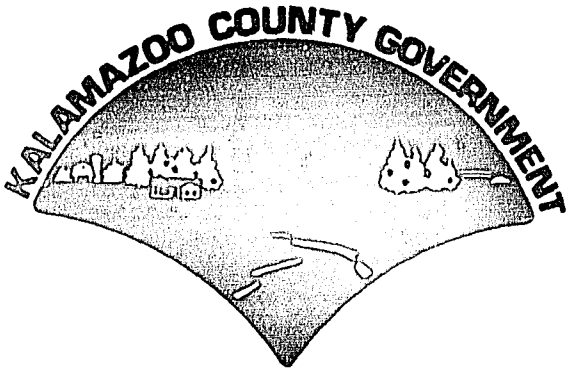
Sincerely,

Patricia

Patricia Davis Baker
Recipient Rights Officer

PDB/cd

attachment



HUMAN SERVICES DEPARTMENT

201 WEST KALAMAZOO AVENUE•KALAMAZOO, MICHIGAN 49007
PHONE (616) 384-8000

TO: Dr. David Sluyter, Director
Center for Developmentally Disabled Adults
FROM: A. Roger Vander Schie, Ed.D.
DATE: February 11, 1991
RE: Research Proposal

"INTERSPERSAL TRAINING OF TACT AND INTRAVERBAL: A COMPARISON TOPOGRAPHY-BASED AND SELECTION-BASED PARADIGMS" - Mr. Riad M. Wraikat

I am authorizing the commencement of the research proposal titled, "Interspersal Training of Tact and Intraverbal: A Comparison Topography-Based and Selection-Based Paradigms" contingent on compliance with recommendations made by the Research Review Committee.

Please forward a copy of the results of this study to the Recipient Rights Office upon its completion.

ARV/cd

cc: Patricia Davis Baker
Riad M. Wraikat

Appendix B

Consent Form, Assent Script, and Subject Selection Protocol

CONSENT FOR PARTICIPATION IN STUDY

"Interspersal training of tact and intraverbal: A comparison of topography-based and selection-based paradigms"

I, _____ as the legal guardian for _____, give my full consent for_____ to participate in the research study to be conducted by Riad Wraikat. In this study each subject will be taught to make three nonsense signs when shown three nonsense objects (objects that don't have any well-known name), and then to make the same three signs when the experimenter says three nonsense words. The same subjects will also be taught to point to three nonsense visual symbols on a symbol board when shown three different nonsense objects, and to point to the same symbols when the experimenter says three different nonsense words. The main purpose of this research will be to compare the ease of learning these two kinds of simple language relationships.

The proposed study will consist of five 15 to 20 minute sessions per week, per subject. It is estimated that the study will last between 20 to 40 sessions. Confidentiality will be maintained as follows: only the research team ,{Riad Wraikat and two (CDDA) employees}, the case managers, and guardians will be allowed to observe the sessions; all data collected or other materials which could potentially identify the subjects will be kept in a locked file at (CDDA) administration office; treated same as all records at (CDDA). By signing this Informed Consent document, I give permission for the data to be used in scientific presentations and publications.

There are no apparent risks involved in this study that are not encountered in every day teaching and programming for each subject. The benefits, for the most part will affect future situations rather than the subjects current situation. There are, however, some immediate benefits for the subjects. This procedure will act as an intellectual exercise. Every day the subjects will required to spend 20 minutes engaging in a thought provoking task. After the subjects have mastered the material in this study they can continue on with new (real) words and objects. This procedures might also work as an assessment tool in that the subjects may show some potential that was originally not shown. In this case more advanced and beneficial teaching techniques may be used for further programming. Each week subjects will have the opportunity to go to McDonalds.

Participation is voluntary. Your decision will not in any way affect current or future services received through the mental health system. Participants can withdraw at any time during the study without penalty.

Questions or complaints regarding this research , your rights or ward's rights may be directed to Sue Oole, the Right Advisor for the Center for Developmentally Disabled Adults at 388- 6163

YOUR SIGNATURE BELOW INDICATE THAT YOU UNDERSTAND THE ABOVE INFORMATION AND HAVE DECIDED TO LET YOUR WARD PARTICIPATE. you will be given a copy of this form to keep and someone will read it to you .

