

# Teaching Mands by Manipulating Conditioned Establishing Operations

Genae Hall<sup>1</sup> and Mark L. Sundberg

West Virginia University and Sundberg & Associates, Concord, CA

Skinner's (1957) analysis of verbal behavior suggests the functional independence of the verbal operants. However, only a few empirical studies have directly examined the nature of these operants, and their independence. The present study evaluated whether teaching topographies as tacts would lead to their emission as mands. The results indicated that manding only occurred reliably after direct mand training, which consisted of the use of imitative and tact prompts, and fading those prompts, to transfer stimulus control from nonverbal stimuli to conditioned establishing operations. The results contribute to the existing data on the functional independence of mands and tacts, as well as demonstrate the value of manipulating conditioned establishing operations for mand training.

Skinner's (1957) book *Verbal Behavior* provided a functional analysis of verbal events from the perspective of an individual speaker and classified those events into the "verbal operants" (mands, tacts, echoics, intraverbals, textual behavior, taking dictation, and copying a text). This analysis was unique because it made no appeal to hypothetical explanatory entities such as innate language acquisition devices or internal mechanisms which accept, process and store spoken words. Skinner called the analysis an "exercise in interpretation"; behavioral principles found to be operating under highly controlled conditions in the laboratory, with nonhumans, were extrapolated to complex human behavior in the natural environment. This functional approach departed radically from the linguistic tradition of studying the grammatical structure and "meaning" of verbal response-products, regardless of the controlling circumstances for the speaker's behavior.

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*Verbal Behavior* contributed a functional alternative to the linguistic model and revealed a type of complexity in verbal events that had previously been overlooked. Because verbal relations included both response forms and their controlling variables, identical topographies could participate in a number of different verbal relations and different topographies could participate in a single verbal relation. The dependent variable unit now included controlling variables as well as topographies.

This functional approach suggested new ways to predict and control verbal behavior. At the same time, its complexity revealed new practical problems for researchers in the area. Functional units which included obscure or temporally remote controlling variables were more difficult to observe and measure than words, sentences and parts of speech *per se*. Verbal behavior's complexity also required new research skills, such as manipulating subjects' histories, arranging new types of motivative variables or "establishing operations" (Michael, 1982a) and analyzing equivalence classes (Sidman, 1971).

For various reasons, *Verbal Behavior* failed to generate much research or theoretical activity in the first 20 years after its publication in 1957 (Peterson, 1978; Vargas, 1986). Most behavioral language research was (and still is) controlled by the linguistic model, and the language of the "common culture." Although not conceptualized within a verbal behavior framework, this research has pro-

duced data which are relevant to Skinner's analysis.

The early behavioral language research was mainly designed to solve applied problems (e.g., remediate language deficits with developmentally delayed individuals), and researchers initially assumed that teaching words, sentences and parts of speech *per se* using behavioral methods would establish functional and appropriate language repertoires. Unfortunately, acquiring response forms in training situations rarely led to "initiations" or "spontaneity." This problem was pointed out by Lovaas (1977) who wrote: "Perhaps because of the highly controlled nature of our language training and its reliance on experimental rather than 'natural' reinforcers, many of the children showed verbal behavior that had come under very restricted environmental control" (p. 17).

A functional analysis of this problem might compare the type of verbal relation (unit) established in the training situation with the type of verbal relation desired in the natural environment. If these verbal relations are different, the question arises whether teaching one verbal relation should automatically produce the other.

"Initiations" in the natural environment are often mands—a specific type of verbal relation. Skinner (1957) defined the mand as "a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the control of relevant conditions of deprivation or aversive stimulation" (pp. 35-36). The form of the mand is controlled by these conditions of deprivation or aversive stimulation called "establishing operations" by Michael (1982a, 1987). An establishing operation (EO) is defined by Michael (1987) as "an environmental event, operation, or stimulus condition which affects an organism by momentarily altering (1) the reinforcing effectiveness of other events, and (2) the strength of that part of the organism's repertoire that has been reinforced by those other events" (p. 30). Michael goes on to distinguish between two types of EOs: unconditioned establishing operations (UEO), and conditioned establishing operations (CEO). UEO's "are events, operations, (or) stimulus conditions whose value-altering effects are unlearned. They depend upon the evolutionary history of the particular species, and

vary from species to species" (p. 30). Food deprivation, for example, is an unlearned operation (the behavior of asking for food is, of course, learned, but the value altering effects are not).

The second type of establishing operation, the CEO, involves value-altering effects which have been learned during the individual organism's history. For example, the value of a certain toy may become momentarily strong, because of an individual child's conditioning history, and the immediate contingencies. Michael (1982b) defines the mand as controlled by these two types of establishing operations, as well as the specific consequences linked to the relevant EOs. According to Skinner (1957), the mand is the most functional verbal operant for the speaker. He stated that "When we come to consider other types of verbal operants, we shall find that the behavior functions mainly for the benefit of the listener... The mand, however, works primarily for the benefit of the speaker" (p. 36).

