Effects of Single Versus Multiple Verbal Operant Arrangements on the Acquisition of Mands and Tacts in Preschool Children

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EFFECTS OF SINGLE VERSUS MULTIPLE VERBAL OPERANT ARRANGEMENTS ON THE ACQUISITION OF MANDS AND TACTS IN PRESCHOOL CHILDREN

by

Tina M. Sidener

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EFFECTS OF SINGLE VERSUS MULTIPLE VERBAL OPERANT ARRANGEMENTS ON THE ACQUISITION OF MANDS AND TACTS IN PRESCHOOL CHILDREN

Tina M. Sidener, Ph.D.
Western Michigan University, 2006

Verbal Behavior programs for children diagnosed with autism typically teach novel language in the context of multiple verbal operant arrangements. Commonly called "mixed verbal behavior", this involves the interspersal of various exemplars across verbal operant categories. Despite the current recommended use of this teaching procedure, only 2 studies to date have empirically evaluated its effectiveness (i.e., Arntzen & Almas, 2001; Carroll & Hesse, 1987). In both of these studies, mixed mand-tact training resulted in faster mean acquisition of tacts than tact-only training. In Experiment 1 of the current investigation, a systematic replication of previous studies was conducted with 3 typically-developing children. Although tacts were acquired in fewer mean sessions during the multiple verbaloperant condition than in the single-verbal operant condition across all participants, mean differences were negligible and the effect was inconsistent across stimulus sets. In Experiment 2, a direct replication of Carroll and Hesse was conducted with 2 typically developing children. Mand-tact training did not produce more rapid acquisition of tacts for participants. The results are discussed in the context of idiosyncratic differences between current and previous procedures, and the value of further research on this potentially valid but elusive phenomenon.
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Tina M. Sidener
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INTRODUCTION

Skinner’s (1957) analysis of verbal behavior arose from his contention that language could be accounted for using behavioral principles derived from a laboratory-based, experimental analysis of behavior with nonhumans (Michael, 1984). Defining verbal behavior as behavior indirectly reinforced “through the mediation of other persons” (Skinner, p. 2), Skinner distinguished it from nonverbal behavior, which results in direct reinforcement. Although such behavior is commonly referred to using the terms speech, language, and linguistic, Skinner proposed the term verbal behavior to avoid emphases on vocal behavior and the practices of a community rather than an individual speaker (Skinner).

Although an analysis of verbal behavior may not require novel principles, Skinner (1957) maintained that the complexity of verbal behavior demands special treatment. His conceptualization of language consisted of an analysis of the functional relations between verbal responses, motivating variables, discriminative stimuli (S^D's), and consequences delivered by the verbal community. The result of this functional analysis was a taxonomy consisting of different types of elementary verbal operants, subsequently summarized by Michael (1993) as mand, tact, intraverbal, codic (taking dictation and textual behavior), and duplic (copying a text, echoic, and mimetic behavior).

Mands and Tacts

Because the mand and tact are the focus of the current investigation, a further discussion of these verbal operants is warranted. It should be noted that, although most examples provided throughout this paper will refer to vocal-verbal behavior, both mands
and tacts may be expressed in modes of speaking, writing, and signing, among others (Michael, 1993).

Skinner (1957) defined a mand as “a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation” (p. 36). Michael (1993) proposed a revised version of Skinner’s definition of a mand to provide further clarification, as “a type of verbal operant in which a particular response form is reinforced by a characteristic consequence and is therefore under the functional control of the establishing operation relevant to that consequence. And in contrast with other types of verbal operants, the response form has no specified relation to a prior discriminative stimulus” (p. 101). For example, one may have a tendency to say “juice” as a result of having eaten salty food. The reinforcer in this example, juice, is specific to the mand, “juice”, which occurs in this form because of the current EO created by eating salty food. This is in contrast to the reinforcement for all other elementary verbal operants, which is usually generalized conditioned reinforcement (e.g., social reinforcement).

A tact 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 property of an object or an event” (Skinner, 1957, p. 82). Said another way, a tact is “a type of verbal behavior with the response form controlled primarily by an immediately prior nonverbal stimulus” (Michael, 1993, p. 95-96). For example, one may have a tendency to say “juice” as a result of seeing juice due to a history of generalized reinforcement in the presence of juice. Because of this consistent generalized reinforcement of the same verbal response in the presence of the same stimulus, the effects of any specific EOs are minimized, and
the tact comes under the control of an $S^D$. However, the completely generalized conditioned reinforcement that establishes a “pure” tact rarely occurs, and is “probably never achieved” (Skinner, p. 83). In addition, as Oah and Dickinson (1989) point out, “generalized conditioned reinforcement is not a defining feature of the tact relation...in some studies ... correct tacts were consequated with food delivery rather than generalized conditioned reinforcement and can still be called tacts because the food reinforcement did not control the response topographies emitted. Thus, it would be better to characterize the reinforcement for the tact as *nonspecific* to the response form rather than as *generalized* reinforcement” (p. 59).

According to Michael (1993), Skinner (1957) described two helpful ways in which mands and tacts can be contrasted. First, where the mand provides the listener with information about the speaker apart from the circumstances, the tact provides the listener with information about circumstances apart from the condition of the speaker. Second, through the mand the speaker may change his or her environment through the listener's behavior and through the tact the listener may react to stimuli with which he or she is not directly in contact. For example, a speaker may tact “it’s locked”, providing the listener with information about a door he has not tried to open, so that he might bring a key when he arrives.

A number of studies have demonstrated the functional independence of verbal operants (e.g., Hall & Sundberg, 1987; LaMarre & Holland, 1985; Partington & Bailey, 1993; Watkins, Pack-Teixtera, & Howard, 1989). Although the independent development of mands and tacts is difficult to observe in typically developing children, these repertoires appear to be learned separately and may require specific training in
children with delayed language. For example, a child with autism may learn to mand "car" when he wants to play with it, but may not be able to tact "car" when asked to respond to an array of stimuli. Skinner (1957) hypothesized several ways mands and tacts may be learned seemingly simultaneously in typically developing individuals. This may occur because "the events which reinforce a mand resemble the discriminative stimuli which control a tact" (p. 189), thus acquisition of one relation may facilitate the acquisition of the other relation. This may also occur because if the item manded is present, it may become an S^D and evoke a tact because its presence "constitutes part of the optimal occasion upon which the mand...will be reinforced" (p. 189). Petursdottir, Carr, and Michael (2005) provided evidence supporting this hypothesis by demonstrating that mand training was more likely to result in emergent tacts than tact training was to result in emergent mands.