The anticipated commencement date is February 25, 1991. The anticipated completion date is April 25, 1991. This study will be supervised by Michael Mack, Douglass coordinator, 388-3435

_____ _____

GUARDIAN SIGNATURE, DATE
TYPE OF GUARDIANSHIP (Full, Partial)

_____ _____

ASSISTANT THERAPIST DATE

_____ _____

WITNESS(in Person) DATE

(The witness acknowledges that consent was informed and given by the authorized party willingly. The witness also acknowledges that both the subject and the subjects guardian have had the procedure thoroughly explained to them, and that their questions have been answered to to their satisfaction).

"Interspersal training of tact and intraverbal: A comparison of topography-based and selection-based Paradigms"

Riad Wraikat

Assent script stating what the researcher will say to subjects in the proposed study:

"Hello, _____. My name is Riad. I am sure you know me and that we have worked together here at Douglass. You may see me working with some of the folks here [The experimenter has a training program with some clients.] Yes, I thought maybe you saw me. I have something similar that I would like to do with you, _____. and I need to know if it is OK with you. I would like to show you some little things and teach you to name them using signs and pointing at pictures. Would that be OK with you? You are not putting your name on anything that will let anybody know who you are and what work you did. If it is OK will you sign your name here?_____ (or if the client can't write his or her name) will you make a mark on this piece of paper with this crayon? _____, the coordinator will watch you make the mark. You can stop doing this task any time you want to, and if you stop it won't make any difference for anything else you do here at the center. Thank you for helping me.

SIGNATURE_____. DATE_____.

_____ _____

WITNESS DATE

(The witness acknowledges that assent was informed and given by the authorized party willingly. The witness also acknowledges that the subject have had the procedure thoroughly explained to them, and that their questions have been answered to to their satisfaction.

SUBJECT SELECTION

Subject selection is a three-part process.

Part 1: Permission to conduct the experiment using subjects from Center for Developmentally Disabled Adults(CDDA).

The research proposal is first examined in detail by the Executive Director of (CDDA). He then reviews the proposal and discusses it with the researcher. Particular attention is given to any potential risks to subjects. Recommendations may be made regarding the research before a decision of acceptance is made. If accepted the proposal is then sent to the Kalamazoo County Human Services Department to be reviewed by the Office of Recipient Rights. A committee in this office requests the attendance of the primary researcher and the agency supervisor (the Executive Director) where they defend the research in terms of its possible risks and benefits to the subjects. If this committee approves, then subject selection can begin under the supervision of the Executive Director. Next the research is explained to the subject's Day Treatment Site Coordinator and Therapist and they are given a demonstration of the procedures involved in the experiment.

Part 2: Permission of the subject's guardian.

The experimental procedure is explained and demonstrated to the guardians of those subjects who are not their own guardians. The guardians sign a consent form (see attached sheet) which states that the procedures were explained to them and that they understand fully, and that they see no harm that could come to the subject through participation in the research. The Site Coordinator will witness each of these interactions between primary researcher and guardian and will sign his name under the name of the guardian. When the subject is his/her own guardian this part of the permission procedure will be combined with Part 3 described below.

Part 3: Explanation to the subject.

The experiment is explained to the subject in terms that s/he can understand. If the subject is his/her own guardian s/he will sign the consent form himself/herself. The signature of the subject's therapist (as witness to the signature of the subject) will indicate that the subject showed complete understanding of the procedure and agreed to participate.

Withdrawal from the research: The subjects, guardian, site coordinator and therapist will be informed, vocally and in writing that consent may be withdrawn and participation in the research discontinued at any time during the study without penalty; that willingness to participate will in no way affect current or future services received through the mental health system; if a subject does not want to participate on a given day s/he will in no way be coerced; and that the primary researcher can be contacted by phone at the CDDA office any time there are questions or concerned about the research.

