Conditional Discrimination in the Intraverbal Relation: A Review and Recommendations for Future Research

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Conditional discrimination is inherent in the intraverbal relation when one verbal stimulus alters the evocative effect of another verbal stimulus and they collectively evoke an intraverbal response. Rarely in research on conditional discriminations have both conditional and discriminative stimuli been vocal verbal and rarely have the responses been topography-based. Making conditional discriminations in intraverbal behavior is a repertoire that is often delayed in children with autism and other developmental disabilities. Reviewed in this paper is research on teaching intraverbal behavior, auditory conditional discriminations, and restricted stimulus control. The purpose of these reviews is to identify the extent to which previous researchers examined conditional discriminations in the intraverbal relation and to recommend directions for research in this area.

Key words: intraverbal, conditional discrimination, verbal behavior, autism, developmental disabilities

Intraverbal behavior is defined as a form of verbal behavior controlled by a verbal stimulus in which there is no point-to-point correspondence between the response and the stimulus (Skinner, 1957). A range of complexity exists in intraverbal behavior. Simple intraverbal behavior includes emitting chains of verbal stimuli (e.g., saying the alphabet, saying one's phone number) and filling in words to songs and simple phrases (e.g., saying "go" in the presence of "Ready, set..."). More complex intraverbals are answering questions (e.g., "What's your name?" "When's your birthday?") and stating members of categories (e.g., responding "spaghetti, fish, and chicken" to "What are some things you eat for dinner?"). Learning intraverbal behavior facilitates the acquisition of other behavior (Sundberg & Michael, 2001), such as academic and social skills (Partington & Bailey, 1993). Examined in this paper is perhaps another complex class of intraverbal behavior: making conditional discriminations in intraverbal behavior.

A conditional discrimination occurs when behavior comes under the operant control of one stimulus when it is in the presence or context of another stimulus (Catania, 1998). This

arrangement is distinguished from a simple discrimination in which only one stimulus condition exerts control over a response. For example, if reinforcement is delivered when an individual pushes a green key and not a red key, there is a simple discrimination. But if reinforcement is contingent on pushing the green key only after hearing the auditory stimulus "green," this constitutes a conditional discrimination. In this example, the auditory stimulus is the conditional stimulus, or the sample, and the green key is the discriminative stimulus, or the comparison. In another example, if reinforcement is delivered when an individual pushes a button in the presence of a light and not in its absence, there is a simple discrimination. But if reinforcement is contingent on pushing the button when a bell is sounding while the light is on, this constitutes a conditional discrimination. In this case, the bell is the conditional stimulus and the light is the discriminative stimulus. Hundreds of experiments have manipulated variables related to conditional discriminations in both nonhuman and human subjects (see Green, 2001; Schrier & Thompson, 1980; and Sidman, 1994 for reviews). Many investigators studied conditional discriminations using matching-to-sample tasks and many of these studies were conducted in the context of stimulus equivalence (Sidman, 1994).

Researchers of conditional discriminations and stimulus equivalence have examined stimuli and responses of varying sensory and functional modalities. Researchers have examined visual-visual conditional discriminations in which both the conditional and discriminative

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Table 1
*Questions That Do Not Require Conditional Discriminations (Column 1) and
 Sets of Questions That Require Conditional Discriminations (Columns 2 and 3)*

Simple intraverbals	Conditional discriminations	Conditional discriminations
1. What do you eat?	1. What do you eat that's red?	1. What was the boy wearing?
2. What do you drink?	2. What do you drink that's red?	2. What was the girl wearing?
3. What is red?	3. What do you eat that's yellow?	3. What was the boy eating?
4. What is yellow?	4. What do you drink that's yellow?	4. What was the girl eating?

stimuli were nonverbal (e.g., pictures, colors, shapes; e.g., Meltzer, 1984; Saunders & Spradlin, 1993; Yarczower, 1971). Other studies employed auditory-visual relations in which one stimulus was vocal verbal and one stimulus was nonverbal or nonvocal verbal (e.g., spoken words and written stimuli; Kelly, Green, & Sidman, 1998; Lane & Critchfield, 1998; McIlvane, Withstandley, & Stoddard, 1984; Saunders, Wachter, & Spradlin, 1988; Sidman & Cresson, 1973). In only one study identified were both the conditional and discriminative stimuli vocal verbal (Dube, Green, & Serna, 1993). In terms of responses in research on conditional discriminations and stimulus equivalence, selection-based responding is the dominant form (Polson & Parsons, 2000). Michael (1985) distinguished between selection-based and topography-based responding. Hall and Chase (1991) argued that selection-based responding was more prevalent in stimulus equivalence research and topography-based responding was more often employed in verbal behavior research.¹ By and large, the literatures of conditional discrimination and Skinner's (1957) analysis of verbal behavior have not influenced one another to a considerable extent.

¹ Verbal behavior can be topography-based (e.g., speaking, signing, writing) or selection-based (e.g., pointing to pictures, pointing to text). The focus of this paper is on making vocal verbal responses, but the analyses could be extrapolated to other types of responses.

² What constitutes a verbal stimulus is dependent on a functional relation and is not necessarily a word, but could also be a single phoneme, a letter, a phrase, or a sentence (Skinner, 1957). For convenience in this paper, a verbal stimulus will be considered a word.