*Skinner’s Analysis Applied to Language Training*

Most children who are diagnosed with autism and related disabilities display language deficits that distinguish them from their peers (Sundberg & Partington, 1998). There are several behavior-analytic approaches to language training with this population, including a common behavioral model, sometimes referred to as the “Lovaas approach” (Lovaas & Smith, 2003), and a more recent approach based on Skinner’s (1957) analysis of verbal behavior, sometimes referred to as “Applied Verbal Behavior” or the “verbal behavior” (VB) approach (Carr & Firth, 2005). Because they are both based on the principles of applied behavior analysis, the techniques utilized in these programs overlap, and there is research demonstrating the effectiveness of at least some aspects of both of these approaches.
As described by Sundberg and Michael (2001), programs modeled after the Lovaas approach (Lovaas & Smith, 2003) consist of programmed reinforcement of eye contact, direction following, vocal and motor imitation, pointing to desired items, and naming objects and actions. One autism intervention resource website identifies two main characteristics of these programs as emphasizing the form of the response in language training, and generally teaching sets of words receptively before teaching them expressively ("The Difference," 2003). Some have argued that the common use of this psycholinguistic nomenclature (e.g., receptive language, expressive language, labels, requests) in such programs "seems quite reasonable, but the failure to make use of the technical concepts and principles that appear in B. F. Skinner's (1957) Verbal Behavior seems inconsistent with the stated behavioral focus" (Sundberg & Michael, pp. 700-701). Michael (1993) suggests that mand training, for example, might not be incorporated into common behavioral programs for individuals with severe language delays because they have been developed around a conceptualization of language acquisition as "learning of the meaning of words" (p. 101). In contrast to programs based on Skinner's analysis of verbal behavior, first targets for language training in common behavioral programs are often tacts or "labels" and receptive-discrimination skills (e.g., "Point to the juice."), without the specific training of mands, because it is assumed that when learned in one condition or context, the same word can be used in various conditions and contexts without specific teaching. The perceived difficulty of manipulating/capturing EOs compared to the relative simplicity of presenting objects and pictures may also contribute to the exclusion of mand training (Michael).
Skinner’s analysis of verbal behavior has been described as being particularly productive for the assessment and treatment of children with autism and developmental disabilities because it “identifies the functional, as well as the structural, parts of a language repertoire…as a result of this approach, the variables responsible for defective verbal development can be more clearly identified and tracked, and a more individualized intervention program can be developed” (Sundberg & Partington, 1998, p. 11). Although the superiority of the VB approach to language training relative to other approaches has not been empirically established, there has been some research evaluating procedures commonly included in VB programs (Carr & Firth, 2005). The following section describes common practices and supporting research of such programs.

Caregivers, researchers, and clinicians have recently shown an increasing interest in the application of Skinner’s analysis to language training for children diagnosed with autism, as evidenced by increased publications, workshops, conferences, and subscriptions to Internet list servers on this topic. A recent Internet search of the phrase “verbal behavior program” on www.google.com yielded approximately 300 results. One autism intervention resource website identifies two main characteristics of VB programs as emphasizing the function of the response in language training and generally training mands and other “expressive” responses before receptive skills (“The Difference,” 2003). Carbone (2004) has characterized the VB approach as 1) relying on basic behavioral principles, 2) relying on Skinner’s (1957) definition of verbal behavior, 3) classifying language according to verbal operants rather than labels, requests, etc., 4) recognizing differences in controlling variables corresponding to the verbal operants, 5) assessing language in terms of the verbal operants, and 6) relying on the research on topography-
and selection-based verbal behavior to determine use of augmentative communication systems. Carbone has identified two main teaching procedures that represent clinical application of research on verbal behavior: initial training of mands and a stimulus-stimulus (S-S) pairing procedure to increase vocalizations. Other common teaching procedures reportedly used in VB programs identified through the aforementioned Internet search are teacher-contrived EOs, the S-S pairing procedure, errorless learning, prompt fading, fluency training, fast-paced instruction, interspersal of easy and difficult tasks, use of a quick-transfer procedure, the preferred augmentative use of sign language over the Picture Exchange Communication System (PECS), and sessions with mixed verbal operants ("Automatic Reinforcement," 2003; "Effective Teaching," n.d.; "Elements of," 2004; "Implementing a," 2004; "Summary of," 2004; "Teaching Procedures," 2003; "Teaching Verbal," 2003). Several of these procedures (i.e., errorless learning, prompt fading, fluency training, fast-paced instruction, interspersal of easy and difficult tasks) are commonly used in other language-training programs and are not specifically related to verbal behavior. However, because the other practices are specifically relevant to the implementation of VB programs, they will be described next along with their supporting research.

Initial Training of Mands

VB programs typically employ mand training as one of the first language training procedures with children diagnosed with autism. The rationale for this is based on the idea that mands can be more easily acquired than other verbal operants because manding directly benefits the child by providing access to highly potent and momentarily more valuable reinforcers. In contrast, other verbal operants primarily benefit the listener and
are often reinforced with generalized conditioned reinforcement, such as social approval, which may not be as potent a reinforcer for the learner (Shafer, 1994; Sundberg & Michael, 2001). However, although the mand clearly does benefit the speaker in this way, and tacts are reinforced with nonspecific, generalized conditioned reinforcement in the exchanges of typically developing individuals, tact training of children diagnosed with autism commonly involves the delivery of potent (nonspecific) reinforcers, which could also be described as directly benefitting the speaker. Sundberg and Michael point out that mands are also important for early language training because they allow the learner to control access to reinforcers, provide the groundwork for further language training, and are quickly generalized to other stimulus conditions. Research often reported (e.g., Shafer) in support of initial mand training include Braam and Sundberg (1991) and Stafford, Sundberg, and Braam (1988), who demonstrated that specific reinforcement tasks were more preferred, resulted in shorter latencies to responding than nonspecific reinforcement tasks, and resulted in the emergence of untrained "mand-compliance" responses. An implication in citing these studies as evidence for the importance of training mands before other verbal operants is that individuals may be more cooperative during mand training because they prefer response-specific reinforcers. However, when compared in terms of percentage of correct responses or trials to criterion, no substantial differences between specific and non-specific reinforcement tasks were observed. In addition, conclusions about the relative effectiveness of specific consequences cannot be formed based on the Braam and Sundberg investigation because specific consequences were delivered during the non-specific condition, as well.
**EO Manipulation**

Related to the previous strategy, VB programs typically incorporate many and varied procedures to manipulate EOs in the training of mands. This may include contriving EOs or taking advantage of natural situations as opportunities for mand training. The effectiveness of procedures such as incidental teaching (captured EOs), blocked response (contrived EOs), and interrupted chain (contrived EOs) procedures has been demonstrated in many studies (e.g., Carroll & Hesse, 1987; Hall & Sundberg, 1987; Hart & Risley, 1975; McCook, Cipani, Madigan, & LaCampagne, 1988; Sigafoos, Doss, & Reichle, 1989; Sigafoos, Reichle, Doss, Hall, & Pettitt, 1990; Sundberg, Loeb, Hale, & Eigenheer, 2002).

**Transfer Procedures**

To facilitate the learning of novel verbal behavior, trainers may establish a child's verbal responding under the control of one antecedent and type of reinforcer and gradually alter stimulus control so that the child learns to emit the same response topography under the control of different antecedents and other types of reinforcers. Based on the appropriate controlling stimuli and reinforcement, children can be taught to emit a response as one verbal operant, and as the stimulus control over responding changes, can learn to emit the same topography under the control of different antecedents and maintained by other types of reinforcement. For example, referring to this as a “quick transfer procedure,” Sundberg and Partington (1998) recommend teaching the tact “car” by first teaching the child to emit “car” in the presence of the nonverbal stimulus (car), a verbal stimulus (“What is that?”), and another verbal stimulus (“car”), while receiving social and other reinforcers. Gradually, stimulus control of the verbal stimuli...
could be faded out to attain a pure tact, “car,” which is evoked by a nonverbal stimulus and reinforced with social praise. Research supporting the effectiveness of this type of transfer procedure has been conducted transferring mands to echoics, intraverbals to tacts, and tacts to mands (e.g., Drash, High, & Tudor, 1999; Sigafoos et al., 1989; Sundberg, Endicott, & Eigenheer, 2000).