Appendix C

Data Sheet Forms

Two Objects/Three Verbal Relations Data Sheet

PHASE:
Session #

Name_____ Date_____

Verbal relation **(Test trials)**: ___
Object_____

Total trials_____ Correct trials_____ % Correct_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Verbal relation **(known trials)**_____ **Criterion met Y N**
Object_____

Total trials_____ Correct trials_____ % Correct_____
Object_____

Total trials_____ Correct trials_____ % Correct_____

Verbal relation **(known trials)**_____
Object_____

Total trials_____ Correct trials_____ % Correct_____
Object_____

Total trials_____ Correct trials_____ % Correct_____

Session # ____ Total trials _____ Correct trials _____ % Correct _____

Two Objects/Four Verbal Relations Data Sheet

PHASE:
Session #

Subject name_____ Date_____

Verbal relation (Test trials): ____

Object _____

Total trials _____ Correct trials _____ % Correct _____

Object _____

Total trials _____ Correct trials _____ % Correct _____

Verbal relation (known trials)_____ Criterion met Y N

Object_____

Total trials_____ Correct trials_____ % Correct_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Verbal relation (known trials)_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Verbal relation (known trials)_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Object_____

Total trials_____ Correct trials_____ % Correct_____

Session# _____ Total trials _____ Correct trials _____ % Correct _____

Three Objects/Three Verbal Relations Data Sheet

PHASE:
Session #

Subject name _____ Date _____

Verbal relation (**Test trials**) _____

Object _____

Total trials _____ Correct trials _____ % Correct _____

Object _____

Total trials _____ Correct trials _____ % Correct _____

Object _____

Total trials _____ Correct trials _____ % Correct _____

Criterion met Y N

Verbal relation (**known trials**) _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Verbal relation (**known trials**) _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Object: _____

Total trials _____ Correct trials _____ % Correct _____

Session # _____ Total trials _____ Correct trials _____ % Correct ____

Three Objects/Four Verbal Relations Data Sheet

PHASE:
Session #

Subject name ____________ Date ____________

Verbal relation (**Test trials**) ____________

Object ________

Total trials ____________ Correct trials ____________ % Correct ________

Object ________

Total trials ____________ Correct trials ____________ % Correct ________

Object ________

Total trials ____________ Correct trials ____________ % Correct ________

Criterion met Y N

Verbal relation(**known trials**) ____________

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Verbal relation(**known trials**) ____________

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Verbal relation(**known trials**) ____________

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Object: ____________

Total trials ___ Correct trials ___ % Correct __

Session # ______ Total trials ________ Correct trials ____ % Correct __________

Appendix D

A Sample Order of Interspersal Training Sessions

A Sample Order of Interspersal Training Sessions

For all training sessions the number of trials was determined by the design but the order of presenting each trial was randomly determined. Following is a sample of the training sessions:

Two-object sessions:

1. Noninterspersal sessions consisted of 48 trials with 24 trials for each object/name.
2. Two-interspersed-verbal-relations sessions consisted of 48 trials with 24 trials for the newly trained verbal relation (test items) and 24 trials to already trained verbal relations (known items).
3. Three-interspersed-verbal-relation sessions consisted of 48 trials with 24 trials assigned to the newly trained verbal relation (test items) and 12 trials for each of the already trained verbal relations (known items).

Example

Amelia's phase III training session (where dil, koob are the SB-INV test items; plastic, sponge, the TB-tact known items and; metal, wood are the SB-tact known items): koob, sponge, dil, plastic, dil, plastic, koob, wood, koob, plastic, dil, sponge, koob, plastic, koob, wood, koob, sponge, dil, metal, dil, sponge, dil, sponge, dil, metal, koob, wood, koob, plastic, koob, wood, koob, wood, dil, plastic, dil, metal, dil, metal, koob, sponge, dil, wood, koob, metal, dil, metal.

4. Four-interspersed-verbal-relations session(s): Consisted of 48 trials with 24 trials assigned to newly trained verbal relation (test items) and 8 trials to each of the already trained verbal relations (known items).

Example

Amelia's phase IV training session (where nack, teef are the TB-INV test items; metal, wood are the SB-tact known items; plastic, sponge, the TB-tact known items; and dil, koob, the SB-INV known items): nack, plastic, teef, koob, teef, dil, nack, metal, nack, wood, nack, plastic, teef, plastic, teef, sponge, nack, metal, teef, koob, teef, dil, nack, wood, teef, koob, nack, plastic, nack, sponge, nack, koob, teef, sponge, nack, metal, teef, sponge, teef, wood, nack, wood, teef, metal, teef, dil, nack, dil.

Three object sessions:

1. Noninterspersal sessions consisted of 48 trials with 16 trials for each object/name.
2. Two-interspersed-verbal-relation sessions consisted of 48 trials with 24 trials to the newly trained verbal relation (test items) and the other 24 trials assigned to the already trained verbal relation (known items).
3. Three-interspersal-verbal-relation sessions consisted of 48 trials with 24 trials assigned to newly trained verbal relation (test items), and 12 trials for each of the already trained verbal relations (known items).

