The Functional Independence of Impure Mands and Tacts of Abstract Stimulus Properties

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The functional independence of mand and tact operants (Skinner, 1957) has been demonstrated with humans and non-humans. The purpose of this study was to test whether functional independence held true for impure tacts and impure mands. Four educationally disabled preschoolers were taught to mand an item necessary to engage in a preferred activity, specifying the abstract stimulus property (e.g., "I want a *whole* crayon please"). Tact training of abstract stimulus properties consisted of teaching the students to tact an item, specifying the abstract stimulus property, before continuing with an unrelated activity (e.g., "That is a *whole* crayon"). Results indicated that students who were taught to mand an abstract stimulus property ("I want a *whole* crayon please") did not tact the property ("That is a *whole* crayon"), and vice versa. In 9 out of the 10 conditions, impure mands or tacts for abstract stimulus properties did not reliably occur in the other function without direct training. In addition, training in the first function did not seem to expedite training in the second function. These results provide further support for Skinner's (1957) assertion that the verbal operants are functionally independent at the time of acquisition, and have implications for teaching language to children who fail to acquire a typical verbal repertoire.

B. F. Skinner, in *Verbal Behavior* (1957), presented a functional analysis of verbal events from the perspective of the speaker and its effects upon the listener. This differed from the more common linguistic analysis of the form or meaning of language. He specified verbal behavior as being "shaped and maintained by mediated consequences" (p. 2), and identified several types of primary verbal operants: mands, tacts, echoics, intraverbals, textual behavior, taking dictation, and transcription. Each of these operants differ because they occur under specific circumstances, requiring an analysis of verbal behavior based upon the conditions under which responses are made. In addition, many of these primary verbal operants have subcat-

egories (such as superstitious or magical mands, or extension or abstraction in the tact) which further specify the controlling variables or the conditions under which the response occurs.

Mands. The mand is defined 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" (Skinner, 1957, pp. 35-36). That is, the mand is controlled by a motivative variable. An example of a mand is when, after consuming salty food or engaging in physical exercise, the speaker requests water. The consumption of salty foods or engaging in exercise serve as "establishing operations" – environmental events, operations, or stimulus conditions which affect an organism by "momentarily altering (a) the reinforcing effectiveness of other events, and (b) the frequency of occurrence of that part of the organism's repertoire relevant to those events and consequences" (Michael, 1993, p. 192).

This study is part of a dissertation submitted by the author in partial fulfillment of a Doctor of Philosophy degree at Columbia University/Teachers College. The author would like to thank the reviewers (Genae Hall, Jane Howard, and Phil Chase) and Mark Sundberg for their helpful and insightful comments. Their suggestions were greatly appreciated. Correspondence may be addressed to the author at the Fred S. Keller School, One Odell Plaza, Yonkers, NY 10701.

Michael (1993) differentiated two primary types of establishing operations: unconditioned and conditioned. In unconditioned establishing operations (UEOs), the altering effects of the establishing operation are unlearned, such as food deprivation or painful stimulation. Conditioned establishing operations (CEOs) involve altering the effectiveness of events as a result of that organism's learning history. In addition, he described three kinds of CEOs, all of which were motivationally neutral prior to their relation with another stimulus event. A surrogate CEO involves a correlation in time – where the neutral event is paired with another CEO or UEO. A reflexive CEO establishes its own termination as a form of reinforcement or punishment – thus altering its own function. A transitive CEO involves a stimulus upon which the effectiveness of a conditioned reinforcer is dependent – thus establishing the effectiveness of another event as reinforcement (Michael, 1993). Both unconditioned and conditioned establishing operations control the form of the mand.

Tacts. The tact, as defined by Skinner (1957), is “a verbal operant in which a response of a given form is evoked (or at least strengthened) by a particular object or event or the property of an object or event” (pp. 81-82), and the response is reinforced “with many different reinforcers or with a generalized reinforcer” (p. 83). The focus of a tact lies within an enhanced relation between a typically non-verbal discriminative stimulus and the response. An example would be saying “doll” in the presence of a doll, and receiving some sort of generalized reinforcement such as verbal praise.

It should be noted however, that for mands, tacts, or any response, the reinforcing consequence does not need to be present on *each* occasion of the behavior (Skinner, 1986). Thus the response “water please” (emitted under the control of an establishing operation) would still be considered a mand even if it did not result in the delivery of water. Similarly the tact “doll” would still be considered a tact even when generalized reinforcement is not pre-

sent (such as when the response is intermittently reinforced).

Abstract stimulus properties. According to Skinner (1957), “the presence of a given stimulus raises the probability of occurrence of a given form of response” (p. 82). The term “abstraction” has been used to describe occasions when the properties of an object or event control verbal responses (Catania, 1992; Skinner, 1957, pp. 107-114). Skinner states, “[a]ny property of a stimulus present when a verbal response is reinforced acquires some degree of control over that response, and this control continues to be exerted when the property appears in other combinations” (p. 107). In this manner, essential stimulus features which acquire some stimulus control may be termed “abstract stimulus properties.”

