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# An Analysis of Verbal Stimulus Control in Intraverbal Behavior: Implications for Practice and Applied Research

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A common characteristic of the language deficits experienced by children with autism (and other developmental disorders) is their failure to acquire a complex intraverbal repertoire. The difficulties with learning intraverbal behaviors may, in part, be related to the fact that the stimulus control for such behaviors usually involves highly complex verbal stimuli. The antecedent verbal control of intraverbal behavior may involve discriminative stimuli (i.e., discriminated operants), conditional stimulus control, and/or control by compound stimuli. Distinctions among these different types of antecedent control are presented, along with recommendations for intervention procedures that may facilitate the acquisition of intraverbal behavior.

*Key words*: intraverbal behavior, stimulus control, verbal behavior, conditional discriminations, compound stimuli

Intraverbal behavior occurs when verbal stimuli evoke a verbal response that is different from the antecedent stimulus, in that there is no point-to-point correspondence between the two (Michael, Palmer, & Sundberg, 2011; Skinner, 1957). An example of an intraverbal response is answering a question such as ''What's your name?'' In this instance, the response (the name) has no point-to-point correspondence to the antecedent stimulus (''What's your name?'').

In recent years, several authors have studied intraverbal behavior in the context of education (e.g., Goldsmith, LeBlanc, & Sautter, 2007; Ingvarsson, Cammilleri, & Macias, 2012; Ingvarsson & Hollobaugh, 2010; Ingvarsson & Le, 2011; Ingvarsson, Tiger, Hanley, & Stephenson, 2007; Miguel, Petursdottir, & Carr, 2005; Partington & Bailey, 1993; Pérez-González, Garcıa-Asenjo, Williams, & Carnerero, 2007; Petursdottir, Carr, Lechago, & Almason, 2008; Petursdottir & Haflidadottir, 2009; Shillingsburg, Kelley, Roane, Kisamore, & Brown, 2009). Sundberg and Sundberg (2011) suggested that a common characteristic of the language deficit exhibited by children with autism and other developmental disorders is their failure to acquire a complex intraverbal repertoire. According to Sundberg and Sundberg, such children may learn a number of mand, tact, and listener skills and some simple intraverbal responses, but fail to acquire more complex intraverbal relations. These difficulties with learning may be related to the fact that the primary antecedent variable for most intraverbal behavior involves complex verbal stimulus control (Axe, 2008; Sundberg & Sundberg, 2011).

The purpose of this paper is to provide an analysis of the type of antecedent control involved in intraverbal behaviors typically taught to individuals with developmental disabilities (including autism) and language delays. Previous attempts have focused primarily on one type of complex antecedent control, namely conditional discriminations (Axe, 2008; Sundberg & Sundberg, 2011). In this paper we discuss three types of stimulus control relevant for the acquisition of intraverbal behaviors. They are discriminated operants, compound verbal stimuli, and

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conditional discriminations. In the final part of this paper, we discuss implications for interventions and applied research.

## DISCRIMINATED OPERANTS

A discriminated operant occurs when a response-consequence relation comes under the control of a third element called the discriminative stimulus ($S^D$). The $S^D$ is the stimulus that precedes a particular response and correlates with reinforcement. For example, a discriminated operant exists if a learner emits the verbal response ''book'' in the presence of the object book (the object book is the $S^D$ for saying ''book''). The verbal operant, ''book'' is a tact if it is evoked in the presence of a nonverbal stimulus (i.e., the object book) and maintained by generalized conditioned reinforcement. Hence, a discriminated operant involves a three-term unit consisting of the $S^D$-R-$S^R$ (Sidman, 2000).

Examples of intraverbal behavior evoked by discriminative stimuli are simple fill-in-the-blank phrases, such as; ''ready-set …,'' ''peek-a …,'' ''A, B …,'' ''1, 2 …,'' ''big …,'' etc. In this example ''ready-set'' is the $S^D$ and ''go'' is the intraverbal response. Skinner (1957) suggested that multiple ''words'' do not necessarily equate to multiple stimuli, and that multiple words can function as a single unit. Hence, the two words; ''ready-set'' may function as a single antecedent unit in a three-term contingency.

As the intraverbal responses become more complex, responding to several verbal discriminative stimuli might be required, as when the verbal $S^D$ ''small animal'' is followed by the verbal response (''mouse''). In this case, the two verbal antecedent stimuli (''small'' and ''animal'') together evoke the specific response (''mouse''). This has been referred to as convergent multiple control (Michael et al., 2011). Two types are particularly relevant: conditional discriminations and compound stimuli.