Example,

Jesse's phase III (where puck, nack and teef are the T-B Inv test items; polystyrene, plastic and sponge are the TB-tact known items; and metal, wood and cloth are the S-B Tact known items): Teef, cloth, nack, sponge, puck, metal, puck, polystyrene, teef, cloth, puck, plastic, puck, plastic, teef, polystyrene, nack, metal, teef, metal, nack, wood, nack, polystyrene, teef, wood, puck, cloth, nack, plastic,

teef, wood, puck, polystyrene, puck, cloth, teef, wood, nack, plastic, nack, metal, puck, sponge, teef, sponge, nack, sponge.

4. Four-interspersal-verbal-relation sessions consisted of 54 trials with 27 trials assigned to newly trained verbal relation (test items) and 9 trials for each of the already trained verbal relations (known items).

Example,

Jesse's phase IV session (where dil, koob and doof are the SB-INV test items; puck, nack and teef the TB-INV known items ; polystyrene, plastic and sponge the TB-tact known items and; metal, wood and cloth are the SB-tact known items): Doof, plastic, koob, sponge, doof, teef, dil, sponge, koob, nack, dil, teef, doof, polystyrene, koob, metal, doof, wood, dil, plastic, koob, nack, dil, puck, doof, cloth, koob, nack, dil, sponge, dil, metal, koob, puck, koob, wood, doof, teef, dil, metal, koob, wood, doof, cloth, dil, polystyrene, doof, plastic, dil, cloth, doof, polystyrene, koob, puck.

Appendix E

Cover Letter, Individual and Sets of Names, Symbols, and Signs

Cover Letter

Riad M. Wraikat
Psychology Department
Western Michigan University
Kalamazoo, Michigan 49008

February 20, 1991

Center for Developmentally Disabled Adults
1627 West Main street
Kalamazoo, Michigan 49007

Dear _____:

Enclose you will find a list of ten names, symbols and signs that are intended to be utilized with my dissertation research entitled , " Interspersal training of tact and intraverbal: A comparison of topography-based and selection-based paradigms".

I will be demonstrating the signs and pronouncing the names for you. I will appreciate it if you would rank order these names, symbols and signs according to their level of difficulty for the developmentally disabled adults. Please use the numbers from one to ten assuming one represents the easiest and ten represents the most difficult . Again I appreciate your effort in this matter and I thank you for your cooperation.

Sincerely,

Riad M. Wraikat

List of Individual Names

Please rank order the following names in term of their difficulty level for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

1. **Nack*** the reverse of Can. I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

2. **Dil** the reverse of Lid. I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

3. **Koob** the reverse of Book I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

4. **Puck*** the reverse of Cup I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

5. **Rood** the reverse of Door I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

6. **Pooh** the reverse of Hoop I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

7. **Moor** the reverse of Room I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

8. **Tac** the reverse of Cat I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

9. **Teef** the reverse of Feet I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

10. **Doof** the reverse of Food I I I I I I I I I I
    1 2 3 4 5 6 7 8 9 10

*Extra letter added to adjust word to experimenter pronunciation.

List of Individual Signs

Please rank order the following signs in term of their difficulty level for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

1. Moving the arm several times in a horizontal plane.
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

2. Making a circle in the air
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

3. Making a cross in the air
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

4. Making a whirlwind motion with the index finger in front of the body.
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

5. Holding up a fist
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

6. Opining the hand suddenly from a close fist
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

7. Waving the hand over the head back and forth
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

8. Fist circling.
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

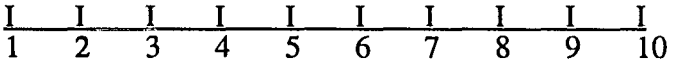
9. Opening hand.
   I I I I I I I I I I
   1 2 3 4 5 6 7 8 9 10

10. Point down with open hand.
    I I I I I I I I I I
    1 2 3 4 5 6 7 8 9 10

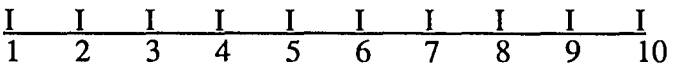
List of Individual Symbols*

Please rank order the following symbols in term of their difficulty level for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