Unfortunately, most structured language sessions often contain training on only tact or echoic relations. Skinner (1957) defined the 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" (pp. 81-82), and the echoic as "verbal behavior... under the control of verbal stimuli... (where)... the response generates a sound pattern similar to that of the stimulus" (p. 55). Tact training often occurs as follows: The child is presented with an object, asked "What is this?", then required to emit the appropriate topography, and then given some educational consequence such as social praise or a small edible. With echoic training, the child might be asked to "Say \_\_\_\_\_," then provided with the same type of consequence as for the tact.

According to Skinner's analysis, teaching tacts or echoic relations should not automatically lead to mands. It is the linguistic model which suggests that once the child learns the "meaning" of a word (e.g., learns to say the word under tact conditions), he or she will then "use" that word under all conditions. Skinner (1957) has instead suggested that the verbal operants are functionally independent: "In the terminology of meaning, we say that the word 'doll' is used at one time

to 'ask for a doll' and at another to 'describe or refer to a doll.' When the response Doll! has been acquired as a mand, however, we do not expect that the child then spontaneously possesses a corresponding tact of similar form. If we find both operants in the repertoire of the child, we must account for them separately" (p. 187). According to this analysis, then manding or "spontaneity" may need to be trained directly.

Without conducting this type of analysis, a number of recent applied behavioral language studies have addressed the problem of restricted stimulus control. In most cases they have trained manding, although the dependent variable has generally been described as "spontaneity" or "language use." These studies manipulated independent variables such as the presence of reinforcing items, imitative prompts, time delays and specific reinforcement procedures, to train manding.

Hart and Risley (1968, 1974, 1975, 1980) used an "incidental teaching" procedure to train more appropriate mands, with disadvantaged children. This procedure was relatively unstructured in the sense that teaching interactions were child-initiated and occurred in the natural environment. Children first made rudimentary mands for presumed reinforcers (establishing operations were not manipulated) which were visible but out of reach. They were then imitatively prompted to improve or elaborate their manding topographies, and specific reinforcers were provided. As a result of this training, the children demonstrated stronger mand repertoires.

Halle, Marshall and Spradlin (1979), Halle, Baer and Spradlin (1981) and Charlop, Schreibman and Thibodeau (1985) employed a "time delay" procedure with developmentally delayed children to establish mands or evoke previously acquired mands. This procedure was more structured than incidental teaching, in that certain times were designated "opportunities" for initiations (manding). At these times, certain reinforcing events which regularly occurred were briefly delayed. If mands for these events did not occur within the designated time period, they were imitatively prompted. Specific reinforcers were then presented. This procedure was also successful in generating mands.

Simic and Bucher (1980) evaluated similar mand training procedures with developmentally delayed individuals. Two manding responses were successfully trained, in the presence of the manded items. In this study, the dependent variable *was* described as manding, however, establishing operations were not manipulated.

In both the incidental teaching, and the time delay procedures, manding was freed from control by verbal discriminative stimuli such as "What do you want?" However, in most cases (except in the time delay procedure, where the reinforcer was assistance from a teacher) manding was still dependent upon the presence of nonverbal discriminative stimuli (the manded items), which makes the response part tact.

Carr and Kologinsky (1983) trained autistic children to mand for missing items, which were presumed to be reinforcers. Children were imitatively prompted to mand for each item, then provided with the specific reinforcer. Carr and Durand (1985) trained developmentally delayed children to mand conventionally for adult attention or help with a task, as alternatives to inappropriate mands (problem behaviors). Appropriate mands were imitatively prompted. In both of these studies, trained mands were under the control of the establishing operation; no verbal or nonverbal stimuli were involved (except an audience).

The above studies appear relevant to Skinner's analysis in two ways: First, they demonstrated that the mand relation could be established. Second, the early problem of restricted stimulus control tentatively supported the notion of functional independence. When response forms were trained as tacts or echoics, they apparently did not automatically occur as mands ("spontaneity" did not occur). This research was not explicitly designed to assess functional independence, however, and the appropriate conditions to assess transfer may not have been present.

Recently, a few basic verbal behavior studies have demonstrated the functional independence of the verbal operants with nonhumans. Savage-Rumbaugh (1984) showed the separation of several verbal repertoires with two chimpanzees. She concluded "the procedures developed for apes support Skinner's analysis...and have

significant applied value for training mentally retarded humans'' (p. 249). Michael, Whitley and Hesse (1983), and Sundberg (1985) also demonstrated the separation of the verbal repertoires, but with pigeons. Birds who were taught to tact did not mand or emit intraverbal behavior until directly trained.