Conditional discriminations are relevant to all the verbal operants described by Skinner as probabilities of verbal responses vary with the presence of conditional and discriminative stimuli (as well as motivating operations in the case of the mand). For example, tacting the color of an apple may be controlled by the presence of the apple (discriminative stimulus) and a person's question, "What color is that apple?" (conditional stimulus; Catania, 1998). Conditional discriminations in the intraverbal repertoire are particularly important because verbal stimuli interact to occasion certain verbal responses. In a simple discrimination in the intraverbal relation, a person can respond to only one verbal stimulus, such as responding, "Hello," in the presence of "Hi." But in a conditional discrimination in the intraverbal relation, a person must come under the control of two or more verbal stimuli. For example, if a person asks, "What time is lunch?" a correct (reinforced) response might be, "noon." The speaker, however, has not made a conditional discrimination if he comes under the control of only one stimulus, such as if he said, "sandwiches" (if responding only to *lunch*) or "nine o'clock" (if responding only to *time*). A correct response is dependent on making a conditional discrimination in which, for example, *time* is the conditional stimulus and *lunch* is the discriminative stimulus (or vice versa). In conditional discriminations in the intraverbal relation, one verbal stimulus alters the evocative effect of the second verbal stimulus and they collectively evoke an intraverbal response (Sundberg, 2006a)².

The purpose of this paper is to examine the issue of conditional discrimination in the intraverbal relation and to review three lines of

Figure 1. Divergent and convergent control in the intraverbal relation.

research: teaching intraverbal behavior, auditory conditional discriminations, and restricted stimulus control. The purpose of these reviews is to identify the extent to which previous researchers examined conditional discriminations in the intraverbal relation and to make recommendations for future research.

CONDITIONAL DISCRIMINATION IN THE INTRAVERBAL RELATION

Stimulus control in verbal relations can be analyzed in a multiple control framework:

Two facts emerge from our survey of the basic functional relations in verbal behavior: (1) the strength of a single response may be, and usually is, a function of more than one variable and (2) a single variable usually affects more than one response. (Skinner, 1957, p. 227)

Convergent multiple control occurs when multiple antecedent variables influence the strength of one response. *Divergent* control is the emission of multiple responses upon the occasion of one antecedent variable. Michael (2003) suggested that divergent control occurs when, for example, a nonverbal discriminative stimulus, such as a dog, evokes multiple responses, such as tacting, writing, and signing the dog, parts of the dog, and features of the dog. Convergent control occurs when one response, saying "dog," is a function of multiple variables, such as a motivating operation related to a dog as reinforcement, the presence of a dog, an auditory stimulus "dog," and the written word *dog*.

These categories of multiple control can be analyzed solely within the intraverbal relation. One verbal stimulus can occasion multiple verbal responses (divergent control) and multiple verbal stimuli can occasion a single verbal re-

sponse (convergent control). For example, with divergent control, *dog* can occasion multiple intraverbal responses, such as *pet*, *barks*, and *collar*; whereas with convergent control, *dog*, *short legs*, and *long body* can evoke the intraverbal response *dachshund* (Figure 1). In another example, if teaching a child to answer the questions in the first column of Table 1, the child can answer correctly by responding to only the last word in each question. Answering correctly does not require the child to make conditional discriminations among the verbal stimuli in the questions and there is no convergent control. But correctly responding to the sets of questions in the second and third columns requires conditional discriminations and convergent control. In the second column, the child must respond to the third-to-last word which alters the evocative effect of the last word. Most question sets with convergent control also involve divergent control. This is the case in the second two columns in Table 1 as each question can evoke multiple responses.

Making conditional discriminations in the intraverbal relation is critical for children with autism and other developmental disabilities because these children are known to have delays in verbally responding to complex verbal stimuli (Schreibman, 1988). Children with developmental disabilities must be taught to respond to complex arrangements of verbal stimuli as this repertoire is critical for developing academic and social skills. Success in school is dependent on making conditional discriminations among verbal stimuli as students must follow teachers' instructions, answer comprehension questions based on stories and text, and verbally respond to classroom discussions with questions from teachers and peers. Responding to complex verbal stimuli is also critical for social development. Young children with

Table 2
Sets of Questions From Three Studies

Sundberg et al., 1990	Finkel & Williams, 2001	Jahr, 2001
1. What do you do to connect a three pronged plug into a two-pronged socket? (adapter)	1. What's your name?	1. What do you like to eat?
2. What do you use to clean the bottom of a deep jar? (bottle brush)	2. How old are you?	2. What do you like to drink?
3. What do you put food in to keep it fresh? (plastic bag)	3. When's your birthday?	3. What do you like to play with?
4. What do you use to pour oil into your car so you won't spill any? (funnel)	4. What do you like to eat?	4. Who do you like to play with?
5. What do you use to fix a hole in your radiator hose? (tape)	5. Where do you live?	5. Who do you live with?
	6. What's your telephone number?	6. Who do you sing with?
	7. What's your address?	7. Where do you buy a snack?
	8. What's your favorite movie?	8. Where do you play football?
	9. What's your mother's name?	9. Where do you swim?
	10. Where do you go to school?	10. Why do you use your hands?
	11. What's your favorite color?	11. Why do you eat?
	12. How are you?	12. Why do you drink?

autism or other language delays must learn to respond to questions, such as "What's your name?" But, they must also learn to respond to verbal stimuli in varying combinations, such as in the set of questions, "What's your mother's name?" "What's your brother's name?" "When's your mother's birthday?" "When's your brother's birthday?" Correctly answering this set of four questions requires the child to make conditional discriminations among the verbal stimuli and to respond with intraverbal responses. In addition, Braam and Poling (1983) suggested that intraverbal behavior is a measure of cognitive capacity because high scores on intelligence tests, such as the Wechsler Intelligence Scales (Wechsler, 1974), are dependent on correct intraverbal responses to complex verbal stimuli (e.g., "How are an orange and a banana alike?"). If individuals with developmental disabilities are going to accurately respond to increasingly complex verbal stimuli, they must learn to make conditional discriminations among verbal stimuli.