To demonstrate true abstraction it is necessary to present novel exemplars of the stimulus property and observe whether the relevant verbal response occurs without direct training. For example, to determine if the response “red” in the presence of apples, cherries, and fire trucks is abstract, it is necessary to test for the response using novel “red” stimuli. Until tested, stimulus features are *abstract* only from the experimenter's or listener's point of view.

Functional independence. A functional analysis of verbal behavior involves examining both the response form and its controlling variables. This allows a single verbal topography to be emitted under various circumstances and function as various verbal operants, depending upon the controlling variables. In addition, varied response topographies may all serve the same function for the speaker under similar controlling variables (Hall & Sundberg, 1987; Skinner, 1957). Skinner (1957, pp. 187-188) suggests that verbal operants, regardless of similarity of form, are functionally independent. The acquisition of a verbal response topography in one verbal operant does not automatically result in its use in a different operant.

The functional independence of mands and tacts has been demonstrated with non-human subjects such as pigeons

(Sundberg, 1985) and chimpanzees (Savage-Rumbaugh, 1984; Savage-Rumbaugh, Rumbaugh, Smith, & Lawson, 1980). With humans, Lamarre and Holland (1985) demonstrated functional independence in the acquisition of mands and tacts. They taught some preschoolers to mand object placement using the phrases "on the left" and "on the right," and tested for the collateral use of the same phrases as tacts. Other preschoolers were taught the tact relation first, with all participants ultimately receiving training in both mand and tact functions. Their results showed that even when using identical response forms, mands and tacts were independently acquired.

Similarly, Hall and Sundberg (1987) investigated the distinction between the variables that control mands and tacts (establishing operations and discriminative stimuli), and found that verbal behavior controlled by nonverbal discriminative stimuli did not transfer to control by establishing operations, without direct training. Following acquisition of an effective tact repertoire for target items, their subjects showed no tendency to mand for those items, even when those items were missing and were needed to perform highly reinforcing chains of behavior. However, their findings indicated that following training in several verbal topographies, some generalization across function did occur.

In addition to mands and tacts, other verbal operants have been shown to be functionally independent. Watkins, Pack-Texiera and Howard (1989) showed the independence of intraverbals and tact responses at the time of acquisition. Chase, Johnson, and Sulzer-Azaroff (1985) demonstrated three functionally independent subclasses of the intraverbal with college students. Partington and Bailey (1993) taught four preschool children to tact picture cards, and demonstrated that these responses were not emitted under intraverbal conditions. A second experiment resulted in the emission of some untrained intraverbal responses, which the authors attributed to differing subject characteristics and the suggestion that the training

may have contained an intraverbal component. Furthermore, speaker and listener repertoires have also been shown to be acquired independently (e.g., Guess, 1969; Lee, 1981; Lee & Pegler, 1982).

The independence of different verbal operants at the time of acquisition has been widely supported in the literature. However, with sophisticated speakers, it appears that emitting a verbal topography as one verbal operant may sometimes lead to its emission as another verbal operant. There are various ways that this may happen. Tact, mand, and echoic functions may occur contiguously, as when a child learns to tact an item by first asking "What is that?" and then echoes the response, tacts the item, and mands the item by saying "Give me the ____," (Skinner, 1957, pp. 189-190). These initial tact or mand forms are under multiple control, and are not regarded as "pure" mands or tacts. However, it may be these multiple controlling variables which provides the means for generalization of verbal topographies across functions.

Skinner (1957, pp. 189-190) suggested other ways a verbal response transfers from one verbal operant to another. The milk delivered following the mand "Milk!" closely resembles the stimulus which occasions the tact "milk" when asked "What is that?" This formal stimulus similarity may assist in the acquisition of whichever operant is learned second. In addition, the occurrence of a tact response following mand instruction may be facilitated by the visible presence of the mand item. Mands often occur in the presence of the manded item, which signals the optimal occasion for reinforcement. The presence of milk indicates an occasion in which the mand "Milk!" is very likely to be reinforced. These responses are part mands in that they occur under motivating conditions, but the presence of the milk as a discriminative stimulus makes the response also part tact.

Although different verbal classes and subclasses may be functionally independent, examples of stimulus generalization,

abstraction, transfer of stimulus control and other forms of general case behavior have been observed *within* verbal operants (e. g., Guess, Sailor, Rutherford, & Baer, 1968; Wheeler, & Sulzer, 1970). In a study designed to teach an autoclitic repertoire, Howard and Rice (1988) successfully trained qualifying autoclitics with preschoolers and determined that the students emitted generalized autoclitic responding within the tact verbal operant. Although this study demonstrated the generalization of autoclitics within a verbal operant (one form across various tact functions), the generalized use of autoclitics or other subclasses of verbal behavior *across* verbal operants has yet to be formally tested.

The purpose of this study was to determine whether training impure mands or tacts of abstract stimulus properties would lead to emission of the other operant without direct training. It was assumed that since mands and tacts have been demonstrated to be functionally independent, that impure mand or tact abstract stimulus properties would also be functionally independent. Data were collected by recording participant responses during impure mand or tact training, and then assessing for the occurrence of a targeted abstract stimulus properties across untrained mand or tact conditions.