Topography-based Communication Systems

VB programs often incorporate topography-based augmentative communication systems, such as sign language, rather than selection-based systems, such as PECS. A conceptual analysis of the skills required for sign language suggest that it may be more like vocal speech because in both there is “point-to-point correspondence between response form and relevant response product” (Michael, 1985; p. 1). In selection-based systems such as PECS, the verbal response requires complex behaviors and “a conditional discrimination in which a stimulus (or establishing operation) alters the controlling strength of another stimulus over a nondistinctive response such as pointing or touching” (Michael, 1985; p. 1). Sundberg and Partington (1998) identify some practical advantages of sign language, including “the deaf community constitutes a natural verbal community that uses sign language, thus materials and trainers are available...signs are free from environmental (mechanical) support, like speech...sign language can improve speech” (p. 75). Although there is some research suggesting that topography-based verbal behavior is acquired more readily than selection-based verbal behavior (e.g., Sundberg & Sundberg, 1990), there is currently insufficient empirical support for the a priori use of one over the other based on speed of acquisition or development of vocal language (e.g., Chambers & Rehfeldt, 2003; Tincani, 2004).
Stimulus-Stimulus (S-S) Pairing Procedure

The S-S pairing procedure utilized in many verbal behavior programs consists of the noncontingent presentation of therapist-produced sounds and known reinforcers to a child for the purpose of increasing vocalizations. The rationale for this procedure is that the pairing of sounds with reinforcers establishes the sounds as conditioned reinforcers. As the child vocalizes, sounds that resemble those that have been presented during pairing are automatically reinforcing and thus increase in frequency. This procedure may approximate a natural process of language learning in typically developing children. Further research on this procedure is necessary because existing studies are few, their findings are equivocal, and many contain methodological flaws (Esch, Carr, & Michael, 2005; Miguel, Carr, & Michael, 2002; Smith, Michael, & Sundberg, 1995; Sundberg, Michael, Partington, & Sundberg, 1996; Yoon & Bennett, 2000).

Multiple Verbal Operant Arrangements

While many intervention programs (e.g., Lovaas & Smith, 2003) frequently teach novel exemplars using a single skill arrangement (e.g., multiple exemplars of a tact program), VB programs typically teach novel language in the context of multiple verbal operant arrangements. Commonly called “mixed verbal behavior,” this involves the interspersal of various novel and acquired exemplars across verbal operant categories. For example, “cookie” might be concurrently taught as a mand and a tact by arranging a situation in which the trainer prevents access to a cookie when the child is hungry, alternated with opportunities for the child to respond to the question, “What is this?” in the presence of the cookie (i.e., a tact-intraverbal trial). Two empirical studies have been conducted in this area that evaluated mixed mand-tact training compared to tact-only
training and reported mixed mand-tact training to result in faster acquisition of tacts than tact-only training (i.e., Arntzen & Almas, 2001; Carroll & Hesse, 1987).

Although clearly a type of interspersal, multiple verbal operant arrangements should be distinguished from interspersal of novel and maintenance tasks (i.e., “task interspersal”). The task interspersal procedure differs from multiple verbal operant arrangements evaluated in the literature in that the latter alternated trials of the same task using two different training procedures. Task interspersal has been shown to be more effective than high-density reinforcement in producing acquisition and retention of novel tasks (Neef, Iwata, & Page, 1977, 1980). Dunlap and Koegel (1980) found that interspersal resulted in superior performance when compared to constant task presentation, and appeared to be preferred by participants. Constant task presentation resulted in substantially higher rates of non-responding, and decreasing trends in correct responses. The authors suggested that superiority of the interspersal condition might be due to its influence on the participant’s motivation to respond once tasks have been acquired, rather than on directly facilitating acquisition. Robinson and Skinner (2002) found that benefits of interspersal were specific to tasks requiring high levels of sustained attention and to tasks that were moderately difficult. Mechanisms proposed for this effect have included decreased negative emotions due to higher incidence of incorrect responding, increased reinforcement value of assignments, and increased rates of reinforcement which enhances attention (Robinson & Skinner).

Despite the current recommended use of multiple verbal operant arrangements (e.g., “Effective Teaching,” 2004; “Implementing a,” 2002; “Teaching Procedures,” 2003) only 2 studies to date have empirically evaluated its effectiveness relative to single
verbal operant presentation. Carroll and Hesse (1987) conducted the first experiment comparing single and multiple verbal operant arrangements with four typically developing 3- to 4-year-old children. A-B replication and multielement designs were used to evaluate the effects of tact-only training versus mand-tact training on the acquisition of tacts. Three objects were trained in each condition, and the order of conditions was counterbalanced across participants. One replication with different toys and sets of objects was conducted with each participant, with the replication sets being more difficult. During the tact-only condition, participants learned to tact 3 objects by responding to the question, “What is this?” and receiving praise for correct responses. Tact trials were alternated with other instructions (e.g., “Touch your nose”, “What color is this?”) to match the pacing of mand-tact sessions, which required more time for toy assembly and play during mand trials. To contrive an EO for mand trials, each participant was first taught to build a toy from various parts. During mand trials, the experimenter instructed him to build the toy, while keeping the last piece hidden. When the participant asked for the last piece correctly, the experimenter gave it to him so he could complete the toy and play with it (i.e., an interrupted chain procedure). During mand-tact training, he received trials of tact training as described above alternated with mand trials, both for a second toy and 3 objects. In other words, during mand-tact training for the first object, he provided tacts and mands of the same topography on alternating trials until mastery. Mastery criterion for each tact was 6 out of 6 unprompted correct trials across 2 consecutive sessions. At the end of the study, follow-up probes were conducted in which participants were presented with all trained objects for one trial each.
Across all participants and evaluations, Carroll and Hesse (1987) found that tacts were acquired in fewer mean tact trials to criterion in the mand-tact training condition than in the tact-only training condition, with tacts acquired in a range of 6 to 29 tact trials. During follow-up “retention tests”, overall, mand-tact training (63.6%) resulted in a higher percentage of correct tacts than tact-only training (27.2%). These results should be interpreted with caution, however, because conclusions about the effects of mand-tact interspersal were based heavily on aggregate mean-line analysis. Analysis of the individual data shows small (range, 3-10 tact trials) and often inconsistent differences between conditions. When examined this way, the effect of mand-tact interspersal on tact acquisition appears less robust, prompting further research.