There is evidence in the literature that the repertoire of making conditional discriminations in intraverbal behavior might be defective in individuals with developmental disabilities (Brinton & Fujiki, 1994; Finkel & Williams, 2001; Loukusa et al., 2007). For instance, examples of incorrect intraverbal responses reported by

Finkel and Williams are the response "telephone" to the question, "What's your telephone number?" and the response "color" to the question "What's your favorite color?" These errors have been categorized as immediate echolalia (e.g., Charlop, 1986; Prizant & Duchan, 1981). Another error observed by Brinton and Fujiki was from the following exchange between an adult with mild-to-moderate mental retardation and the investigator:

Investigator: "What would you do if you found out someone else was stealing?"

Subject: "He'd probably be in deep trouble."

The error here is that the multiple verbal stimuli did not exert control over the subject's response. Specifically, the subject's response came under the control of "what would" and "someone else was stealing," but not under the control of "you do if you found out." This error is characteristic of restricted stimulus control or overselectivity (Lovaas, Koegel, & Schreibman, 1979; Walpole, Roscoe, & Dube, 2007).

Because the repertoire of making conditional discriminations in the intraverbal relation is defective in many children with language delays and critical for effective participation in society, it is recommended that a program of research be explored. In the following section, the extent to which this repertoire has been evaluated in previous research is examined.

Additionally, implications for future research are discussed based on methods used to teach intraverbal behavior, research on auditory conditional discriminations, and research on overcoming restricted stimulus control.

REVIEW OF RESEARCH

Three lines of research are reviewed in this section. The first is a review of research on training intraverbal behavior. This review was conducted to identify the extent to which previous studies examined conditional discriminations in the intraverbal relation and to identify training strategies that will be useful in studying conditional discriminations in the intraverbal relation. Second is a review of research on auditory conditional discriminations and matrix training with implications for research on conditional discriminations in the intraverbal relation. Third is a review of research on overselectivity. As making conditional discriminations in the intraverbal relation requires complex stimulus control, some individuals might have defective complex discrimination repertoires. This review will provide strategies for overcoming restricted verbal stimulus control.

Intraverbal Behavior

Previous research on teaching intraverbal behavior to individuals with disabilities (or to typical children with the intention of informing research with children with disabilities) has primarily focused on two repertoires: answering questions (Finkel & Williams, 2001; Ingvarsson, Tiger, Hanley, & Stephenson, 2007; Sundberg, San Juan, Dawdy, & Arguelles, 1990; Sundberg & Sundberg, 1990) and saying or signing members of categories (Braam & Poling, 1983; Goldsmith, LeBlanc, & Sautter, 2007; Luciano, 1986; Miguel, Petursdottir, & Carr, 2005; Partington & Bailey, 1993; Watkins, Pack-Teixeira, & Howard, 1989). In addition, numerous researchers have evaluated procedures for teaching intraverbal behavior (e.g., question answering) using conceptual systems not directly influenced by Skinner's (1957) *Verbal Behavior* (Brinton & Fujiki, 1994; Davis, Reichle, Southard, & Johnson, 1998; Jahr, 2001; Mechling, Pridgen, & Cronin, 2005; Scherer et al., 2001).

In studies on teaching individuals to answer questions, there is often a one-to-one

correspondence between verbal stimulus and intraverbal response (Davis et al., 1998; Finkel & Williams, 2001; Jahr, 2001; Sherer et al., 2001; Sundberg et al., 1990; Sundberg & Sundberg, 1990). For example, each question asked by Sundberg and colleagues (1990) had one distinct response (Table 2). Through training, correct responses could come under the control of only one word in each question (e.g., *socket* in Question 1, *fresh* in Question 3). The same is true for the questions asked by Finkel and Williams (Table 2), with the exception of the sets of verbal stimuli, "How old are you?" and "How are you?" and "What's your name?" and "What's your mother's name?" In the first pair of questions, the presence of *old* alters the evocative effect of *you* as a discriminative stimulus. In the second pair, *mother's* alters the evocative effect of *name*. A similar case appears with the questions asked by Jahr (Table 2). In those sets of questions, Questions 5–10 involved no requirement to make conditional discriminations, whereas there were conditional discriminations inherent in Questions 1 and 11, 2 and 12, and 3 and 4. However, despite the apparent conditional discriminations involved in these two studies, each member of the mentioned pairs occurred in different sets of questions, which were tested and trained at different times and not presented in proximal succession. This arrangement reduced the necessity to make conditional discriminations. Further, the experimenters did not explicitly arrange conditional discriminations among verbal stimuli.