METHOD

Subjects and Setting

Four students (2 males and 2 females) participated in this study. They were all identified as preschoolers with a disability (language delays) by their school district's Committee on Preschool Special Education, and were enrolled in the preschool program in which this study took place. All students had scored at least 1 year below chronological age level in expressive language on standardized tests (e.g., Preschool Language Scale, Sequenced Inventory of Communicative Development) and were described as moderately to severely language delayed. They were chosen as participants for this study due to their limited vocal-verbal behavior and

their frequent emission of mands or tacts for items without specifying an abstract stimulus property. The students had been attending the program for approximately 9 months prior to the onset of this study and had received daily individual instruction on manding and tacting verbal behavior as part of their typical school program. All were vocal-verbal and had moderate to strong echoic, imitative, and compliance repertoires. Table 1 contains the gender and age of each participant, as well as the total number of mand or tact training criteria previously achieved during the mand and tact training sessions that were part of the school curriculum. These numbers reflect the total criterion achieved by each participant prior to the onset of the study, and give an indication of the sophistication of each student's verbal repertoire.

Table 1

Participant characteristics.

Student Number	Gender	Age	Previous Training Criteria Achieved	
			Mand	Tact
1	F	4-4	12	13
2	M	4-5	21	16
3	F	4-8	21	13
4	M	4-10	12	12

The study was conducted in a publicly funded, state-approved special education preschool program managed by a not-for-profit cooperation. The school was located outside a major metropolitan city and served students from a range of socio-economic and cultural backgrounds. Students attended half-day sessions in classrooms of six students, a certified special education teacher, and a classroom aide. Instructional trials in social, emotional, school self-sufficiency, cognitive, physical development and verbal behavior domains were presented to students (individually and in small groups) throughout the school day. During the study, sessions took place at a small work table in a corner of the classroom. Both the experimenter and a student sat at this table, with the student's back to

the activity in the classroom. The materials required for the activity were either on the floor next to the experimenter or on the table during use.

Materials

The materials used in this study consisted of items necessary to engage in 4 continuous response activities (playing with playdough, blocks, puzzles, and coloring). For the playdough activity, the materials were soft pliable Playdoh®, dry hardened playdoh, a rolling pin, and dough cutters. During legos, small Lego® blocks and larger Duplo® blocks were used. The materials for the puzzle activity were wooden puzzles containing at least 8 pieces which combined to fit into the puzzle frame, and Lauriland® rubber puzzle pieces which were approximately the same size or color as the wooden puzzle pieces but could not be used to complete the puzzle. For coloring, large Crayola® crayons, small tips of broken crayons, and coloring sheets were used. Multiple exemplars of each set of materials were used (for example, 8 different colors of crayons were used throughout the study). These activities were chosen due to the students' preference for these four activities over other

similar activities, and his or her history of requesting the items necessary to engage in the activity.

Response Definition

Response topographies targeted for training were "whole," "large," "soft," and "wooden." These were termed "abstract stimulus properties," in that the targeted stimulus features occasioned the responses "whole," "large," "soft" and "wooden" in the (experimenter's) verbal community. It should be noted, however, that since there was no test for generalized responding to these stimulus properties across other "whole," "large," "soft" or "wooden" items, they were "abstract" only from the experimenter's perspective. Participant responses are referred to as mands or tacts of (or specifying) "abstract stimulus properties." Table 2 lists the each abstract stimulus property and the corresponding mand and tact training forms. A mand occurred when the student requested a *withheld* item which was required to continue engaging in the activity. This procedure may be viewed as a transitive conditioned establishing operation (Michael, 1993), in which a high frequency activity cannot occur until a mand item becomes available, thus

Table 2
Targeted abstract stimulus properties across mands and tacts.

Abstract Stimulus Property	Exemplar	Non-Exemplar	Sample Mand Form	Sample Tact Form
whole	whole crayon	broken crayon tip	"whole crayon, please."	"whole crayon."
large	large lego (Duplo®)	small lego (Lego®)	"large lego, please."	"large lego."
soft	soft playdoh	hardened playdoh	"soft playdoh, please."	"soft playdoh."
wooden	wooden puzzle piece	rubber puzzle piece	"wooden puzzle (piece), please."	"wooden puzzle (piece)."

increasing the probability of the student emitting behavior which in the past was consequated with delivery of the mand item. For example, coloring was blocked until a response which would obtain crayons was emitted. Mand responses had to include the targeted abstract stimulus property and the autoclitic "please" to be scored as correct. Correct responses ranged from "large lego please" to "I want the large lego please," depending upon the sophistication of the student's prior verbal repertoire.

A tact occurred when the student emitted the "label" for a presented object, however the object was not relevant to the activity in which the student was engaging. The unrelated activity was changed at least two times during a tact training session. Correct tact responses resulted in non-specific reinforcement (e.g., verbal and social praise, and the opportunity to continue an unrelated activity). Tact responses had to specify the targeted abstract stimulus property to be scored as correct. Responses ranged from "large lego" to "That is a large lego," depending upon the sophistication of the student's prior verbal repertoire.