There are several other considerations in evaluating the Carroll and Hesse (1987) investigation. First, a difference between mand and tact trials was that tact trials were always preceded by a question, “What is this?” Because of this, responses during these trials are best conceptualized as impure tacts (i.e., tacts trained under the multiple control of verbal and nonverbal stimuli). Although this commonly occurs both in contrived language training situations and in the natural environment, training impure verbal operants may introduce confounds that prevent conclusions about variables responsible for changes in behavior. Second, specific information about the tasks interspersed during the tact-only condition was not provided. Difficulty and reinforcement of these responses was not specified, and a rationale for utilizing both intraverbal and tact trials was not provided. Finally, mands may have been trained in the presence of stimuli similar to the item being manded, in that the partially completed toy may have created a space that clearly resembled the target item being manded. If this was the case, this could have
increased the role of a nonverbal stimulus during mand training, and thereby facilitate tact training.

Arntzen and Almas (2002) also evaluated tact-only training versus mand-tact training in a systematic replication of the Carroll and Hesse (1987) investigation. The design and most of the procedures used appeared to be identical to those in the previous study. Because this study was a brief report, some methodological details were not included; however several differences were identified. First, participants were 2 typically developing 3-year-olds and 3 children (ages 3, 15, 17) diagnosed with developmental disabilities and autistic characteristics. Second, tokens were delivered in addition to praise for tact trials. Third, training materials were different and varied across participants. For 4 participants, a letter puzzle was used to train 6 letters in the first evaluation (3 letters per condition) and 6 different letters in the replication (3 letters per condition). For one participant, a photograph album with pictures of objects was used to train 6 objects in the first evaluation (3 objects per condition) and 6 objects in the replication (3 objects per condition). During mand trials, he was instructed to find the object that matched each picture in the album, with the last object hidden from view. A fourth difference in this systematic replication was the mastery criterion of 10 out of 12 consecutive, unprompted correct trials across 2 sessions. Finally, follow-up probes were conducted at various periods, ranging from 7 to 137 days after the study.

As in the Carroll and Hesse (1987) study, Arntzen and Almas (2002) found that across all participants and evaluations, tacts were acquired in fewer mean tact trials to criterion in the mand-tact training condition than in the tact-only training condition, although a range for individual evaluations could not be ascertained from the data.
provided. In contrast to the findings of the Carroll and Hesse investigation, there was little difference in performance on follow-up probes between items trained in tact-only and mand-tact arrangements. As in the Carroll and Hesse investigation, conclusions should be interpreted cautiously due to heavy reliance on mean-line analysis. Although the finding was more robust than observed in Carroll and Hesse, individual data were variable.

There are several other points worth noting in evaluating the Amtzen and Almas (2002) study, three of which are similar to that of Carroll and Hesse (1987). First, specific information about the reinforcement delivered during the tact-only condition was not reported. Information about the number of tokens exchanged, the item(s) for which tokens were exchanged, and the relative reinforcer potency of tokens, puzzle, and photograph album was not provided but may be critical to the outcomes obtained. In addition, the extent to which there was an EO for puzzle and photograph album completion in unclear. Second, mands were trained in the presence of stimuli similar to the item being manded, thus increasing stimulus control and possibly facilitating tact training. Third, specific information about the tasks interspersed during the tact-only condition was not provided. Difficulty and reinforcement of these responses was not specified, and a rationale for utilizing imitation, direction following, and intraverbal trials was not provided.

At least 3 potential mechanisms could produce the superiority of multiple verbal operant arrangements in the two studies in this area. First, it is possible that mand-tact training facilitates acquisition of tacts because the reinforcement for the mand is typically more potent. Second, it is possible that mand training facilitates tact training because the
reinforcement for the mand is more specific, and specific reinforcers facilitate faster acquisition than non-specific reinforcers and/or increase motivation during training (Shafer, 1994). Third, because visually similar stimuli were present during mand trials, learners could engage in covert tacts during mand training. This procedure, then, could essentially be best described as enhanced tact training, in that tact trials were alternated with mand trials with additional tact practice “built in”. For example, Petursdottir et al. (2005) demonstrated that mand training was more likely to result in emergent tacts than tact training was to result in emergent mands when this type of preparation was used.

Given the limited research (i.e., Carroll & Hesse, 1987; Arntzen & Almas, 2002) but common clinical use (e.g., “Effective Teaching,” 2004; “Implementing a,” 2002; “Teaching Procedures,” 2003) of multiple verbal operant arrangements in language training of children with autism and related disabilities, further research in this procedure is warranted. The purpose of Experiment 1 was to replicate and extend previous research on single and multiple verbal operant arrangements, with the following changes/additions: 1) an assessment of mand acquisition to determine potential effects of mand-tact training on mand acquisition, 2) use of stimuli with low probability of exposure outside of the study, 3) analysis and presentation of data on sessions to criterion performance, 4) elimination of verbal antecedents in tact training, and 5) application of more rigorous mastery criteria to avoid false mastery due to first-trial vocal prompts, 6) immediate (rather than delayed) interspersal of tasks in mand-only and tact-only conditions to more closely resemble the mand-tact condition, 7) interspersal of novel tasks reinforced with high preference tangible items to avoid inadvertent increased acquisition of mands and tacts, 8) delivery of equivalent reinforcers across mand and tact
trials, and 9) access to preferred items at the end of sessions to facilitate child participation.

Experiment 1

Method

Participants

Participants were 2 girls and 1 boy, ranging in age from 3 years, 3 months to 3 years, 7 months. This population was selected because the training of elementary verbal operants is germane to common parent and school goals for this age group. In addition, children of this age do not typically exhibit complex verbal repertoires that would produce rapid acquisition, thus preventing observable differential effects of training arrangements. All participants were typically developing, without cognitive impairment (e.g., learning disabilities, developmental disabilities, attention-deficit/hyperactivity disorder) and displayed language skills within a normal range for their age, as identified via the Expressive Vocabulary Test (Anne, 4 years, 4 months; Brooke, 3 years, 11 months; Adam, 4 years, 1 month). Similar language skills among participants were ensured to allow for results to be more confidently discussed solely in terms of different training arrangements, rather than interactions between arrangements and different skill levels.

Dependent Variables and Data Collection

Sessions were conducted in a quiet area of each participant’s home or school 3 to 5 days a week. Sessions consisted of 10 trials and lasted between 5 and 15 minutes. This number of trials was selected because it is comparable to the number of trials per session used in previous studies and facilitated rapid summary of data. This length of sessions is
considered an appropriate amount of time for children of this age to concentrate on a task based on attention span (University of Michigan Health System, 2003). Two to three sessions of each condition were conducted daily. A session was terminated after a participant attempted or requested to leave 3 times. After each session, participants were given a 2- to 5-min break, during which they had an opportunity to choose and play with a toy from a box containing several high-preference items (explained below). A graduate-student experimenter conducted all sessions with each participant at a table along with training materials, data sheets, and a video camera in a corner of the research area. Undergraduate research assistants sat at the table and remained disengaged from the task and interactions with the participants, with the exception of serving as primary data collectors. Undergraduate research assistants collected secondary data from videotape for the assessment of interobserver agreement. Trial-by-trial data were collected on correct (unprompted), prompted, incorrect, and no-response trials per session, and summarized as sessions to criterion performance. Criterion for mastery of each target was 4 out of 5 mand/tact trials correct (and unprompted), with the first trial correct, across 2 consecutive sessions. This criterion was chosen to demonstrate consistent correct responding and rule out false mastery due to echoic responses resulting from a first trial prompt.