Research on teaching individuals to say or sign members of categories also had limited requirements for subjects to make conditional discriminations. In many of these studies, the experimenters asked subjects to "Name some (category)," with categories such as *toys*, *pieces of furniture*, *kitchen items*, *tools*, *musical instruments*, *colors*, and *animals* (Goldsmith et al., 2007; Luciano, 1986; Miguel et al., 2005; Partington & Bailey, 1993; Watkins et al., 1989). In these sets of verbal stimuli, subjects' responses could come under the sole control of the category (e.g., *instruments*) with no requirement to make conditional discriminations. In a recent study, Perez-Gonzalez, Garcia-Asenjo, Williams, and Carnerero (2007) presented verbal stimuli in the form, "Name the opposite of ____," and tested the emergence of reversals (e.g., *hot* to *cold* and vice

Table 3
Simple Verbal Stimuli and Verbal Stimuli That Require Conditional Discriminations

Simple verbal stimuli	Conditional discriminations
1. What do you like to do at recess?	1. What do you like to do at recess?
2. What do you like to do on the weekend?	2. Who do you play with at recess?
3. What are your favorite games?	3. What is your favorite game?
4. What are your favorite TV shows?	4. What is your least favorite game?

versa). Had the subjects been exposed to "Name the opposite of ____" and "Name the same as ____" with the same words in the blanks, there would have been a requirement to make conditional discriminations. In Experiment 3 of Braam and Poling (1983), the verbal stimuli were *school things, home things, school people, home people, do home, and do school*. This was the only study identified that explicitly analyzed conditional discriminations in the intraverbal relation. Transfer of stimulus control from pictures was effective in generating trained and novel intraverbal responses in two subjects.

Teaching procedures. For the benefit of future research in conditional discriminations in the intraverbal relation, it is important to examine the training procedures used to establish intraverbal behavior. Two issues arise when examining intraverbal training procedures: transfer of stimulus control and errorless teaching. Stimulus control has previously been transferred to intraverbals from echoics (Sundberg et al., 1990; Watkins et al., 1989), mimetics (Sundberg & Sundberg, 1990), objects (Luciano, 1986), pictures (Braam & Poling, 1983; Goldsmith et al., 2007; Luciano, 1986; Miguel et al., 2005), and/or text (Braam & Poling, 1983; Finkel & Williams, 2001). Delays between the target stimulus and the controlling stimulus have been gradually faded in a number of studies (Braam & Poling, 1983; Finkel & Williams, 2001; Luciano, 1986; Watkins et al., 1989). An errorless teaching format was used in two studies in which the controlling stimulus was presented immediately after the target stimulus (Goldsmith et al., 2007; Luciano, 1986). Two other procedures used to teach intraverbal behavior were the high probability (hi-p) request sequence

(Davis et al., 1998) and video modeling (Sherer et al., 2001). In the study by Davis and colleagues, answering questions (e.g., "What are you having for lunch?") was the hi-p response and responding to nonobligatory statements (e.g., "I like to ski") was the low-p response. Sherer and colleagues had both the subjects and their peers model intraverbal responses to questions in videos.

Procedures that have not produced substantial improvements in intraverbal behavior are also worth noting. For example, teaching subjects to tact pictures with both the name of the picture and the category to which it belonged did not increase correct intraverbal responses to instructions to name members of the category (Miguel et al., 2005; Partington & Bailey, 1993). In addition, the same intraverbal repertoire was not established following training on selecting a picture when hearing its category name (Miguel et al., 2005).

Implications for future research. Considerations for future research on teaching conditional discriminations in the intraverbal relation based on the intraverbal training literature are prerequisite skills, stimulus arrangements, and teaching procedures. Although there are no firm data on prerequisite skills for training verbal behavior, general guidelines are included in a manual on teaching verbal behavior (Sundberg & Partington, 1998). Sundberg and Partington recommend children have reliable mand, echoic, tact, and listener repertoires before starting a systematic intraverbal training program. In addition, prestudy repertoires reported in previous studies are between 50 and 200 mands and tacts (Braam & Poling, 1983; Goldsmith et al., 2007). According to Sundberg (2006b), intraverbals involving conditional discriminations are developmentally more advanced than

Table 4
Sets of Verbal Stimuli Requiring Conditional Discriminations

A	B	C
1. What do you write with?	1. What is a brown animal?	1. Kite and Bird
2. What do you eat with?	2. What is a green animal?	
3. What do you write on?	3. What is a brown food?	2. Dog and Bird
4. What do you eat on?	4. What is a green food?	
5. What do you eat that's red?	5. What is a red food?	3. Fork and Knife
6. What do you play with that's red?	6. What is a red drink?	
7. What do you eat that's round?	7. What is a yellow drink?	4. Saw and Knife
8. What do you throw that's round?		

intraverbal fill-ins (e.g., “ready, set, (go),” “1, 2, (3)”), noun-noun association fill-ins (e.g., “Shoes and (socks),” “Table and (chairs)”), verb-noun association fill-ins (e.g., “Tie your (shoes),” “Write with a (pencil)”), and “what” questions with simple discriminations (e.g., “What’s your name?” “What do we read?”). It is probable that these repertoires will facilitate learning conditional discriminations in the intraverbal relation.