Some clarification is required regarding the use of the terms "mand" and "tact" to describe the operations used. Since the desired item was in view of the student during mand sessions, there existed a possibility of discriminative stimulus (or tact-like) control during mand conditions. However, the primary controlling variables for the response appeared to be both the prior of a state of deprivation (the transitive establishing operation) and the specific consequence to a correct mand (the delivery of the requested item). These variables indicate that the response most likely functioned as a mand.

Similarly, in the tact conditions, the students were prevented from engaging in a preferred activity until a correct tact response was made. This increased the likelihood that the response may have functioned as a mand to continue the activity. However, since the tact items were not required for the ongoing activity, a correct

tact had to be occasioned by some sort of discriminative stimulus control. In addition, the activities were changed at least twice during each tact session, and correct responses resulted in other forms of generalized reinforcement (verbal and social praise). The influence of these variables suggest that the response probably functioned as a tact.

Multiple sources of control were operating during both the mand and the tact conditions, thus making the responses part mand and part tact. Skinner (1957, p. 151) commented upon the possibility of mixture of controlling relations in verbal operants, calling the resulting responses "impure." Due to these multiple controls present in the current study, the procedures are more accurately referred to as "impure mand" or "impure tact" conditions.

Procedures

For all training sessions, three-term contingency trials were presented during continuous response tasks such as completing a puzzle or building a house with blocks. Impure mand training consisted of a mand for a withheld item which was needed to engage in an activity (e.g., manding "crayon" for coloring, or "lego" for block building). Impure tact training consisted of a tact of a presented item before receiving verbal praise and continuing with an unrelated activity (e.g., tacting "crayon" before resuming block building). The use of the same four activities for both mand and tact training was done to control for differences in the findings attributable to differing activities.

Students 1 and 2 first received impure mand training, while Students 3 and 4 received impure tact training first. Initial training order (mand or tact) was randomly determined. Training conditions were then alternated between mand and tact (e.g., if a student had just completed a mand training condition, he then received tact training). Target abstract stimulus properties were randomly assigned to each training condition, however an attempt was made to use each exemplar. The general sequence of the investigation was to

conduct an initial probe of all stimulus properties, train an echoic then mand or tact response, immediately probe for emergence in the untrained function, and following criterion in training, probe all stimulus properties again.

Probe procedures. Probe sessions were conducted at the onset of the study and prior to the training of each new abstract stimulus property, to test for the emergence of any untrained responses. It should be noted that since all "probe" trials consisted of a contingent consequence for each response, only the first trial represents a *true* test (or probe) trial. For the sake of clarity, the procedures described in this section will be referred to as a "general probe." All general probe sessions consisted of 80 trials (10 mand and 10 tact presentations for each of 4 targeted stimulus properties). General probe trials were presented exactly as described for training trials (see below), except *all* stimulus properties and mand/tact functions were presented. Presentation order was rotated (non-sequentially) across abstract stimulus properties and mand or tact functions (e.g., tact soft playdoh, mand large lego, mand wooden puzzle, tact whole crayon). Correct responses during general probes were reinforced with the contingent mand or tact consequence. Error responses (or no response) were ignored, and after a 3 second intertrial interval the next general probe trial was presented.

Training Procedures

Echoic-mand training procedures. One abstract stimulus property was trained at a time. At the onset of each training session, echoic-mand trials (impure) were presented using the target form. For an echoic trial, the experimenter held up the target stimulus and the non-exemplar, and modeled the correct mand (e.g., "whole crayon please"). Correct responses resulted in the delivery of the whole crayon and a 3-5 second opportunity to color. Error echoic responses (e.g., "crayon please" "crayon," or no response) resulted in 3-5 seconds of planned ignoring. Following three consec-

utive correct echoic responses, impure mand trials were presented.

Impure mand training procedures. Impure mand trials consisted of allowing the student 3-5 seconds to engage in a designated activity (coloring), following which the target item necessary to continue engaging in that activity (whole crayon) was removed and placed on the table. Both the mand item and its non-exemplar (whole crayon and piece of crayon) were placed in view of the student. If the student's mand specified the previously modeled abstract stimulus property ("whole crayon please"), the item was immediately delivered and the student was allowed to continue participating in the activity. This was considered a correct mand response. After 3-5 seconds the item was again removed and the next impure mand trial was presented. If the student did not emit a mand within 5 seconds of removal of the item, he or she was prompted with the question "What do you want?" (this rarely occurred). If the student emitted a mand for the item which did *not* specify the targeted abstraction ("crayon please"), the non-exemplar was delivered and an error was scored for that trial. The student was allowed to manipulate the non-exemplar, however due to its stimulus properties it could not be used to effectively engage in the preferred activity. After approximately 3-5 seconds the non-exemplar was taken back and the next impure mand trial was presented. If no response was emitted an error was scored and the student was denied access to the activity until the next impure mand trial was presented (a 5 second intertrial interval).