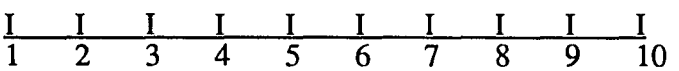
1. The Greek letter Beta



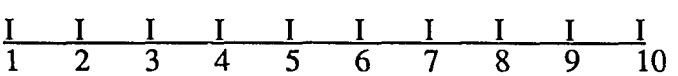
2. The Greek letter Gamma



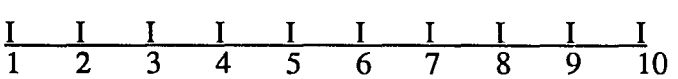
3. The Greek letter Delta



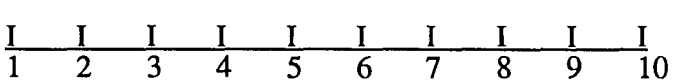
4. The Greek letter Lambda



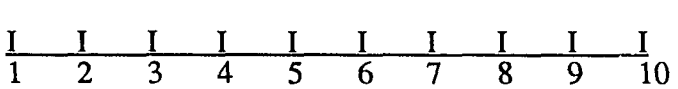
5. The Greek letter Sigma



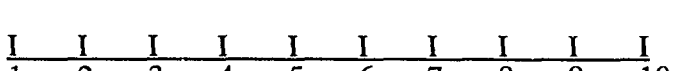
6. The Greek letter Phi



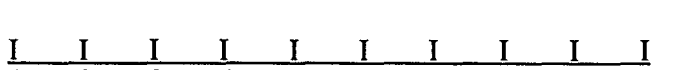
7. The Greek letter Psi



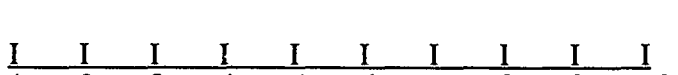
8. The Greek letter Omega.



9. The Arabic letter "B."



10. The Arabic letter "D."



*Enclosed was a copy of these symbols drawn on cardboard.

Symbol Sets[8]

Please rank order the following symbols sets in term of their difficulty level when combined for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

Set #1

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One Paradigm:
- Psi
- Delta
- Phi

The other Paradigm:
- Beta
- Omega
- Sigma

Set #2

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- Phi
- Arabic "D"
- Psi

The other paradigm:
- Omega
- Arabic "B"
- Sigma

Set #3

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- Sigma
- Phi
- Beta

The other paradigm:
- Omega
- Delta
- Psi

[8]In the case of two objects/names, one symbol from each paradigm was dropped.

Sign Sets[9]

Please rank order the following sign sets in term of their difficulty level when combined for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

Set #1

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One Paradigm:
- Moving the arm several times in a horizontal plane
- Waving the hand over the head back and forth
- Fist circling

The other Paradigm:
- Pointing down with open hand
- Opening hand
- Making a circle in the air

Set #2

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- opening hand
- Waving the hand over the head back and forth
- Holding up a fist

The other paradigm:
- Making a circle in the air
- Moving the arm several times in a horizontal plane
- Pointing down with open hand

Set #3

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- Holding up a fist
- opening hand
- Moving the arm several times in a horizontal plane

The other paradigm:
- Making a circle in the air
- Waving the hand over the head back and forth
- Pointing down with open hand

[9]In the case of two objects/names, one sign from each paradigm was dropped.

Name Sets[10]

Please rank order the following name sets in term of their difficulty level when combined for developmentally disabled adults utilizing the scale (1= Not at all difficult , 10= Very difficult).

Set #1

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One Paradigm:
- Tac
- Teef
- Nack

The other Paradigm:
- Dil
- Puck
- Doof

Set #2

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- Dil
- Puck
- Koob

The other paradigm:
- Nack
- Teef
- Doof

Set #3

I I I I I I I I I I
1 2 3 4 5 6 7 8 9 10

One paradigm:
- Puck
- Nack
- Teef

The other paradigm:
- Koob
- Dil
- Doof

[10]In the case of two objects/names one name from each paradigm was dropped.