More immediate prerequisites that might facilitate learning conditional discriminations in intraverbal behavior include repertoires of tacting and sorting pictures of items to be trained (e.g., tacting *apple* and sorting colors and foods to facilitate learning to respond to “What is a red food?”). In addition, an advanced listener repertoire, “listener responding by feature, function, or class” (LRFFC; Sundberg, in press), is thought to influence learning intraverbal behavior. An example of an LRFFC task is selecting a picture of an apple from an array of pictures when asked, “Which one is a food?” A more immediate step in training conditional discriminations in intraverbal behavior would be for a subject to select an apple among an array of foods when asked, “Which one is a red food?” This selection, in conjunction with tacting the apple when selecting it, might facilitate learning the relevant response.

In addition to prerequisite skills, verbal stimulus arrangements are important for future research. Stimulus arrangements should be designed in ways that require subjects to make conditional discriminations. Such a requirement

exists if the last word the subject hears is the same, but the words that precede it are different and thus alter the function of the last word. For example, instead of having a series of questions in which the end of the questions change, such as in the first column in Table 3, verbal stimuli should be arranged so that the first verbal stimulus alters the evocative effect of the next verbal stimulus, as in the second column of Table 3. In the first set of a questions, a child can hear “recess” and say, “swings,” and be correct every time because there is not a conditional discrimination. But if there is, as in the second column, “swings” is only correct for the first question. “Who do you play with” is another verbal stimulus that must alter the evocative effect of *recess* as an intraverbal stimulus.

These examples involve fairly complex verbal arrangements and it will likely be profitable to begin instruction with simpler arrangements and with more overlap. The arrangements of questions in Columns A and B of Table 4 are examples. Another arrangement would be to ask the subject how two words are alike (Table 4; Column C). These word pairs involve the requirement to make conditional discriminations because the second word is the same and the first word differs. This is how verbal stimuli are arranged and presented in a subtest of the *Test of Language Development—P:3* (Newcomer & Hammill, 1997). The verbal stimulus arrangements used by Braam and Poling (1983) could also be used. These included *school things*, *home things*, *school people*, *home people*, *do home*, and *do school*.

Procedures used to teach conditional discriminations in the intraverbal relation should come from previous literature and be based on the repertoires of the subjects. That is, if a child's behavior comes more reliably under the control of textual stimuli than nonverbal stimuli (e.g., pictures), the former should be used for transfer. Teaching could involve presenting the verbal stimulus (e.g., "Tell me a green animal") and then immediately presenting the correct response vocally or with a picture, an object, or text. Delay to the controlling response could then be gradually increased. Training could occur with questions similar to those used by Perez-Gonzalez et al. (2007), such as "Name the opposite of ____" and "Name the same as ____." This might be easier for early learners because of the need to discriminate among only two conditional stimuli (i.e., *opposite* and *same*). Subjects can be taught to emit members of categories in the context of conditional discriminations (e.g., "Tell me some big animals," "Tell me some small animals," "Tell me some big vehicles," "Tell me some small vehicles"). Complexity can increase further as more terms are added to the question (e.g., "Tell me some small, green animals"). Although complexity can increase, the next section is concerned with basic auditory discrimination.

Auditory Conditional Discriminations and Matrix Training

Previous research on auditory conditional discriminations and matrix training could be useful in designing research on conditional discriminations in the intraverbal relation. Individuals with developmental disabilities often have more difficulty learning auditory conditional discriminations than visual discriminations (Serna, Stoddard, & McIlvane, 1992). This may be because visual stimuli are static and can co-occur with responses, whereas auditory stimuli are transitory. Learning delayed matching-to-sample with visual stimuli, in which the sample is removed before the comparisons are presented, is a possible way to bridge this gap (Dube & McIlvane, 1999). A line of research on teaching auditory discriminations that has produced mixed results is pairing an auditory stimulus with a visual stimulus and fading the visual stimulus. This procedure was less successful in generating auditory stimulus control in subjects with profound mental retardation

(Stoddard & McIlvane, 1989) than with subjects who were higher functioning (Stoddard, 1982). Additionally, Serna and colleagues recommended using computers to study auditory discriminations due to the ease of manipulating speech sounds.

As described previously, conditional discrimination research in which both the sample and comparisons are auditory stimuli is rare. One exception is a study by Dube, Green, and Serna (1993). The seven subjects were typically developing adults and sat in front of a computer screen. In the experiment, they heard a sample stimulus (e.g., "cug") and then a comparison stimulus (e.g., "zid"). When they heard the comparison stimulus, a key illuminated on one side of the screen. The sample was then repeated and followed by the presentation of the other comparison stimulus (e.g., "paf") and a key illuminating on the other side of the screen. The subjects were then shown the illuminated keys on both sides of the screen and were reinforced for pushing the key that corresponded with the comparison that matched the sample. The order of comparisons and positions of the illuminated keys were randomized. Three subjects required a secondary procedure to acquire these baseline relations. This consisted of removing the incorrect key following the presentation of both keys on the screen. With correct responding, the latency to disappearance was gradually increased. One subject required printed rules to control her correct baseline responding. Five subjects then demonstrated the formation of equivalence classes among auditory stimuli.