Interobserver Agreement

Interobserver agreement (IOA) on responses was assessed using the overall (i.e., point-by-point) agreement method (# of agreements / [# of agreements + disagreements] x 100%). An agreement was defined as both observers recording the mand or tact response as correct or incorrect per trial. Mean IOA for Anne’s sessions was 99% (range,
80%‐100%) and was assessed during 47% of sessions. Mean IOA for Brooke’s sessions was 99.7% (range, 90%-100%) and was assessed during 59% of sessions. Data on IOA and treatment integrity for Adam are unavailable due to loss of data.

*Independent Variable Integrity*

Following each trial, a plus or minus was scored on the experimenter’s correct or incorrect presentation of stimuli and reinforcement during the trial, and summarized as percentage of correct trials per session. Correct presentation of stimuli during mand trials included instructing the participant to complete the task and hiding the target part; during tact trials this included presenting the target part without saying anything; during receptive discrimination trials this included instructing the participant to point to one of the pictures. Correct reinforcement during mand trials included giving the hidden part to the child without saying anything; during tact trials this included presenting a tangible reinforcer and praise; during receptive discrimination trials, this included providing praise. IOA on treatment integrity was calculated using the overall agreement method. Anne’s mean treatment integrity score was 99.5% (range, 80%-100%) and was assessed during 89.4% of sessions. Mean IOA was 100% and was assessed during 27.6% of these sessions. Brooke’s mean treatment integrity score was 99.2% (range, 80%-100%) and was assessed during 52% of sessions. IOA was 100% and was assessed during 28% of these sessions.

*Preliminary Procedures*

An initial screening interview was conducted with each participant’s primary caregiver to assess age and the reported presence of any known cognitive disability.
Language assessment. The Expressive Vocabulary Test (EVT; Williams, 1997) was administered to participants to provide a measure of language skills. The EVT is a two-part, norm-referenced assessment of “expressive vocabulary,” which approximates a measure of the tact repertoire. During the first section of the EVT, the evaluator asks the child to identify up to 38 pictures/body parts. During the second section, the evaluator asks the child to provide synonyms for up to 152 picture/word pairs. This test is appropriate for 3-year-old children and requires approximately 15 min for administration. Reliability and validity of the EVT as a measure for evaluating language ability has been well established (Sattler, 2001).

Preference assessment. Each participant’s caregiver was asked to complete a questionnaire indicating 10 toys and 10 foods that his or her child seemed to prefer. Each participant was also asked to indicate preferred toys and foods by responding to the questions, “What is your favorite toy/food…what else?” and “What toys/foods would you like me to bring when I come to play with you?” Two separate multiple-stimulus (without replacement) preference assessments (MSWO; DeLeon & Iwata, 1996) were then conducted with these items to identify preferred toys to be used in the toy container during breaks and preferred toys and foods as reinforcers during tact trials. During this assessment, participants were asked to choose from a linear array of eight toys/foods. For the toy preference assessment, the selected item was removed after the participant has 10 s of access. The remaining items were then rearranged and a new instruction was issued. This procedure was repeated until all items are chosen or the participant does not indicate preference for any items in the array. The assessment was repeated two more times, yielding a total of three arrays (Carr, Nicolson, & Higbee, 2000).
Experimental Procedures

Design and materials. The effects of three different training arrangements on the acquisition of mands and tacts were evaluated using an alternating treatments design (Barlow & Hayes, 1979). Participants were exposed to multiple evaluations of the training arrangements by using 2 to 4 different sets of stimuli. Three different flat puzzles, photograph albums, cube puzzles, and felt board activities were used for each of the training arrangements (i.e., mand-only training, tact-only training, mand-tact training). Target pieces were asymmetrical and unfamiliar in shape and did not depict any one item so that participants did not learn nonsense responses for real shapes or pictures. Flat puzzles consisted of 4 pieces, were contiguous, and set within a board. Photograph albums consisted of 4 pages with 1 silhouette on each page, with the first 3 silhouettes corresponding to small objects around the research area (e.g., toy car). During mand trials, participants were instructed to "match the pictures" by turning one page at a time, and retrieving each item; all matching objects were provided except one. Cube puzzles consisted of four 3-dimensional pieces. Felt board tasks consisted of 4 pieces that could be affixed to a vertically mounted felt board on which an outline of each felt piece was provided. The daily order of conditions was conducted in a quasi-random order by a draw. Responses trained were two-syllable fictitious words and are presented in Table 1.

Mand-only training. All sessions in this condition began with the experimenter asking the participant to complete the task. The last object required to complete the task was hidden by the experimenter (i.e., an interrupted chain procedure). When the child correctly stated the name of the hidden object, the experimenter provided it to the child without saying anything. Participants were taught to complete tasks prior to experimental
Table 1. Experiment 1 Target Responses by Condition and Activity.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mand-only</th>
<th>Tact-only</th>
<th>Mand-tact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Puzzles</td>
<td>boosha</td>
<td>doso</td>
<td>heenye</td>
</tr>
<tr>
<td>Photograph Albums</td>
<td>middy</td>
<td>bindo</td>
<td>novere</td>
</tr>
<tr>
<td>Cube Puzzles</td>
<td>lacket</td>
<td>meecot</td>
<td>cheynoo</td>
</tr>
<tr>
<td>Felt Boards</td>
<td>bloggy</td>
<td>yerba</td>
<td>simger</td>
</tr>
</tbody>
</table>

sessions. Mands were interspersed with receptive discrimination tasks on a 1:1 ratio (described below). As in previous studies, mands were trained in the presence of stimuli that resembled the target object (e.g., the outline of the missing puzzle piece in the board was identical to the shape of the actual piece).

**Tact-only training.** The experimenter placed the target object in front of the participant. If the participant correctly stated the name of the object, the experimenter provided praise (e.g., “Great! You got it!”) and a tangible reinforcer. Tacts were interspersed with receptive discrimination tasks on a 1:1 ratio (described below).

**Mand-tact training.** During this condition, participants were taught to respond to one item as both a mand and a tact. The mand trial was always first, as was the practice in previous studies, and mand and tact trials were alternated in a 1:1 ratio. Procedures for
the mand and tact trials were conducted as above; however, interspersal with other tasks was not included.

*Interspersal.* During mand-only and tact-only training, other tasks were interspersed with the target mand or tact to rule out the possibility that interspersal alone produced superior acquisition in the mand-tact training condition. Interspersed tasks were novel 3-choice receptive discrimination tasks with nonsense stimuli. Incorrect interspersal tasks were prompted as described above, and correct responses were consequated with praise and high preference tangible items. Interspersal was conducted with novel tasks and reinforced with high-preference tangible items to avoid inadvertent increased acquisition of mands and tacts.

*Reinforcement.* When the tasks were completed during mand trials or correct tacts were emitted during tact trials, tangible reinforcers were randomly delivered from a group of 6 toys and foods that ranked the highest in the MSWO preference assessments (3 toys and 3 foods). Small pieces of food were given, and only toys that could be played with in less than 30 s were used. This nonspecific reinforcement procedure was incorporated in an attempt to provide equivalent reinforcer strength across mand and tact trials, and eliminate the possibility that one verbal operant would be acquired faster due to reinforcer strength.