Appendix F

Correct Trials Per Session for Jesse, Kathleen, Jessica, and Jordan

Table 11

Jesse's Correct Trials Per Session

Session	S-B Tact	T-B Tact	T-B Inv	S-B Inv
1	43 out of 48	not trained	not trained	not trained
2	24 out of 24	24 out of 24	not trained	not trained
3	12 out of 12	11 out of 12	24 out of 24	not trained
4	9 out of 9	9 out of 9	8 out of 9	20 out of 27
5	9 out of 9	9 out of 9	7 out of 9	23 out of 27
6	9 out of 9	9 out of 9	9 out of 9	23 out of 27

Table 12

Kathleen's Total

Session	T-B Tact	S-B Tact	S-B Inv	T-B Inv
1	44 out of 48	not trained	not trained	not trained
2	not trained	23 out of 24	not trained	not trained
3	18 out of 24	20 out of 24	not trained	not trained
4	22 out of 24	23 out of 24	not trained	not trained
5	9 out of 12	10 out of 12	13 out of 24	not trained
6	12 out of 12	12 out of 12	11 out of 24	not trained
7	12 out of 12	12 out of 12	17 out of 24	not trained
8	8 out of 8	8 out of 8	4 out of 8	13 out of 24
9	8 out of 8	8 out of 8	4 out of 8	17 out of 24
10	8 out of 8	8 out of 8	4 out of 8	22 out of 24

Table 13

Jessica's Correct Trials Per Session

Session	S-B Tact	T-B Tact	T-B Inv	S-B Inv
1	21 out of 48	not trained	not trained	not trained
2	25 out of 48	not trained	not trained	not trained
3	25 out of 48	not trained	not trained	not trained
4	not trained	32 out of 48	not trained	not trained
5	11 out of 24	43 out of 48	not trained	not trained
6	10 out of 24	19 out of 24	not trained	not trained
7	12 out of 24	23 out of 24	not trained	not trained
8	N out of A	24 out of 24	not trained	not trained
9	not trained	not trained	29 out of 48	not trained
10	not trained	not trained	23 out of 24	not trained
11	not trained	not trained	not trained	26 out of 48
12	not trained	not trained	not trained	22 out of 48
13	not trained	not trained	not trained	25 out of 48
14	not trained	not trained	18 out of 24	11 out of 24
15	not trained	not trained	19 out of 24	10 out of 24
16	not trained	not trained	22 out of 24	13 out of 24

Table 14

Jordan's Correct Trials Per Session

Session	T-B Tact	S-B Tact	S-B Inv	T-B Inv
1	44 out of 48	not trained	not trained	not trained
2	22 out of 24	6 out of 24	not trained	not trained
3	24 out of 24	11 out of 24	not trained	not trained
4	24 out of 24	12 out of 24	not trained	not trained
5	24 out of 24	16 out of 24	not trained	not trained
6	24 out of 24	16 out of 24	not trained	not trained
7	24 out of 24	16 out of 24	not trained	not trained
8	not trained	not trained	15 out of 48	not trained
9	not trained	not trained	20 out of 48	not trained
10	not trained	not trained	25 out of 48	not trained
11	not trained	not trained	not trained	32 out of 48
12	not trained	not trained	not trained	42 out of 48
13	not trained	not trained	not trained	22 out of 24

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EASE OF LEARNING AND THE EMERGENCE OF EQUIVALENCE CLASS FORMATION: A COMPARISON OF TOPOGRAPHY-BASED AND SELECTION-BASED PARADIGMS

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Michael (1985) identified two types of verbal behavior, topography-based (i.e., speaking or using sign language) and selection-based (i.e., symbol board). Sundberg & Sundberg (1990) and Wraikat (1991) compared these systems in terms of the ease of learning object naming (tact) and giving the correct sign or pointing to the correct symbol on hearing the object name (intraverbal). Sundberg & Sundberg (1990) also compared them for the spontaneous development of a new relation, identifying the object when hearing its name (stimulus class formation or equivalence). The results of both studies favored the topography-based system, but in each case some subjects were too low functioning to learn either system and some learned both too easily to permit a useful comparison. The current study replicated the two previous ones by teaching the same two verbal relations and testing for the emergence of the same new relation, but obtained more useful comparisons by adjusting the task to the subject's level of function during the experiment. This was accomplished by varying the number of object relations being learned, and by interspersing already learned tasks with the training of new tasks. Useful comparisons were obtained from all seven subjects. As with the earlier studies, topography-based verbal behavior was easier to learn and led to more new stimulus-class relations than selection-based verbal behavior. These data confirm the relevant theoretical analysis, and have practical implications for a change in current language training practices.