Research on matrix training is relevant to research on conditional discrimination among verbal stimuli because in many matrix training studies, subjects had to respond to two-component vocal verbal stimuli (Goldstein, Angelo, & Mousetis, 1987; Goldstein & Brown, 1989; Goldstein & Mousetis, 1989; Nigam, Schlosser, & Lloyd, 2006; Striefel, Wetherby & Karlan, 1978). In the instruction-following portions of these studies, responses were nonverbal. Striefel et al. employed a 12 x 12 action-object matrix resulting in subjects learning to follow 144 instructions each with two controlling verbal stimuli (Figure 2). In other matrix training studies, verbal stimuli were combinations in the following forms: action-object (e.g., "push the cup"), object-location (e.g., "ball on chair"), action-adjective-object (e.g., "drop the green

ACTIONS	OBJECTS											
	Glass	Scissors	Car	Ball	Comb	Plane	Glove	Spoon	Feather	Fork	Banana	Block
	Push											
	Drop											
	Blow on											
	Hold out											
	Point to											
	Wave											
	Tap											
	Pound with											
	Smell											
	Elevate											
	Turn											
	Encircle											

Figure 2. A 12 x 12 action-object matrix adapted from Striefel et al. (1978).

car”), and object-preposition-location (e.g., “car under tree”). When making these conditional discriminations among vocal verbal stimuli, multiple nonverbal stimuli were available requiring subjects to make an additional discrimination among nonverbal stimuli.

Implications for future research. Research on training conditional discriminations in intraverbal behavior could be informed by previous research on auditory conditional discriminations and matrix training. The pairing procedure described by Serna et al. (1992) could be used to teach conditional discriminations in intraverbal behavior by presenting a complex verbal stimulus (e.g., “Tell me a brown animal”) and pairing a picture of “brown” and a picture of “animals” when those words were stated. These visual stimuli could control correct responding and then be faded to transfer control to the auditory stimuli. In addition, establishing initial conditional discriminations in intraverbal repertoires could be enhanced with computer programs that allow the experimenter to consistently manipulate the presentation of vocal verbal stimuli.

An extension of the study by Dube, Green, and Serna (1993) could have subjects make

conditional discriminations among the vocal verbal stimuli and make vocal verbal responses. The experimenter could present two verbal stimuli (e.g., “cug-zid”) and reinforce a vocal response (e.g., “paf”). Another vocal response (e.g., “vek”) could be reinforced in the presence of another compound stimulus with the same second stimulus (e.g., “dace-zid”). The subject must respond differentially not only to *zid*, but also to the word that precedes *zid*. The subject must then make different responses to other stimulus complexes with overlapping components, such as *cug-reen*, *dace-reen*, *jile-reen*, and *jile-zid*. Reinforcing different responses in the presence of these stimuli in reversed order (e.g., *zid-jile*) could also be analyzed. This experiment is removed, however, from intraverbal research because intraverbal behavior often involves divergent relations in which multiple responses are brought to strength in the presence of a compound verbal stimulus. Nevertheless, this preparation could be a step in the direction of evaluating conditional discriminations in the intraverbal relation. Such research could also potentially inform future research in stimulus equivalence.

The experimental preparations used in matrix training (e.g., Goldstein et al., 1987; Goldstein & Moussetis, 1989; Striefel et al., 1978) could be useful in teaching subjects to respond to multiple vocal verbal stimuli. In these studies, when subjects had to make conditional discriminations among vocal verbal stimuli, their responses were nonverbal (i.e., they manipulated toys or other stimuli). For some children, making these nonverbal responses might be less effortful than making vocal verbal responses. The types of stimuli used in matrix training could be used to teach the conditional discriminations without the requirement to make vocal verbal responses. If teaching some of the questions in the second two columns in Table 3, for example, the subject could make nonverbal responses in which he or she selects pictures or objects. This repertoire could then facilitate the development of conditional discriminations in the intraverbal relation.

Overselectivity and Restricted Stimulus Control

Failure to make conditional discriminations among verbal stimuli could be the product of failing to respond to multiple stimuli in a stimulus complex, an observation referred to as overselectivity (Lovaas, Koegel, & Schreibman, 1979). Researchers in the area of overselectivity found that some children with autism and other developmental disabilities respond to only one of two or three sensory modalities presented in a conditional discrimination task (Dickson, Deutsch, Wang, & Dube, 2006; Kolko, Anderson, & Campbell, 1980; Lovaas & Schreibman, 1971; Lovaas, Schreibman, Koegel, & Rehm, 1971). Most researchers examined overselectivity in the context of visual stimuli (Dube & McIlvane, 1999; Hedbring & Newsom, 1985; Koegel & Wilhelm, 1973; Koegel, Schreibman, Britten, & Laitinen, 1979). For example, Koegel and Wilhelm (1973) taught children with autism and typically developing children to discriminate two-picture cards (e.g., horse and tree vs. chair and lamp). The subjects were then tested on single cues (e.g., horse vs. lamp). Unlike the typically developing children, the children with autism responded to only one of the two components. Dickson and colleagues detected stimulus overselectivity of visual stimuli in 35 of 49 sub-

jects with intellectual disabilities using a two-sample delayed matching-to-sample task.