Several basic studies with humans have directly assessed the functional independence of the speaker and listener, and of the verbal operants. Lee (1981) assessed functional independence of verbal and nonverbal behavior (speaker and listener repertoires) related to the same prepositional configuration of objects, with moderately retarded and elementary school children. It was found that initial training on nonverbal relations never led to verbal relations, but acquiring verbal relations sometimes led to nonverbal relations (when nonverbal topographies had been emitted during baseline, but under defective stimulus control). After subjects were trained in *both* verbal and nonverbal relations, reinforced changes in verbal responding led to collateral changes in nonverbal responding, but not vice versa. Thus, transfer was unidirectional and related to the subjects' entering repertoires; functional independence was conditional.

Lee and Pegler (1982) evaluated functional independence of reading and spelling, with two fifth graders who could not read. This study assessed the effects of oral reading, reading overtraining, repeated testing on spelling and a "word exposure" procedure on correct spelling of the same words that were read. Two of these conditions led to greatly improved spelling, two did not; functional independence was inconsistent.

Lamarre and Holland (1985) assessed functional independence of mands and tacts related to the same prepositional configuration of objects, with nursery school children. Some subjects received mand training first and others received tact training first, then transfer to the untrained repertoire was tested. It was found that mands and tacts of the same form were functionally independent, at the time of acquisition. After subjects were trained in *both* verbal relations, reinforced changes in the first repertoire led to collateral changes in the second repertoire, with three of the nine subjects; functional independence was maintained with six sub-

jects. This inconsistency points to the need for future research to elucidate the controlling variables for functional independence.

The above research has raised further questions related to effective mand training and the conditions under which functional independence occurs. One question related to effective mand training is whether it is necessary to conduct training only in the natural environment. By manipulating conditioned establishing operations the value of consequences can be rapidly changed allowing for more controlled training procedures. Training in the natural environment is important and usually effective, but many of the natural UEOs build up slowly and, like most CEOs in the natural environment, weaken following the delivery of the specific reinforcement characteristic of the mand. Procedures conducted in naturalistic settings were *sufficient* to teach manding, but perhaps they were not necessary. Structured settings might avoid the problem of restricted stimulus control by training the mand relation (where the form of the response, by definition, is not controlled by a discriminative stimulus) and determine which reinforcers are currently effective by manipulating establishing operations.

A second practical question concerns to what extent mand training procedures allow the experimenter to control the specific topographies to be trained. Incidental teaching and time delay procedures trained mands for items or events which had already been established as reinforcers; they did not manipulate the reinforcing effectiveness of these items or events. Procedures which did manipulate establishing operations would allow mands for *any* objects or actions to be trained. With such procedures, the experimenter might not have to "capitalize on opportunities, when they arose" to train manding; these opportunities would be created.

A third practical question is whether manding for a variety of missing items or events can be trained. With incidental teaching and time delay procedures, the mandated items were usually present and visible. Manding was not dependent on verbal discriminative stimuli such as "What do you want," but the presence of particular items served as discriminative stimuli that mands for those items would be reinforced. Mand-

ing for missing items would seem to be maximally functional, since subjects would not have to wait for items to appear before manding them. Two applied studies (Carr & Kologinsky, 1983; Carr & Durand, 1985) demonstrated that manding for missing items or events could be trained. The first study trained autistic children to mand for missing items which were presumed to be reinforcers; establishing operations were not manipulated. In the second study, establishing operations were manipulated; task difficulty was varied with developmentally delayed children, to establish the effectiveness of adult attention or help as reinforcers. Then, manding for those reinforcers was trained. This research might be extended by developing systematic procedures to establish the effectiveness of a wider range of items as reinforcers, so that a variety of mands could be trained.

In addition to these applied questions, the basic issue of functional independence remains to be clarified. Lamarre and Holland (1985) found unambiguous evidence of functional independence of mands and tacts at the time of acquisition, but Lee (1981) and Lee and Pegler (1982) showed results that were less consistent. None of these studies showed that functional independence was maintained with all subjects *after* both repertoires had been acquired. Inter-subject differences raised the question of how subjects' histories interact with the different conditions, to produce transfer or functional independence. Further research is needed, to identify the relevant variables.

The purpose of the present study was to assess the following research questions with two deaf, mentally impaired and language delayed students:

1. Whether mands can be trained in a structured setting, where the experimenter controls the topographies to be trained by manipulating conditioned establishing operations.

2. Whether structured procedures will lead to generalized manding (where untrained mands occur under the same as well as novel stimulus conditions, and trained mands occur under novel stimulus conditions).

3. Whether subjects' histories and conditioned establishing operations can be manipulated in order to create opportunities for manding (teach specific mands at specific times).

4. Whether establishing specific verbal topographies under tact conditions is sufficient to produce emission of those same topographies under mand conditions.