*Prompts.* A response was considered correct if it was independent and matched (or improved from) the articulation of the response following the first vocal prompt at the beginning of training. During each condition, if the participant did not respond during a trial, the experimenter waited 5 s, provided a vocal prompt for the participant to imitate, and then provided an opportunity for the child to independently respond to the object.
again. If the participant did not imitate vocal prompts for three consecutive opportunities or attempted/requested to leave three times, the session would have been terminated; however, this never occurred. If the participant responded incorrectly, the experimenter provided a vocal prompt for the participant to imitate. If correct, this trial was scored as “prompted”, but the child received the reinforcer appropriate to that condition.

Facilitation of participation. Following each trial, the experimenter marked 1 of 10 boxes on a small dry-erase board to indicate completion of the trial to the participant to reinforce responding and to depict trials to completion of the session. When all boxes were marked, the experimenter indicated to the participant that the session was over and that he or she may play with a toy from the toy container. A timer was then set for 2 to 5 min, depending on the nature of the toy (i.e., an appropriate amount of time required to play with the toy). When the timer sounded, the experimenter indicated to the child that it was either “time to play with the other toys now” or that they were “finished playing for today.” This procedure was intended to facilitate continued voluntary participation in the study.

Results and Discussion

Due to participant access, not all tasks could be evaluated with all participants. However, participants did not appear to acquire responses more or less quickly when trained with certain tasks or materials.

Mand acquisition graphs across stimulus sets for each participant are depicted in Figure 1. Although not standard for measures that are not scaled in units of time along the x-axis, line graphs appear to more clearly depict the effects of mand-tact interspersal across tasks for all participants. As seen in the top panel, Anne acquired the mand for the
puzzle piece more quickly in the mand-only condition, but acquired mands for the album and cube pieces more quickly in the mand-tact condition. As seen in the middle panel, Brooke acquired mands for cube and puzzle pieces more quickly in the mand-only condition, but acquired mands for the album and felt pieces more quickly in the mand-tact condition. The resulting overlapping data paths of mand acquisition for Anne and Brooke demonstrate inconsistent effects of mand-tact interspersal; that is, during some tasks, acquisition was more rapid during mand-only training and during other tasks, acquisition was more rapid during mand-tact training. For Adam, mands were acquired more quickly during mand-only training than during mand-tact training for both stimulus sets; however, the differences were negligible.

Tact acquisition graphs across stimulus sets for each participant are depicted in Figure 2. As seen in the top panel, Anne acquired the tact for the puzzle piece more quickly in the tact-only condition, but acquired tacts for the album and cube pieces more quickly in the mand-tact condition. As seen in the middle panel, Brooke acquired the tact for the album piece more quickly in the tact-only condition, but acquired tacts for the cube and felt pieces more quickly in the mand-tact condition. There was no difference in acquisition of tacts for the puzzle pieces. Again, the resulting overlapping data paths of tact acquisition for Anne and Brooke demonstrate inconsistent effects of mand-tact interspersal. For Adam, tacts were acquired more quickly during mand-tact training than during tact-only training for both stimulus sets, demonstrating the most consistent replication of the 3 participants.

In summary, across all participants, 3 out of 9 evaluations demonstrated the facilitative effects of mand-tact interspersal on mand acquisition; 6 out of 9 evaluations
Figure 1. Sessions to Criterion for Mands Across Stimulus Sets for Each Participant.
Figure 2. Sessions to Criterion for Tacts Across Stimulus Sets for Each Participant.
demonstrated facilitative the effect on tact acquisition. Furthermore, many of the differences were negligible. Presented this way, these data demonstrate a relatively weak effect of mand-tact interspersal on acquisition. Data were then graphed using bar graphs, and mean lines were examined to provide a better comparison with results from previous studies.

The mand acquisition bar graphs for each participant are depicted in Figure 3. As seen in the top panel, Anne acquired mands in fewer mean sessions in mand-tact training ($M = 9$) than in mand-only training ($M = 11.7$), ranging from a difference of 7 to 12 sessions. As seen in the middle panel, Brooke acquired mands in fewer mean sessions in mand-tact training ($M = 6.75$) than in mand-only training ($M = 11$), ranging from a difference of 1 to 11 sessions. As seen in the bottom panel, Adam acquired mands in more mean sessions in mand-tact training ($M = 7$) than in mand-only training ($M = 6$), with mands differing by 1 session in both tasks.

The tact acquisition bar graphs for each participant are depicted in Figure 4. As seen in the top panel, Anne acquired tacts in fewer mean sessions in mand-tact training ($M = 4.3$) than in tact-only training ($M = 6.3$), ranging from a difference of 2 to 6 sessions. As seen in the middle panel, Brooke acquired tacts in fewer mean sessions in mand-tact training ($M = 6.5$) than in tact-only training ($M = 9.75$), ranging from a difference of 1 to 9 sessions. As seen in the bottom panel, Adam acquired tacts in fewer mean sessions in mand-tact training ($M = 5.5$) than in tact-only training ($M = 9$), ranging from a difference of 2 to 5 sessions. In summary, mean differences, although demonstrating a consistent
Figure 3. Sessions to Criterion for Mands Across Training Arrangements for Each Participant.
Figure 4. Sessions to Criterion for Tacts Across Training Arrangements for Each Participant.
effect of mand-tact interspersal, were negligible across participants (i.e., 2, 3.25, 3.5 sessions) with considerable within-participant variability.

As mentioned earlier, although the two existing studies in this literature (Arntzen & Almas, 2001; Carroll & Hesse, 1987) reported positive effects, a closer analysis of their findings reveals relatively weak effects and substantial variability within participants. It appears as though the previous authors’ reliance on mean differences heavily influenced their effect reporting. When tact data from the present experiment were evaluated using mean lines, the effects of mand-tact training on tacts are more in line with previous studies. The line-graph and bar-graph aggregate analyses of the mand data from the present study do not indicate a reliable facilitative effect of mand-tact training on mand acquisition.

Working under the assumption that a robust mand-tact effect is demonstrable under some conditions, it was hypothesized that failure to produce a more robust demonstration of this phenomenon may be due to differences in reinforcement between conditions. It is possible that participants had higher rates of reinforcer delivery during mand-only and tact-only conditions because of the receptive tasks interspersed during these conditions and not during mand-tact sessions. These receptive tasks were arguably easier in nature, perhaps resulting in more reinforcers delivered earlier in their trials. If so, this could reduce the difference in acquisition between mand-only/tact-only conditions and mand-tact condition. Graphs showing mean reinforcers delivered during each condition are depicted in Figure 5. Although the mean number of reinforcers delivered during mand-only sessions was higher than during mand-tact sessions for one stimulus set (i.e., Brooke, puzzles), and during tact-only sessions than during mand-tact
sessions for some stimulus sets (i.e., Anne, albums; Brooke, cubes, puzzles, albums), differences were negligible and this was not observed across all other stimulus sets. It was concluded that these differences did not pose a confound to the study, and did not affect the outcomes observed.