Overselectivity to auditory stimuli has been studied to a lesser extent. Schreibman, Kohlenberg, and Britten (1986) taught nonverbal children with autism, echolalic children with autism, and typically developing children to differentially respond to a spoken word with either a monotone or varying intonation. Probe trials detected the extent to which the subjects differentially responded to the content or intonation of the words. The typically developing children responded to both components or to content, the nonverbal children responded to content only, and the echolalic children responded to intonation only. This study provided evidence of overselectivity of auditory components of complex stimuli in children with autism.

Overcoming overselectivity. Procedures used to overcome overselectivity that could be useful for training conditional discriminations in the intraverbal relation are within-stimulus prompting, requiring a differential observing response, and altering schedules of reinforcement. A common intervention for overselectivity is using within-stimulus, as opposed to extra-stimulus, prompting. Wolfe and Cuvo (1978) taught children with mental retardation to discriminate letters. Within-stimulus prompting was accentuating the critical features of letters and extra-stimulus prompting was a finger pointing to the correct letter. The letters trained with within-stimulus prompting were learned more quickly in fewer trials and were retained for longer periods of time. Summers, Rincover, and Feldman (1993) compared extra-stimulus and within-stimulus prompting to teach preschool children with developmental delays to discriminate the vocal stimuli, "in" and "on." The extra-stimulus prompts included modeling (putting a block in or on a container), pointing prompts, positional prompts, and physical prompts. The within-stimulus prompt involved saying "in" or "on," repeating it three times loudly, and then fading the loudness and repetition with correct trials. The within-stimulus prompting procedure produced more correct instruction-following responses than the extra-stimulus prompting procedure.

In their series of matrix training studies, Striefel et al. (1978) used three procedures similar to within-stimulus prompting techniques:

emphasis, prolongation, and double-word. In the emphasis procedure, one of two words of the verbal instruction was presented at a louder volume than the other stimulus. The volume was faded following correct responding. In the prolongation procedure, part of a word in a verbal instruction was elongated for 3 s; following correct responding, it was faded by 0.5 s increments. In the double-word technique, one of the two words in a verbal instruction was repeated (e.g., “touch shoe-shoe”). Following correct responding, individual syllables of the two-word repetition were faded successively. These procedures enhanced the salience of the vocal verbal stimuli.

Another set of strategies for ameliorating restricted stimulus control is “specific orienting cues” (Koegel, Dunlap, Richman, & Dyer, 1981), “distinctive feature training” (Smeets, Hoozeveen, Striefel, & Lancioni, 1985), and “differential observing responses” (Dube & McIlvane, 1999; Walpole, Roscoe, & Dube, 2007). These strategies require subjects to make an orienting or observing response prior to making the ultimate response. In the Koegel et al. study, conditional discriminations were facilitated by requiring subjects to not only select a stimulus, but to also tact it. Smeets et al., in addition to using within-stimulus prompts (i.e., exaggerating relevant features of the letters) and stimulus fading, improved conditional discriminations of printed words by requiring subjects to place plastic letters on the printed letters on the stimulus cards. In the study by Dube and McIlvane, identity matching a two-stimulus complex facilitated performances on delayed matching-to-sample between a two-stimulus sample and one-stimulus comparisons. Finally, to facilitate matching words with overlapping letters (e.g., cat, can, car), Walpole et al. had a subject first match the distinguishing individual letters (e.g., t, n, and r).

Overselectivity has also been manipulated by altering reinforcement schedules. Koegel et al. (1979) provided a measure of overselectivity by presenting “complex” cards with two pictures on each, designating some the S+ and others the S-, and training discriminations to criteria. Then they overtrained (Schover & Newsom, 1976) the discriminations for 100 trials on either a continuous (CRF) schedule or a variable ratio 3 (VR3) schedule. Finally, they tested overselectivity by testing

discriminations with “simple” cards with only one of the two pictures from the “complex” cards on each. The degree of overselectivity of the picture cues was the measure of incorrect discriminations with the simple cards. There was more correct responding to the simple cards when the subjects received overtraining on the VR3 schedule. The proposed explanation was that on the VR3 schedule, there was intermittent extinction-induced attending to multiple cues which weakened overselective responding.

A final study evaluating procedures for overcoming restricted stimulus control was conducted by Saunders and Spradlin (1989). They tested the extent to which discriminating the samples and comparison stimuli individually facilitated making conditional discriminations. First, the 2 subjects learned to differentially respond to the sample stimuli on the basis of schedule requirements: a differential reinforcement of low rate 3-s schedule for Sample 1 and a fixed ratio 8 schedule for Sample 2. This learning did not improve conditional discrimination performances. Second, the subjects were trained to differentially respond to the comparison stimuli using simple discrimination reversals and this, with the maintained sample schedule performance, did not improve conditional discrimination performance. Third, both component simple discriminations were maintained and conditional discrimination training on one sample was brought to criterion before gradually fading in training trials with the other sample. This was successful in improving the conditional discrimination performances.