5. If establishing tact relations is insufficient to produce mands, whether an imitative or tact prompting procedure will train mands more effectively.

## METHOD

### *Subjects and Setting*

The subjects were two deaf students, one male and one female, enrolled in a day training program for the mentally and/or physically impaired. In addition to being profoundly deaf, they were diagnosed as severely mentally impaired. They were 16 and 17 years old respectively, and were chosen because of their extremely low rates of manding behaviors. Both subjects had extensive tacting repertoires, and had received some training on manding for items which *were* present, using a "mand frame" (e.g., "I want \_\_\_\_\_."). However, they never manded in the absence of a verbal discriminative stimulus; and, when asked, "What you want?" in sign when no reinforcing objects were present, each would emit a single stereotypic response. Subject 1 (the male) would mand "walk" and subject 2 (the female) would mand "coloring book." They emitted no other mands for missing items or actions. The form of these stereotypic manding responses did not appear to be controlled by what would function as strong reinforcers at the moment, since the students would make these responses at any time during the day (early in the morning, before lunch, whenever they counted their tokens to exchange for back-up reinforcers).

### *Observation and Reliability*

The experimenter (the first author) conducted all primary observations, and two other staff members at the facility served as reliability observers. One class of behaviors to be observed during pretraining, baseline, and training conditions consisted of manual signs in American Sign Language (tacts or mands). Other responses which were observed, during pretraining only, were actions which the subjects were required to independently initiate with one object in each of the four response chains. The reliability observers were shown the signs they

could not already tact, although both were familiar with sign language.

During tact and mand probes, a trial was scored as correct if the appropriate tact or mand occurred at any time during a 10-second observation period (if it was recognizable, it was scored as correct). For tacts, the observation period began immediately after an object to be tacted was presented. For mands, the observation period began at the point that the subject needed a missing item to complete a chain of behavior leading to a reinforcer.

The response definitions for actions initiated with one object for each chain (during chain completion probes) are presented in the Procedure section. During these probes, a trial was scored as correct if the subject initiated the appropriate action with the object, without assistance.

Reliability was taken during pretraining, both in chain completion sessions, where data were collected to establish that the students had met criterion on initiating actions with particular objects in the chains, and in tact training sessions. Reliability was also taken during mand probes in baseline and training conditions. Reliability observers were instructed to score correct responses immediately—the primary observer waited one second, reinforced the mand by presenting the item manded, and then scored the response. Incorrect responses were not scored. The primary and reliability observers were seated at the same table as the student, about two yards away from each other, with their data sheets faced in different directions.

### Design

The designs used were a multiple baseline across subjects and behaviors (Baer, Wolf, & Risley, 1968) and a multielement design (Ulman & Sulzer-Azaroff, 1975). Subject 1 received training on the first and second pairs of mands sooner than Subject 2. In addition, within *each* subject, a first pair of mands was trained before a second pair. Pairs of mands were also trained simultaneously in a multielement design, to compare the effectiveness of tact and imitative prompting procedures.

### Pre-training

Prior to the baseline conditions, both subjects were trained to criterion on the following prerequisite skills:

1. Both were taught to complete four chains of behavior leading to a reinforcer. The trainer provided some assistance in completing the chains, but the subjects were required to independently initiate the first action for each object that would later be trained as a mand, at a criterion of 100% accuracy for two consecutive days. Physical guidance was used initially and was faded until criterion was reached. The four chains of behavior, the objects and actions involved, and the response definition for "initiating the first action with the object" are presented below.

### Subject 1

- a. *Making instant soup.* The objects involved were instant soup, hot water, a bowl, and a spoon. The actions consisted of tearing open the package of instant soup, pouring it into a bowl, pouring hot water on it from a plug-in pot which had already been heated, stirring the soup, and eating it with a spoon. The object from this chain that would later be trained as a mand was the hot water. It was, therefore, required that the student initiate an action with the water. This action consisted of picking up the pot and pouring at least one drop into the bowl.
- b. *Opening a can of fruit.* The objects involved were a can, can opener, a bowl, and a spoon. The actions consisted of taking the can opener, opening the can, pouring the fruit into the bowl, and eating the fruit with a spoon. The object from this chain that was to be trained was the can. Initiating an action with the can consisted of touching the top of it with the can opener.
- c. *Wiping up water spilled on the table* (a dry table was a reinforcer for the student, when water had been spilled). The objects involved were water and a paper towel. The chain consisted of the trainer spilling a small amount of water on the table, from a glass that was filled to the top. The student then took the paper towel which was present and wiped up the water. The object to be trained was the

paper towel. Initiating an action with the paper towel consisted of picking it up and at least touching the water spilled on the table.