It should also be noted that it is possible that completion of the activities (i.e., albums, puzzles, felt, cubes) used in the current study was not sufficiently reinforcing, and this weakened potential effects of mand-tact training. With the preparations employed in this and previous studies (as well as information reported in previous studies), it is not possible to make comparisons about reinforcer strength. Although consequences were arranged so that mand and tact trials both ultimately ended in comparable tangible reinforcement, this reinforcement was slightly delayed during mand trials until the toy was completed. The more immediate consequence (and putative reinforcer) of completion may not have been sufficiently reinforcing.

Experiment 2

It was hypothesized that the weak effect observed in the current study may have been due to strategies employed to increase methodological rigor and employ more effective teaching strategies (e.g., prompts, reinforcers). To evaluate this hypothesis, a direct replication of previous research was conducted. The Carroll and Hesse (1987) study was selected rather than the Arntzen and Almas (2002) brief report because the former contained more methodological details. Procedures were identical to those reported in Phase 2 of Carroll and Hesse, with the exception of using slightly different toys and the use of the toy container at the end of sessions to facilitate participation.
Figure 5. Mean Reinforcers Delivered During Mand-only, Tact-only, and Mand-tact Conditions for Each Participant.

Method

Participants

Participants were 2 girls, ages 3 years, 2 months and 2 years, 10 months. Both participants were typically developing, without cognitive impairment (e.g., learning disabilities, developmental disabilities, attention-deficit/hyperactivity disorder) and
displayed language skills within a normal range for their age, as identified via the Expressive Vocabulary Test (Caroline, 3 years, 8 months; Dara, 4 years, 1 month).

Dependent Variables and Data Collection

Sessions were conducted in a quiet area of each participant’s home or school 3 to 5 days a week. Sessions were conducted until 6 consecutive trials were correct or 20 minutes passed for Caroline, or until 15 minutes passed for Dara, whichever came first. One to two sessions of each condition were conducted daily. Other data collection procedures were identical to those in Experiment 1. After each session, participants were given a 2 to 5 min break, during which they had an opportunity to choose and play with a toy from the toy container. Trial-by-trial data were collected on correct (unprompted), prompted, incorrect, and no-response trials per session, and summarized as trials to criterion performance. Criterion for mastery of each target was 6 out of 6 correct (and unprompted) responses across 2 consecutive sessions. As in the Carroll and Hesse (1987) investigation, training continued until 6 out of 6 consecutive responses were made, but in analysis, tacts were considered mastered after the third consecutive tact trial. The rationale for this was to keep mastery in the tact-only condition equivalent to mastery in the mand-tact condition, in which only 3 tacts were required.

Interobserver Agreement and Independent Variable Integrity

IOA and IV Integrity were assessed and calculated as in Experiment 1. IOA for Caroline’s sessions was 100% during all sessions and was assessed during 50% of sessions. Mean IOA for Dara’s sessions was 97.7% (range, 83%-100%) and was assessed during 55% of sessions.
Dara’s mean treatment integrity score was 100% and was assessed during 35% of sessions. Mean IOA was 97.5% (range, 90%-100%) and was assessed during 57% of these sessions. Data on treatment integrity for Caroline are unavailable due to loss of data.

*Preliminary Procedures*

Language and preference assessments were conducted with both participants as described in Experiment 1. However, only toys were included in order to identify high preference toys to include in the toy container. It was unnecessary to assess food because tangible items were not delivered during sessions in Experiment 2.

*Experimental Procedures*

*Design and materials.* As in Carroll and Hesse (1987), the effects of 2 different training arrangements on the acquisition of tacts were evaluated using an alternating treatments design. Participants were exposed to multiple evaluations of the training arrangements by using 3 pieces from each of 2 different structures. As in the Carroll and Hesse investigation, assembling the pieces resulted in structures which were toys appropriate to this age group (i.e., creatures with arms and legs). Two different structures were used for each of two training arrangements (i.e., tact-only training, mand-tact training). Structures consisted of 3 pieces to assemble and target pieces were comprised of brightly colored, plastic Kid K’Nex™ toy parts. Specific pieces included a combination of rod and gear-like pieces interconnected with pieces that ranged in shape and form from ovals to springs. Participants were taught to build the structures prior to experimental sessions. None of the pieces bore a resemblance to any familiar items known to the participants, as indicated by each participant’s non-response or incorrect
response when asked, “What is this?” prior to training. Responses trained were two-syllable technical terms for body parts and are presented on Figure 6. The daily order of conditions consisted of alternating between tact-only and mand-tact sessions until all tact-only sessions were completed. After the structure was completed, the experimenter provided praise.

*Tact-only training.* The experimenter placed the target object in front of the participant, and said, “What part is this?” If the participant correctly stated the name of the object, the experimenter provided praise (e.g., “Great! You got it!”) Tacts were interspersed with receptive and imitation tasks on a 1:1 ratio.

*Mand-tact training.* During this condition, participants were taught to respond to one item as both a mand and a tact. The mand trial was always first and mand and tact trials were alternated in a 1:1 ratio. Procedures for tact trials were conducted as above. Mand trials began with the experimenter asking the participant to build the structure. The last piece required to complete the task was hidden by the experimenter (i.e., an interrupted chain procedure). When the child correctly stated the name of the hidden object, the experimenter provided it to the child without saying anything.

*Interspersal.* During tact-only training, other tasks were interspersed with the target tact. Interspersed tasks were previously acquired motor imitation and receptive identification tasks reported to be easy by the child’s teacher or parent. Incorrect interspersal tasks were prompted as described above, and correct responses resulted in praise.

*Prompts.* A response was considered correct if it was independent and matched (or improved from) the articulation of the response following the first vocal prompt at the
beginning of training. During each condition, if the participant did not respond during a trial, the experimenter waited 5 s, provided a vocal prompt for the participant to imitate, and then provided an opportunity for the child to independently respond to the object again. If the participant did not imitate vocal prompts for three consecutive opportunities or attempted/requested to leave three times, the session was terminated. This occurred during 9 sessions with Dara (all mand-tact sessions). If the participant responded incorrectly, the experimenter provided a vocal prompt for the participant to imitate. If correct, this trial was scored as “prompted”, but the child received the reinforcer appropriate to that condition.

*Facilitation of participation.* As in Experiment 1, at the end of each session, the experimenter indicated to the participant that the session was over and that he or she may choose a toy from the toy container to play with. However, the experimenter did not mark a box in front of the participants in Experiment 2 because neither the number of trials nor the duration of sessions could be predicted, being based on participant performance.

*Results and Discussion*

The tact acquisition bar graphs for each participant are depicted in Figure 6. As seen in the top panel, Caroline acquired tacts in fewer mean tact trials in tact-only training ($M = 36$) than in mand-tact training ($M = 45$). As seen in the bottom panel, Dara acquired tacts in fewer mean tact trials in tact-only training ($M = 14$) than in mand-tact training ($M = 19$), ranging from a difference of 3 to 17 tact trials ($M = 10$). Line graphs are not presented as in Experiment 1 because targets were not linked in pairs according to stimulus sets; however, examination of acquisition of individual targets on the bar graphs.
shows substantial variability for both participants. For Caroline, tact acquisition ranged from 23 to 59 trials to criterion in the tact-only condition and 30 to 60 trials to criterion in the mand-tact condition. Similarly, for Dara tact acquisition ranged from 9 to 24 trials to criterion in the tact-only condition and 12 to 26 trials to criterion in the mand-tact condition. In summary, tact-only training resulted in faster mean acquisition of tacts than mand-tact training both participants; however, as in Experiment 1, individual data were inconsistent.