Implications for future research. Research on overcoming stimulus overselectivity provided procedures for directing attention to multiple stimuli, a necessary strategy for teaching conditional discriminations in intraverbal behavior. Three areas of overselectivity research that could inform future research are within-stimulus prompting, making differential observing responses, and altering schedules of reinforcement. Within-stimulus prompting procedures, such as emphasis, prolongation, and double-word (Striefel et al., 1978), could be used in establishing conditional discriminations in intraverbal behavior. For example, if a child responds, “stop sign,” after hearing, “What do you eat that’s red?” the therapist could use one of these procedures to make

Table 5

Training Exchanges for Transferring Stimulus Control From Selection and Tact, Echoic, and Simple Intraverbal to Intraverbal With Conditional Discriminations

Selection and tact	Echoic	Intraverbal
Experimenter: "What is green?"	E: "What is a brown" (point)	E: "What is tall?"
Subject: selects and tacts pictures of things that are green	S: "Brown"	S: "Trees, buildings"
E: "What is an animal?"	E: "Animal" (point)	E: "What is an animal?"
S: of the things that are green, selects and tacts an animal	S: "Animal"	S: "Bears, lions"
E: "What is a green animal?"	E: "What is a brown animal?"	E: "What is a tall animal?"
S: "A frog."	S: "A bear."	S: "A giraffe."

"eat" more salient. This increase in salience of the stimulus that originally failed to control the response could be successful in producing control by both verbal stimuli.

Learning conditional discriminations in the intraverbal relation could be facilitated by having subjects make differential observing responses to the relevant verbal stimuli. For example, subjects could make a selection-based response to each relevant word in a complex verbal stimulus (Table 5). Tacting the stimulus after selecting it could further support the repertoire. Subjects could make an echoic response to each of the relevant verbal stimuli. Prior to this training, a point to the subject could be trained to signal an echoic response and this could function to occasion echoic responses following emission of the verbal stimuli. Having subjects read or write each verbal stimulus could be another beneficial strategy. Finally, subjects could be required to emit an intraverbal response to each of the relevant verbal stimuli alone before making a response based on the complex verbal stimulus. This final procedure could be conceptualized in terms of teaching overt or covert problem-solving skills prior to making an intraverbal response (Foxy & Faw, 2000; Goldsmith, LeBlanc, & Sautter, 2007; Skinner, 1984).

Altering schedules of reinforcement could facilitate attention to multiple vocal verbal stimuli, but the response would have to be a "yes/no" type of response, similar to the response in Dube et al. (1993). This study could

be conducted by teaching subjects to discriminate between sets of two-word vocal verbal stimuli. The discriminations could then be overtrained with one set contacting a CRF schedule and the other set on a leaner schedule of reinforcement (e.g., VR3). Subjects could then be tested on their responses to single stimuli from the sets. This differential schedule arrangement could influence responding to multiple vocal verbal stimuli, which would likely prepare subjects to learn conditional discriminations in the intraverbal relation.

A procedure similar to the one used by Saunders and Spradlin (1989) could be applied to teaching conditional discriminations in intraverbal behavior. First, subjects would make simple discriminations to the individual stimuli by, for example, using a differential observing response as described above. Second, subjects would be exposed to trials in which only one of the two critical words changed. For example, if teaching a child to answer questions with adjectives and nouns in the questions, the child could be exposed to multiple questions with the same adjective (e.g., "What is a big animal?" "What is a big vehicle?"). Third, trials with another first critical word would be gradually faded into the session. In the example above, trials with a different adjective would be gradually faded into the session. This procedure could help subjects discriminate the individual components of the verbal stimuli, achieve success with making conditional discriminations with verbal responses, and then gradually make

more complex conditional discriminations among verbal stimuli.

SUMMARY

It is clear from a review of research on verbal behavior and conditional discriminations that there is very little research on training individuals to make conditional discriminations in the intraverbal relation. It is also evident that this repertoire is defective in many individuals with developmental disabilities. These individuals would benefit from training in this repertoire as it is critical for engaging in social interactions and learning academic skills. Research in this area would also likely benefit behavior analytic theory as there appears to be limited research analyzing conditional discriminations with vocal verbal stimuli and topography-based responses. Empirical examinations of the extent to which intraverbal behavior operates in the multiple control framework with divergent and convergent relations would likely benefit the field.

The literatures reviewed provided further directions for future research. The intraverbal literature suggested preliminary guidelines on prerequisite skills required for learning conditional discriminations in intraverbal behavior. These included substantial mand and tact repertoires as well as advanced listener repertoires. A simple intraverbal repertoire would also likely facilitate learning complex intraverbals. Arranging verbal stimuli in ways that require conditional discriminations is also critical for researching this repertoire. In addition, conducting basic research using computers is a way to gain tight control over the presentation of vocal verbal stimuli.

Training conditional discriminations in the intraverbal relation could be separated into two distinct goals: (1) training individuals to come under the control of multiple verbal stimuli and (2) teaching individuals to make particular verbal responses in the presence of particular verbal stimuli. Many strategies for teaching subjects to come under the control of multiple verbal stimuli were discussed. These included pairing visual stimuli with auditory stimuli, the methods Dube et al. (1993) used to train auditory-auditory conditional discriminations, and the instruction-following strategies used in matrix training studies. Strategies for overcoming barriers to responding under the control of multiple verbal stimuli were also discussed. These

included increasing the salience of verbal stimuli using within-stimulus prompting, requiring a differential observing response to increase attention paid to both verbal stimuli, and altering schedules of reinforcement to bring behavior under the control of each verbal stimulus. Finally, in terms of the second goal of evoking intraverbal responses to complex verbal stimuli, transfer-of-stimulus control procedures were discussed. For early learners, it might be useful to discriminate these two goals and develop the repertoires separately. But the goals must ultimately join to produce the repertoire of making conditional discriminations in the intraverbal relation.

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