- d. *Operating a vending machine to get candy.* The objects involved were the vending machine and money (a quarter). The chain consisted of the student taking the quarter and putting it in the slot. The trainer then assisted the student in pressing the right button to get a candy bar. The object to be trained was the money. Initiating an action with the money consisted of taking it and making contact with the money slot on the machine.

### Subject 2

- a. *Making instant soup.* The objects, actions, and response definition for initiating the action were the same as for Subject 1.
- b. *Opening a can of fruit.* Again, the objects, actions, and response definition were the same as for Subject 1.
- c. *Making instant coffee.* The objects involved were instant coffee, hot water, a cup, and a spoon. The chain consisted of opening the jar of coffee, taking out a teaspoonful of coffee, putting it in the cup, pouring hot water in the cup, and stirring the coffee with a spoon. The object to be trained was the cup. Initiating an action with the cup consisted of putting some (any) amount of instant coffee in the cup.
- d. *Coloring a large picture.* The objects involved were a large, partly uncolored picture and colored pens. The chain consisted of selecting a pen from the container and coloring a small section of the picture. The object to be trained was the pen. Initiating an action with the pen consisted of taking a pen and touching the picture with it.
2. Both subjects were tested to determine whether they had correct tacts for all items necessary to complete each chain. The experimenter successively presented each item and signed, "What that?" Correct responses were reinforced with

tokens. If a tact was incorrect, the experimenter modeled the correct response and re-presented the discriminative stimulus. This correction loop was repeated until the student emitted a correct response without the imitative prompt. Tacts were either tested or trained until a criterion of 100% accuracy for two consecutive days was met.

### Baseline

Baseline consisted of mand probes, where all items necessary to complete a chain, except for one item, were presented to the student. Then, the trainer manually signed the specific discriminative stimulus to begin each chain. The following discriminative stimuli were used:

1. Soup chain—"Make soup. Start."
2. Can chain—"Open. Start."
3. Wiping table chain—"Wipe. Start."
4. Vending machine chain—"Get candy. Start."
5. Coffee chain—"Make coffee. Start."
6. Coloring chain—"Make picture. Start."

After the discriminative stimulus was given, the trainer provided some assistance for the student in completing the chain up to the point that the missing item was needed. The assistance consisted of the minimal amount of physical guidance necessary to ensure that the steps in the chain were completed. At the point where the missing item was needed to continue, the trainer provided no assistance and waited 10 seconds. If the missing item was mandated within this time period, it was presented; the student could complete the chain and obtain the reinforcer. If an incorrect mand or no response occurred within the time period, all items were removed and the next chain was presented.

### Training

Mand probes continued during training and were conducted the first time a particular chain was presented, for each session. If students failed to mand within the 10-second time period in the probe situation, training was conducted.

Two training procedures, tact prompt and imitative prompt, were compared in a multi-element design. Of the four mands eventually trained for each subject, two were trained only with the tact prompt procedure; and

two only with the imitative prompt procedure. First, two mands were simultaneously trained (both in each session) using the different procedures; and, after both were mastered, two more were simultaneously trained. The mand that was trained first each session was alternated randomly.

The tact prompt procedure occurred as follows. First, a mand probe was conducted, as described in the Baseline section. If the correct mand did not occur, the trainer presented the missing item, signed, "What that?" and the student tacted the item. If a correct tact did not occur, the trainer modeled the topography and represented the question. After a correct tact, the item was left in front of the student, the trainer signed, "What you want?" and the student repeated the topography. If the correct response (partly mand and partly tact) did not occur, the trainer modeled it and represented the question. After a correct response to "What you want?", all items were removed for 5 seconds, then re-presented except for the previously missing item. At this point, the stimulus situation was identical to the previous probe condition, where the student could mand without prompts and receive a specific reinforcer (the missing object). If the correct mand did not occur, training was continued by repeating the correction loop. All correct responses during training, except correct mands under unprompted probe conditions, were reinforced with tokens. Both students were already on a token economy and tokens had been established as conditioned reinforcers. At the end of each session, tokens were exchanged for backup reinforcers that the students typically earned, such as edibles or activities different from those used in the chains.

The imitative prompt procedure differed from the tact prompt procedure in only two ways:

1. Instead of presenting the missing item after a failure to mand within 10 seconds and signing "What that?", the trainer did not present an item but instead signed, "Do this."
2. After signing "Do this," the trainer presented an imitative prompt. If a correct imitation of the topography occurred, the subject could then go on to the next step, which was, "What you want?" If not, the trainer physically prompted

the response and represented the instruction.

#### *Generalization probes*

When the target response was a mand which had been previously trained, stimuli slightly different from those used in training were presented. When the target response was a topography which had not been previously trained as a mand (it had been previously trained under tact, but not mand, conditions), stimuli which were the same as those used in training were presented. In a few cases, the stimuli used in generalization probes and the target responses were both different. The specific stimuli and target responses are shown in Table 1 of the Results section.