Echoic-tact training procedures. One abstract stimulus property was trained at a time. At the onset of each training session, echoic-tact trials (impure) were presented using the target form. For an echoic trial, the experimenter put both the target stimulus and the non-exemplar on the table (whole crayon and piece of crayon), pointed to the target stimulus (whole crayon), and modeled the correct tact ("whole crayon"). Correct responses resulted in verbal and social praise (e.g., "That's right" paired with smiles) and a 3-5

second opportunity to engage in an unrelated activity (building with blocks). Error echoic responses (e.g. "crayon please" "crayon," or no response) resulted in 3-5 seconds of planned ignoring. Following three consecutive correct echoic responses, impure tact trials were presented.

Impure tact training procedures. Impure tact trials consisted of allowing the student 3-5 seconds to engage in an activity unrelated to the target item (building with blocks), then denying the student access to that activity (The student was told "Look at me," or the experimenter placed her hand over the materials, causing the student to halt their activity.). The experimenter placed both the target stimulus and the non-exemplar on the table (whole crayon and piece of crayon), and pointed to the target stimulus (whole crayon). If the student emitted a tact of the item which specified the previously modeled abstract stimulus property ("whole crayon"), he received verbal and social praise (e.g., "That's right" paired with smiles) and a 3-5 second opportunity to continue participating in the unrelated activity. This was considered a correct tact response. After 3-5 seconds the activity was again halted and the next impure tact trial was presented. If the student did not emit a tact within 5 seconds of the interruption, he or she was prompted with the question "What is this?" (again, this rarely occurred). If the student emitted a tact of the item which did not specify the targeted abstraction ("crayon"), the experimenter pointed to the non-exemplar and an error was scored for that trial. If no response was emitted an error was scored, and the student was denied access to the activity until the next trial was presented (a 5 second intertrial interval). Table 3 outlines the impure mand and tact training sequences.

General procedures. Ten out of 10 correct responses for 2 consecutive sessions was considered a training criterion. During training conditions, three consecutive impure mand or tact errors resulted in the presentation of an echoic trial. Following the first correct echoic response, impure mand or tact training resumed. A training

session consisted of the presentation of 10 mand or tact trials. Echoic trials were not counted in this total. At the end of each training session, a 10 trial probe was presented to assess for emergence of a response specifying the abstract stimulus property in the alternate function. These 10 trial probes followed the general probe procedures outlined above (including the delivery of contingent consequences), however involved only one abstract property and one function. These are referred to as either a "probe in the untrained function" or simply "probe." Upon meeting criterion in a trained function, and if correct responses were not criterion level the untrained function, the student then received training in the second function.

Interobserver Agreement

Dependent measure and procedural reliability was assessed by one of three independent observers who were trained in the procedures prior to the onset of the study. During interobserver agreement sessions, an observer simultaneously recorded student responses to the trials presented and experimenter actions which deviated from the scripted procedural sequence. These sessions were conducted on 29.9% of the total probe and training sessions conducted. By using a point by point reliability method of dividing the total number of agreements by the agreements plus disagreements and multiplying by 100, both student responses and experimenter fidelity to outlined procedures showed 100% reliability for all probe, mand and tact training sessions.

RESULTS

The number of correct responses during probes, and impure mand and tact training for each abstract stimulus property for Students 1-4 are presented in Figures 1 through 4, respectively. Due to her reliable attendance, Student 1 received training in impure mands and tacts for all four abstract stimulus properties. Infrequent attendance and the end of the school year hampered the completion of all four conditions for Students 2-4. In all figures, the first four ses-

Fig. 1. Number of correct probe, training, and untrained mands and tacts containing the target abstract stimulus property for Student 1. One impure mand or impure tact abstract stimulus property was trained in each condition. Correct mands are indicated with circles, and correct tacts with triangles. Mand and tact data points may overlap.

Table 3

Training sequence for impure mands and tacts of abstract stimulus properties.

	Mand	Tact
Antecedents	-Disruption of the activity, removal or denial of the item needed to continue -The 2 exemplars of the mand item are in view of the student -Experimenter asks "What do you want?" if no mand is emitted within 5 seconds	-Disruption of an unrelated activity -The 2 exemplars of the tact item are in view of the student, the experimenter points to the target exemplar -Experimenter asks "What is this?" if no tact was emitted within 5 seconds
Correct Student Response	-Student mands the abstract stimulus property	-Student tacts the abstract stimulus property
Consequence of a Correct Response	-Delivery of the mand item -Student resumes activity -Experimenter records a +	-Delivery of social praise -Student resumes unrelated activity -Experimenter records a +
Incorrect Student Response	-Student mands without the abstract stimulus property; does not mand	-Student tacts without the abstract stimulus property; does not tact
Consequence of an Incorrect Response	-Experimenter delivers the item according to the mand, the item cannot be used to engage in the activity -Experimenter records a - -After 3-5 seconds the next trial is presented	-The non-target exemplar is shown, the student is not given access to the activity -Experimenter records a - -After 3-5 seconds the next trial is presented

sions show the number of correct impure mands or tacts for the target items without the abstract stimulus property ("crayon," "puzzle," "playdoh," and "lego"). The second group of sessions (also labeled 1-4) indicate the number of correct impure mands or tacts specifying the abstract stimulus property ("whole crayon," "wooden puzzle," "soft playdoh," and "large lego"). These data were collected simultaneously during the first general probe, however are graphed separately for clarity.