Examination of both the individual and aggregate data in Experiment 2 demonstrates a failure to produce an effect of mand-tact interspersal on tact acquisition. In addition, when the means are compared, interspersal of mands and tacts appears to produce a detrimental effect on tact acquisition when compared to tact-only training. Anecdotal observations during sessions reveal at least 4 potential reasons for these outcomes. First, the interrupted chain procedure appeared to be effortful, and completion of the structures may not have been sufficiently reinforcing, even with the toy container. For example, Dara appeared to respond more slowly, attempted to leave the experimental area, and declined to participate during mand-tact sessions. Second, these behaviors often led to fewer trials being conducted during mand-tact sessions than during tact-only sessions. Because of this, there was a difference in density of trials conducted per visit between these conditions. For example, although Dara reached criterion performance for the tact *Xyphoid* and the mand *Lumen* in a comparable number of trials (24 and 26, respectively), acquisition of the tact *Xyphoid* occurred after only 3 sessions, but acquisition of the mand *Lumen* occurred after 9 sessions. Third, the nature of the structures was such that they could be played with before they were completed, thereby
possibly decreasing the reinforcing value of the final piece. Finally, the interspersal of novel and previously-acquired tasks in the tact-only condition (as conducted in Carroll and Hesse, 1987) may have produced more rapid acquisition of tacts in the tact-only condition.

Figure 6. Tact Trials to Criterion Across Training Arrangements for Caroline and Dara.
General Discussion

The current studies evaluated the effects of mand-tact interspersal on mand and/or tact acquisition relative to mand-only and tact-only training arrangements in 5 typically developing children. In Experiment 1, a systematic replication was conducted to replicate, extend, and provide increased methodological rigor from previous research on this phenomenon. In Experiment 2, a direct replication of Phase 2 of the Carroll and Hesse (1987) investigation was conducted when robust effects were not observed during Experiment 1. Taken together, the data from the two present experiments do not provide convincing support for the clinical use of multiple verbal operant (mand-tact) arrangements.

However, the effect of multiple verbal operant arrangements may be a valid but elusive phenomenon, potentially meriting further research. For research to truly inform the current clinical use of this procedure, its features should be roughly comparable to what is done clinically. The existing studies, which do not overwhelmingly support mand-tact interspersal, are perhaps not the best analogs.

Specifically, future research might address the limitations (described above) of the interrupted chain preparation. Although this procedure was employed to create a consistent EO that would evoke a mand, this preparation may have prevented an accurate evaluation of the mand-tact arrangement because the final piece of the chain may not have functioned as a reinforcer. In studies utilizing interrupted chain procedures, it is difficult to ensure that completing the chain is reinforcing for all participants, and that the reinforcing effectiveness of completion remains consistent. However, a mand arrangement that does not employ the interrupted chain might not be practical for
research with typical learners because it may be difficult to identify activities or items that are reinforcing and yet novel, and it may be difficult to identify targets typical learners would not quickly encounter. Teaching nonsense responses for actual objects would be unethical. In addition, typical learners might acquire the response too quickly to examine differences in acquisition. Thus, a non-chain preparation with a clinical preparation might be a better arrangement.

Wallace, Iwata, and Hanley (2006) used a promising preparation to evaluate the effects of tact acquisition on establishment of mands. First, stimulus preference assessments were conducted to identify low-preference (LP) and high-preference (HP) items. The experimenter then presented LP and HP items individually, and trained a tact in the presence of each (non-specific reinforcers were delivered). Next, LP and HP items were presented in pairs (as in a preference assessment) to observe the emergence of mands. Although not directly trained, participants manded for the HP items on almost all trials. As the authors point out, previous research has shown that responding is allocated to high preference items in this type of free-operant concurrent preparation. This preparation may be useful in the current line of research because a stronger and consistent EO may be more confidently inferred, and addresses other limitations of the interrupted chain procedure (e.g., use of nonsense syllables).

Future research might also address other potential beneficial effects of multiple verbal operant arrangements that were not evaluated in the current studies. For example, it is possible that, although this arrangement does not produce more rapid acquisition, it does produce better maintenance effects. This finding was reported by Carroll and Hesse (1987), but was not found by Arntzen and Almas (2001); however, neither authors
speculated about the possible reasons that mand-tact training would result in better maintenance than tact-only training. It is also possible that another beneficial effect of mand-tact training could be shorter latency to responding. For example, Stafford, Sundberg, and Braam (1988) reported that the use of specific reinforcement tasks did not result in better accuracy, but did result in shorter latencies to responding than nonspecific reinforcement tasks.

It should be noted that a problem inherent to studies on skill acquisition is that acquisition strategies as independent variables are always treatment packages, consisting of a component being studied in addition to a variety of performance enhancing teaching strategies offered by the most current behavioral technology. These include such strategies as stimulus preference assessments, reinforcer variation, prompt-fading techniques, task interspersal, and reinforcer thinning techniques. In the current study, the component evaluated was mand-tact interspersal, but additional teaching strategies employed included prompting strategies, preference assessments, specific arrangement and delivery of reinforcers (e.g., methods to obtain equivalence in reinforcement, toy container), reinforcer variation (except following mands). Although the experiments were designed to evaluate one component impacting participants, these other components by themselves should, based on previous research, produce acquisition. Thus, there might be relatively little room to demonstrate an effect with one specific variable. Replication failures or weaker effects of the independent variable being studied may be observed because of a ceiling effect or because these strategies improve performance in conditions with and without the intended independent variable. In the current study, a direct replication was conducted, suggesting that these "background" independent
variables probably not did not produce the weak effects obtained. However, future research might be conducted in light of these potential effects.

In conclusion, the data from the two present experiments do not provide convincing support for the clinical use of multiple verbal operant (mand-tact) arrangements for facilitating tact or mand acquisition. Although the investigation was arranged to employ more rigorous procedures than those used in previous studies, robust effects were not obtained. Considerations for future research in this area include utilization of clinically relevant populations and preparations, as well as preparations that more confidently contrive or capture EOs for mand training. In addition, unintended effects of performance-enhancing strategies should be evaluated. Finally, the value of future applied research on this procedure might be best determined in light of the number of these empirically supported alternatives for enhancing performance. The search for conditions that predict a modest and unreliable effect of an intervention (e.g., mand-tact interspersal) should be balanced with the knowledge that a variety of effective components that produce more reliable findings are available.
REFERENCES


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Appendix

Approval Letter From the Human Subjects Institutional Review Board
Date: August 26, 2004

To: James Carr, Principal Investigator
   Tina Sidener, Student Investigator for dissertation
   Amanda Firth, Student Investigator

From: Amy Naugle, Ph.D., Interim Chair

Re: HSIRB Project Number: 04-07-11

This letter will serve as confirmation that your research project entitled “An Evaluation of Different Training Arrangements on Language Acquisition of Preschool Children” has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

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

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

Approval Termination: July 21, 2004