The general procedure for probes remained the same as during baseline and training, except that the discriminative stimuli to begin the coffee chain and the coloring chain for Subject 2 had to be slightly modified. Since the new target response for the coffee chain was "coffee," the discriminative stimulus was changed from "Make coffee. Start." to "Make drink. Start." So that an imitative prompt would not be provided. Likewise, the new target response for the new coloring chain was "picture"; it was therefore necessary to change the discriminative stimulus from "Make picture. Start." to "Draw. Start."

## RESULTS

Reliability was taken in pretraining, baseline, and training conditions. In pretraining, reliability was taken in 49% of tact training sessions and 100% of chain completion sessions used to establish that subjects had met criterion on the chains. Reliability was taken in 29% of baseline sessions and 29% of training sessions. There were no instances of disagreement in any of the conditions.

As shown in Figure 1 only a few mands occurred during the baseline probes. Correct mands reliably occurred only after training was implemented. Teaching topographies under tact conditions and arranging stimuli so that previously tacted objects currently functioned as reinforcers was not sufficient to produce the same topographies under mand conditions. This did not appear to be a tact maintenance problem, because when the tact prompt procedure was initiated after



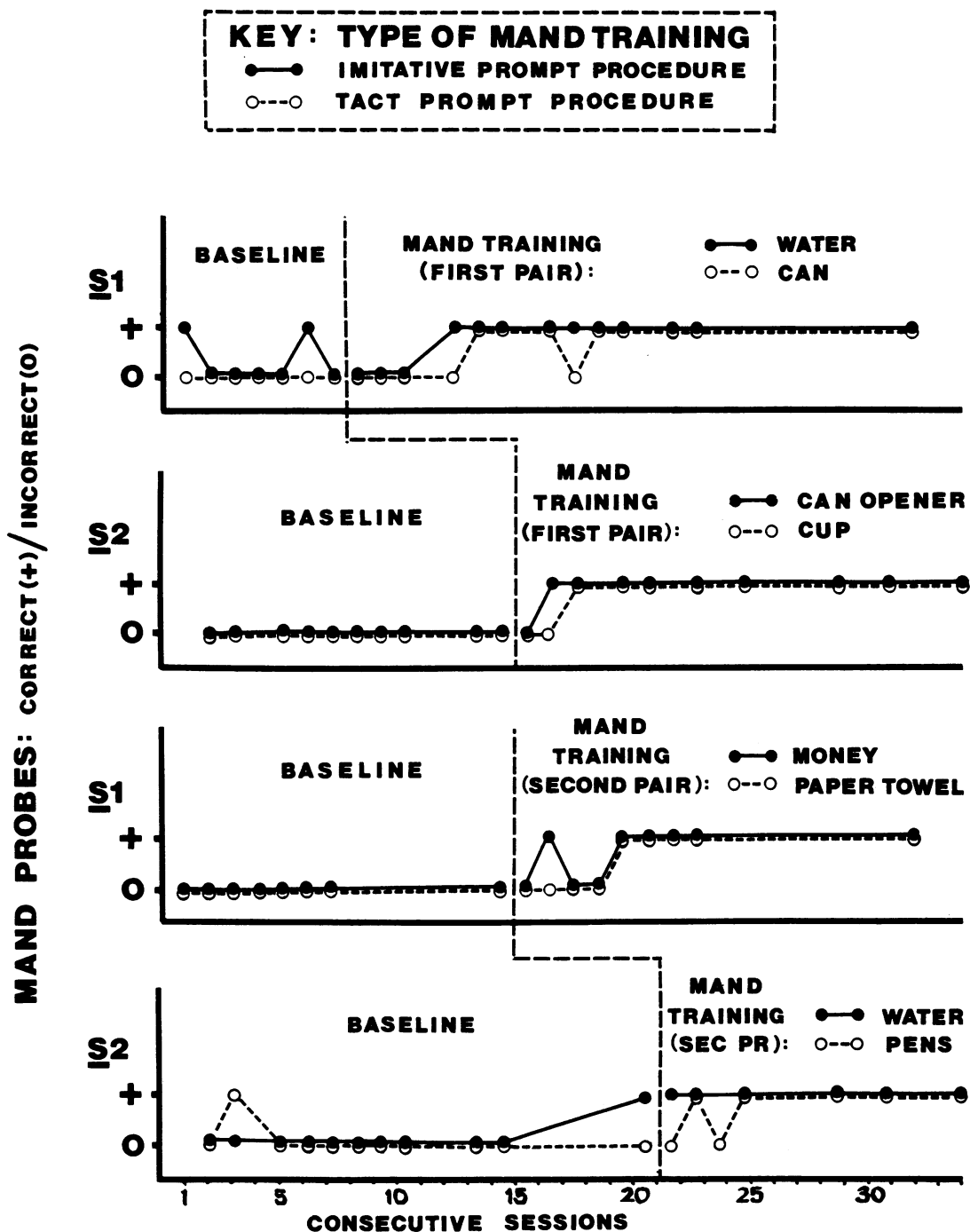


Figure 1. Performance on mand probes during baseline and training during both training conditions, for Subject 1 and Subject 2.