Results indicate that for all students, mands or tacts specifying the targeted abstract stimulus property were not emitted until direct training began. Each student achieved criterion on trained abstract stimulus properties. During the first training condition, Students 1, 2, and 3 did not emit mands or tacts specifying the abstract stimulus property in the untrained verbal

operant. Mands or tacts specifying the targeted abstract stimulus property were emitted in the alternate function only after direct training was implemented. Students 2 and 3 *never* emitted a mand or a tact specifying the abstract stimulus property until direct training in that function commenced. Tables 4-6 presents numerical summary data for all students across impure mand and tact conditions. These tables allow for easy comparison of the number of abstract stimulus properties trained, sessions and trials to criterion, and criteria met during impure mand and impure tact conditions.

A generalization criterion was achieved when the student specified the target abstract stimulus property for 10 out of 10 trials in the untrained operant. Only one student (Student 1) demonstrated generalization of the abstract stimulus property at

Fig. 2. Number of correct probe, training, and untrained mands and tacts containing the target abstract stimulus property for Student 2. One impure mand or impure tact abstract stimulus property was trained in each condition. Correct mands are indicated with circles, and correct tacts with triangles. Mand and tact data points may overlap.

Table 4

Training, criteria, and generalization totals for impure mands and tacts combined.

	Student			
	1	2	3	4
Forms Targeted for Training	7	4	4	4
Training Sessions Presented	20	15	12	12
Training Trials Presented (Correct/Total)	188/200	124/150	114/120	110/120
Training Criteria Met	7	4	4	4
Generalization Trials Presented (Correct/Total)	37/120	0/60	0/60	43/60
Generalization Criteria Met	1	0	0	0

criterion levels. This occurred when she manded “I want soft playdoh please” after only receiving impure tact training.

The results for Student 1 are found in Figure 1. During the first training condition, she met criterion on the impure mand “whole crayon please” in 3 sessions, and maintained this mand response during impure tact training of “whole crayon.” Both mands and tacts for “whole crayon” maintained at criterion levels at the following probe. During the next condition (impure tact training of “soft playdoh”) she demonstrated a generalized mand criterion before meeting a training criterion on the tact. This was the only occasion in which this phenomena occurred, and thus was the only generalization criterion achieved in the study. Results from the following probe showed a drop in level of correct responses for the previously trained tacts “whole crayon” and “soft playdoh” and mand “whole crayon.” Only the mand “soft playdoh please” (also the only untrained response) remained at criterion level. In the third training condition, the number of correct responses for the untrained tact (“wooden puzzle”) remained low, while mand criterion was met in 4 sessions. Once impure tact training with “wooden puzzle” began, criterion was met in 2 sessions (with an initial drop in the correct frequency of the mand). In the final training condition criterion in

both the tact and mand forms of “large lego” was met in 2 sessions, with some untrained correct responding occurring mand probes. The last probe showed criterion level responding for 3 tacts (“whole crayon,” “soft playdoh,” and “large lego”) and 2 mands (“soft playdoh please” and “large lego please”). Data for one stimulus property, “wooden puzzle,” showed no correct responses for both mands and tacts during the final probe. Overall, Student 1 required a relatively equal number of impure mand trials to criterion as impure tact trials. However during probes she emitted a much greater number of correct untrained mands than untrained tacts (34 to 2).

Student 2’s data may be found in Figure 2. He received training in two of the target stimulus properties. During the first training condition (impure mand “large lego please”), he met criterion in 4 sessions. However, this mand did not maintain in the probes presented during impure tact training of “large lego.” The impure tact “large lego” required 7 training sessions before meeting criterion, and maintained criterion levels of performance at the general probe following training. During the second training condition (“wooden puzzle”) he met tact and mand criterion in 2 training sessions each, with no generalization evidenced across untrained verbal

Fig. 3. Number of correct probe, training, and untrained mands and tacts containing the target abstract stimulus property for Student 3. One impure mand or impure tact abstract stimulus property was trained in each condition. Correct mands are indicated with circles, and correct tacts with triangles. Mand and tact data points may overlap.

Table 5

Training, criteria, and generalization totals for impure mands.

	Student			
	1	2	3	4
Forms Targeted for Training	3	2	2	2
Training Sessions Presented	9	6	5	7
Training Trials Presented (Correct/Total)	81/90	52/60	49/50	61/70
Training Criteria Met	3	2	2	2
Generalization Trials Presented (Correct/Total)	34/50	0/20	0/30	20/30
Generalization Criteria Met	1	0	0	0

operants. When comparing mand and tact training conditions, Student 2 emitted a higher ratio of correct trials and required fewer training trials to criterion in the mand training conditions.