Table 1  
 Generalization Probes: Specific Stimuli Used,  
 Target Responses (Mands) and Whether the Responses Were Correct

| Session   | Stimulation during Generalization Probes   | Trained Responses  | Generalization Responses   | Correct? |
|-----------|--|--|--|----------|
| Subject 1 |  |  |  |          |
| Session 1 | 1. Soup chain items, plus S <sup>D</sup>   | Water  | Bowl   | 0        |
|           | 2. Can chain items, plus S <sup>D</sup>  | Can  | Can opener   | +        |
|           | 3. Vending chain items, plus S <sup>D</sup><br>(different machine)   | Money  | Money  | +        |
|           | 4. Wiping table chain items, plus S <sup>D</sup><br>(different table)  | Paper towel  | Paper towel  | +        |
| Session 2 | 1. Coke chain items (entirely different chain and S <sup>D</sup> --items were coke and cup; the S <sup>D</sup> was, "Drink pop. Start.") | None for this chain  | Cup  | +        |
| Session 3 | 1. Empty table, no S <sup>D</sup> . Reinforcement period after session.  | Soup, water, bowl, spoon, can, can opener, paper towel, walk, money, run, sit, eat | Soup, water, bowl, spoon, can, can opener, paper towel, walk, money, run, sit, eat | all +    |
| Subject 2 |  |  |  |          |
| Session 1 | 1. Soup chain items, plus S <sup>D</sup>   | Water  | Bowl   | +        |
|           | 2. Coffee chain items, plus S <sup>D</sup><br>(different S <sup>D</sup> )  | Cup  | Coffee   | 0        |
|           | 3. Can chain items, plus S <sup>D</sup>  | Can opener   | Can  | +        |
|           | 4. Picture chain items, plus S <sup>D</sup><br>(different S <sup>D</sup> )   | Pens   | Picture  | +        |

baseline, students made the correct facts three out of four times without prompts.

Only one mand (the third trained for Subject 2) appeared to be acquired during baseline, after training for the first and second mands had been completed. The incidences of correct manding of "water" during baseline for Subject 1 and "pen" for Subject 2 were not maintained. No other correct manding responses occurred during baseline. After training on the four mands for each subject, correct responding across time was maintained, with the exception of one incorrect response for Subject 1, which was retrained in one trial.

As shown in Table 1, three types of generalizations occurred after completion of training on all four mands. Subject 1 emitted trained mands in the presence of both the same stimuli (except for the item that was missing from the chain) and different stimuli with respect to the training conditions. He also emitted trained mands in the presence of slightly different stimuli. Subject 2 emitted different mands in the presence of the same stimuli (except for the missing item) and different mands in the presence of different stimuli.

In terms of comparing the two prompting

procedures, they produced similar results. Both were effective in training manding, and neither was markedly superior.

## DISCUSSION

The present results indicate that manding for missing items can be trained using a structured procedure, where the experimenter selects the mands to be trained. This procedure manipulated subjects' histories and conditioned establishing operations (Michael, 1982a, 1987) to teach specific mands at specific times. Subjects' histories were manipulated by allowing them to repeatedly complete four chains of behavior (with some assistance) and contact certain reinforcers at the end. This pretraining established the objects needed for chain completion as conditioned reinforcers, and established an invariant sequence of responses. After this history, it was possible to manipulate conditioned establishing operations by removing items which were essential for chain completion. This procedure established the momentary effectiveness of the missing objects as reinforcers, and topographies correlated with these missing objects could then be prompted.

A second finding was that direct mand

training was necessary, to establish reliable manding responses. Teaching subjects to tact objects during pretraining and establishing conditions under which those objects functioned as reinforcers during baseline were not sufficient to produce manding for missing items. These results (together with Lamarre & Holland, 1985) would support Skinner's (1957) interpretation that mands and tacts are functionally independent at the time of acquisition.

There were indications that subjects were affected by establishing operations during the mand baseline (after tacts were established), but simply did not have appropriate manding responses. For example, Subject 1 had to mand for the missing item "money" to operate a vending machine and get candy. Instead of emitting the conventional topography (which he reliably emitted as a tact), he tried putting his hand into the experimenter's pocket. With the other chains, both subjects tried to get up and find the missing items themselves, or they emitted unconventional topographies, like tapping the experimenter's arm. Another possible unconventional mand occurred during baseline. On the wiping table chain, Subject 1 did not have the conventional mand "paper towel" and aggressed toward the experimenter. There were additional indications that the chains led to strong reinforcers. Both subjects ate the consumables and engaged in reinforcing activities quickly; they also repeated mands vigorously when there was a short delay before presentation of a reinforcer.