Student 3 also received training on only two of the targeted stimulus properties (see Figure 3). During the first training condition, she met criterion on the impure tact “wooden puzzle” in 3 sessions and maintained this response at criterion levels during the impure mand training sessions. The mand “wooden puzzle please” met criterion in 2 sessions and both verbal operants maintained at criterion levels during the following general probe. During the second training condition criterion for the mand “whole crayon please” was achieved in 3 sessions, with no generalization to the untrained tact form. Once in training, criterion for the tact (“whole crayon”) was met in 4 sessions, with some maintenance of the previously trained mand. The final general probe showed criterion levels of responding for the 2 trained mand forms (“wooden puzzle please” and “whole crayon please”) and 1 of the trained tact forms (“whole crayon”). When comparing impure mand and tact training conditions, Student 3 also emitted a higher ratio of correct trials and required fewer training trials to criterion in the impure mand training conditions.

Student 4 (see Figure 4) also received training on two of the four stimulus properties. He was the only student to consistently emit correct responses in an untrained verbal operant function, but did not achieve criterion on these functions without direct training. During the first training condition (tact “soft playdoh”), he met criterion in 3 sessions, but did not consistently maintain this tact response during the impure mand training sessions. Impure mand training of “soft playdoh please” required 4 sessions to meet criterion. Neither responses maintained at criterion levels at the general probe. During the second training condition the mand (“large lego please”) was trained first. He achieved mand criterion in 3 training sessions and tact criterion in 2 training sessions. The final general probe showed criterion levels of responding for both of the trained tacts (“soft playdoh” and “large lego”), and one of mands (“soft playdoh please”). Student 4 was the only student to emit a higher ratio of correct tact trials than mand trials, and require fewer tact trials to meet criterion.

DISCUSSION

The results of this investigation indicate that young children who require training to mand objects qualified by soft, large, wooden, and whole, do not emit the same verbal topographies under tact conditions,

Fig. 4. Number of correct probe, training, and untrained mands and tacts containing the target abstract stimulus property for Student 4. One impure mand or impure tact abstract stimulus property was trained in each condition. Correct mands are indicated with circles, and correct tacts with triangles. Mand and tact data points may overlap.

Table 6

Training, criteria, and generalization totals for impure tacts.

	Student			
	1	2	3	4
Forms Targeted for Training	4	2	2	2
Training Sessions Presented	11	9	7	5
Training Trials Presented (Correct/Total)	107/110	72/90	65/70	49/50
Training Criteria Met	4	2	2	2
Generalization Trials Presented (Correct/Total)	2/70	0/40	0/30	23/30
Generalization Criteria Met	0	0	0	0

and vice versa, without direct training. All students were taught to emit mands or tacts of the targeted abstract stimulus properties. Following training, tests were conducted for their occurrence in the untrained function. Almost always, the results showed that teaching a topography in one function (impure mand or tact) did not lead to its emission in the other function.

These data extend the literature on functional independence to verbal operants specifying abstract stimulus properties. In 9 out of the 10 conditions, the students required direct mand or tact training before the abstract stimulus property was reliably specified in that operant. Students 2 and 3 never emitted an untrained mand or tact which specified the abstract stimulus property. Although Students 1 and 4 each showed some correct responding in the untrained function, only Student 1 demonstrated criterion level responding – and then only for one abstract stimulus property. The results failed to show an generalized relation between mands and tacts of abstract stimulus properties.

Within this study, the sophistication of the students prior verbal behavior (length of mand or tact utterances, number of previously trained mands and tacts) did not appear to affect the occurrence of untrained mands or tacts specifying the abstract stimulus property. Each of the students in this study could reliably mand

and tact the items without specifying the abstract stimulus property (e.g., “crayon please”), and frequently did so in the classroom outside of the experimental conditions. Although not specifically demonstrated in this study, each participant emitted generalized mands and tacts for all stimuli (without the targeted abstract stimulus properties) prior to the investigation. This was demonstrated by their manding or tacting novel crayons, playdoh, puzzles, and blocks. Although this was an anecdotal observation and untested empirically, these responses appeared to be under abstract stimulus control.

Contingent consequence during probes may have strengthened later responding. Since correct responses during probes were reinforced, only the first trial of each abstract stimulus property served as a true “test” trial. Additional investigations that utilized reinforcement fading procedures could be used to test for generalization under non-reinforcement conditions while minimizing the possibility of extinction.

The target stimuli used in the investigation were termed “abstract stimulus properties,” in that these stimulus features occasioned the responses “whole,” “large,” “soft” and “wooden” in the verbal community. Students were presented with multiple pairs of exemplars and non-exemplars of each, with the intent that the “wholeness” of the crayons or the “large-ness” of

the blocks, in contrast to the non-exemplar, would occasion the response "whole crayon" or "large lego." However, since only a single type of concrete item was used for each abstract stimulus property (e.g., only crayons were used for "whole") it is highly unlikely that the properties were "abstract" for the students. To demonstrate abstract control, further research testing for abstract responding across a variety of concrete items, including novel ones, would be needed.

Even though stimuli items were presented in exemplar and non-exemplar pairs (e.g., hard and soft playdoh), error responses frequently consisted of omitting the abstract stimulus property when manding or tacting the target stimulus item (e.g., manding "crayon please" when both a whole crayon and a broken crayon tip were presented). These "error" responses may be due to the students' long prior history of successful mands or tacts for the targeted items without specifying the abstract property. These previously maintained responses may have exerted some control over student responding during this investigation.