After four mands were trained for each subject, transfer from tacts to mands and stimulus generalization were tested. Subject 1 showed transfer from tacts to mands in three out of three probes, and emitted two trained mands in the presence of slightly different stimuli. After a few transfer and generalization sessions, Subject 1 also began manding before the discriminative stimulus to begin the chain was presented, and before any items were placed on the table. After each mand, the manded item was presented; and he continued manding for all the necessary items to complete the chain. When the items were all present, he made the sign for the discriminative stimulus to start the chain, and completed it. After the chain was completed and the reinforcer obtained, he manded to engage in activities that generally

occurred after the session (walk, run, sit, eat). Training manding for missing objects apparently led to manding for reinforcing actions, without further training.

For Subject 2, one mand to be trained (the third) emerged after the first two mands were trained. (As with all mands that were trained or tested, the topography had first been acquired as a tact.) The fourth mand still required direct training, however. After all four mands were established, transfer from tacts to mands was assessed with different items missing from the same chains. In three out of four probes, transfer was found; mands emerged without direct mand training. The occurrence of untrained mands in slightly different stimulus situations was also assessed with Subject 2, when the discriminative stimuli for two of the chains were changed. It was found that correct manding still occurred, under those conditions.

For both subjects, these results indicate that functional independence was present when mands were initially trained, but it was not maintained indefinitely. After initial training on four mands, both subjects appeared able to mand any item that they could tact, although additional data would be necessary to firmly support this conclusion. Generalization data from both subjects also suggest that manding was not under restricted stimulus control. Even though training was conducted in a structured setting, manding generalized to somewhat novel stimulus situations.

When compared in a multielement design, the tact and imitative prompt procedures were about equally effective. When one behavior was trained using the imitative prompt procedure, a second was simultaneously trained using the tact prompt procedure (in the same session, with the order of presentation of each procedure randomized). One potential advantage to the imitative prompt procedure would be that it is not necessary to learn the tact for an item before manding can be acquired; imitation of the topography is sufficient. On the other hand, a tact prompt has the advantage of requiring the subject to emit the response form in the absence of a model.

With one exception, all manding responses were maintained at 100% accuracy once they had met the criterion of being emitted without prompts for two consecutive ses-

sions. The mand that did not initially maintain with Subject 1 ("can") was retrained in one trial and maintained successfully after that point. Once responses were trained to criterion, the time lapse between probes was gradually lengthened. The maintenance data were especially interesting for Subject 1, since he had a long history of inconsistent responding during tact training in his regular academic sessions (averaging around 70%) and of failing to maintain behaviors he had previously acquired. Four months after termination of the study, his teacher reported that he was still consistently manding for missing items in novel stimulus situations (a different room) and with novel trainers. He would mand "paper towel" and wipe the sink. He was also manding for activities (eat, walk, sit). Maintenance data remained at 100% for Subject 2.

There are several directions for future research. First, the mand training procedures could be refined. In the present study, it appeared that the tact and imitative prompt procedures might have been more efficient if there had been fewer verbal discriminative stimuli. The subjects sometimes made imitative responses to the discriminative stimuli rather than responding to the tact or imitative prompts. For example, during the imitative prompt procedure, the imitative prompt "water" was preceded by the discriminative stimulus "Do this." Instead of correctly responding to the imitative prompt, Subject 1 in particular would often imitate "Do this." Such problems could perhaps be avoided by using as few discriminative stimuli as possible in the training procedure, especially with subjects with strong imitative histories. The design of the study could also be improved by assessing transfer and generalization more systematically. Maintenance could be assessed for a longer period of time.

Future research could further assess the controlling variables for functional independence versus transfer between the verbal operants. Perhaps mands could be trained first with some subjects and tacts with others (as in Lamarre & Holland, 1985) and functional independence assessed at that point, before the second operant was trained. If the present procedures for training tacts and mands were used (with manipulation of subjects' histories and conditioned establishing

operations to ensure that mands were indeed being trained), this would represent an extension of Lamarre and Holland's research. After the first operant was trained (either mands or tacts) and functional independence assessed at that point (at the time of acquisition), each topography trained as the first operant could successively be trained as the second operant. After each was trained as the second operant, remaining topographies trained only as the first operant could be assessed as the second operant (transfer could be tested). If transfer was produced using this procedure, one might train new topographies as one operant (mand or tact) and test whether they occurred as the other operant, without direct training. This procedure might assess some of the necessary conditions for functional independence.

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