The students did not emit a consistent pattern of increased correct responding in the untrained verbal operants as they progressed through the training conditions. Within this study, students never demonstrated abstract relations between impure mands and tacts. The relatively small number of abstract stimulus properties trained may have contributed to these findings. There is evidence in the literature that generalized responding increases with the number of exemplars trained (Howard & Rice, 1988; Lee, 1981)

In addition, student performance on manding or tacting abstract stimulus properties sometimes deteriorated following the training of new abstract stimulus properties or a new function (see Figures 1 and 4). However, this deterioration was inconsistent. Low levels of correct probe responding following training often increased at subsequent probes. The contingent consequence provided during "probe" sessions may actually have consti-

tuted training and thus may have contributed to these effects. Similarly, the discretionary criterion of 10/10 correct responses for two consecutive sessions may not have provided enough opportunities for the abstract stimulus property to develop sufficient stimulus control.

More firm (fluent) student responses during general probe sessions would allow stronger statements about the functional independence of impure mands and tacts of abstract stimulus properties. The deterioration of some previously trained tacts and mands of abstract stimulus properties indicates that these responses may have been under weak stimulus control. In this case the findings may more likely represent weak stimulus control rather than true functional independence of verbal operants.

An infrequent, yet notable error response was the emission of the autoclitic "please" during impure "tact" conditions, suggesting some mand control. Also, as Student 1 progressed through the training conditions, she began to make errors during general probes by inappropriately combining an abstract stimulus property and a stimulus item (e.g. "soft puzzle please"). These errors were made by either specifying an unrelated abstract stimulus property or by incorrect stimulus item. The occurrence of these types of errors suggest the absence of abstract stimulus control. Although these kinds of error responses were made on fewer than 10 occasions, they suggest some stimulus control procedural problems. Additional study in this area is needed.

The presence of the items during impure mand training may have influenced later tact responses. It has been suggested that the presence of the manded item (in view) during mand training sessions may partially control the form of the response (Hall & Sundberg, 1987; Skinner, 1957, pp. 188-189). According to Skinner (1957 p. 189), these responses are mands in that they occur under motivating conditions, but the presence of a discriminative stimulus brings the speaker closer to the production of a tact. Responses of this sort are consid-

ered part mand and part tact. Due to this multiple control, it would appear that an increase in generalized tact responses might occur following impure mand training. However, findings from the present investigation indicated greater generalization for mands specifying abstract stimulus properties (a slightly higher ratio of correct/total mand trials), and not tacts – as would be assumed from the possibility of some discriminative stimulus control. The higher frequency of correct mand responses is, however, consistent with other comparisons of mand and tact training procedures (e.g., Carroll & Hesse, 1987; Sigafos, Doss, & Reichle, 1989; Stafford, Sundberg, & Braam, 1988).

Impure tact training involved a “mand-like” condition – the denial of access to an activity. However, since classroom instruction was typically presented in this manner (the interruption of an on-going activity or the brief removal of a previously delivered reinforcer upon trial presentation) the students were accustomed to emitting tacts (and other responses) under these conditions. When told “Look here,” or “Look at me,” or when the experimenter’s hand was placed over the materials, the students reliably paused in their activity and responded to the stimulus presentation. They did not show any outward signs of distress or anxiety in this presentation format. However, since an ongoing activity was present in the impure tact conditions, it is conceivable that this made the impure tact conditions more “mand-like,” and thus influenced increased generalized mand responding. The impure mand and impure tact procedures used in this study shared some similar features. Determining the exact nature and effect of these similarities requires further investigation.

In future studies of functional independence or abstract relations between mands and tacts, the use “pure” mand and tact training conditions would be desirable. Although students apparently could and did discriminate between the conditions (as indicated by the regular use of the autoclitic “please” in mand conditions and rare use in tact conditions), the findings of func-

tional independence in this study are clouded by the similar nature of the mand and tact conditions. That is, the tact condition contained mand variables and the mand condition contained tact variables. Since the two conditions shared similar features, it is somewhat unclear what the findings of functional independence present.

An important further investigation would involve testing for generalization across abstract mands and tacts (rather than stimulus properties that were abstract only from the experimenter’s point of view). In the present study, only one “concrete” stimulus item was used for each abstract stimulus property trained. This did not sufficiently program for abstraction. Only after the abstract stimulus property had been trained across a variety of objects, and occurred with novel objects, could true abstract mands or tacts be demonstrated. Once true abstract mands and tacts had been demonstrated, generalization between these abstract mands and tacts could be tested. That is, only after establishing abstract mands or tacts for abstract stimulus properties, could the emergence of the untrained abstract verbal operant be tested. If emergence did not occur, then functional independence across the verbal operants would be demonstrated.

Mands and tacts have been empirically demonstrated to be separate and independent verbal behavior repertoires. These results suggest that impure mands and tact for abstract stimulus properties are also functionally independent. The data from this study show that, at least initially, impure mands and tacts for abstract stimuli properties need to be directly trained.

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