## CONDITIONAL DISCRIMINATIONS

Conditional discriminations involve a four-term unit (Sidman, 2000). This is because the discriminated operant (i.e., the three-term unit) comes under contextual control. Hence, in a conditional discrimination, whether a particular stimulus functions as an $S^D$ or $S^\Delta$ ($S^\Delta$ is a stimulus that precedes a response, but does *not* correlate with reinforcement) depends on another stimulus, the conditional stimulus (Catania, 2007). For example, when the conditional stimulus A1 is presented, the antecedent stimulus for the three-term unit, for example B1, takes on the function of an $S^D$ (or S+) and stimulus B2 takes on the function of an $S^\Delta$ (or S−). Conversely, when A2 is presented as the conditional stimulus, stimulus B2 takes on the function of an $S^D$ (or S+) and stimulus B1 takes on the function of an $S^\Delta$ (or S−). Hence, in conditional discriminations, the conditional stimulus determines the function of the antecedent stimulus in a discriminated operant (Sidman, 2000).

Conditional discriminations can also involve verbal stimuli. That is, one verbal conditional stimulus can establish another verbal stimulus as a $S^D$ or $S^\Delta$. Catania (2007) gives an example involving the autoclitic relations, ''I doubt the coffee is ready'' and ''I'm sure the coffee is ready.'' Catania argues that the verbal stimuli, ''I doubt'' and ''I'm sure'' differentially alter the evocative effect of the subsequent verbal stimuli (i.e., ''the coffee is ready''), where ''I doubt'' and ''I'm sure'' are analogous to the conditional stimuli of a conditional discrimination (p. 258). Skinner (1957) uses an example of the conditional mand, ''If your name is Charlie, stand up!'' to make a similar argument. Here, the verbal stimulus ''If your name is Charlie'' differentially alters the evocative effect of the subsequent verbal stimulus (i.e., ''stand up''). The former stimulus is analogous to the conditional stimulus, whereas the latter stimulus is the antecedent stimulus for a particular response.

In intraverbal behavior, a conditional discrimination exists when some verbal stimuli determine the function of other verbal stimuli. An example is when a speaker responds appropriately to the verbal antecedent: ''If your name is Charlie, say your ABCs!'' The speaker will say his ABCs only if his name is Charlie. In other words, the verbal conditional stimuli ''If your name is Charlie'' determine the function of the verbal stimuli: ''Say your ABCs.'' This is because ''say your ABCs'' is an $S^D$ for saying the ABCs if the person's name is Charlie and an

$S^{\Delta}$ for saying the ABCs if the person's name is *not* Charlie. Hence, it may be a conditional discrimination. To assess whether this intraverbal response indeed has been established as a conditional discrimination, the learner must respond by saying his ABCs on trials when hearing his name, and refrain from doing so on trials when hearing other names, when these two type of trials are presented in a random order. If the learner says his/her ABCs on every trial (no matter which name is heard), the intraverbal response has likely been established as a rote response as part of a three-term contingency.

In conditional discriminations, the stimuli controlling the verbal behavior are often both verbal and nonverbal. In these instances, the speaker's response is typically part intraverbal and part tact. For example, the speaker may observe a particular car (e.g., a black Ford Mondeo). In this case, the question ''What color?'' will evoke the response, ''black'' and the question, ''What make?'' will evoke the response ''Ford.'' Here, the question and the object form a conditional discrimination: the question, ''What color?'' is a verbal conditional stimulus establishing the color of the car as an $S^{D}$ (or S+) and the make and the model as $S^{\Delta}$s (or S−). Conversely, the question, ''What make?'' is a verbal conditional stimulus establishing the make of the car as an $S^{D}$ (or S+) and other properties such as color, year, and model as $S^{\Delta}$s (or S−). A defining feature of conditional discriminations is that the same stimulus (or stimulus property) serves as a $S^{D}$ on some occasions and a $S^{\Delta}$ in others.

Other examples of intraverbal and tact responses involving a conditional discrimination are if-then questions, such as: ''If you are wearing blue, say your name.''

## COMPOUND STIMULI

Compound stimuli can occur in discriminated operants as well as in conditional discriminations (Cohn & Weiss, 2007; Pérez-González & Alonso-Álvarez, 2008; Wolf, 1963). A compound stimulus in a discriminated operant exists when a particular response is controlled by two or more stimuli, or two or more elements of a stimulus. That is, the $S^{D}$ involves several elements, or there are several $S^{D}$s, that together evoke a particular response correlating with reinforcement. Two or more stimuli refers to stimuli that are in some way topographically distinct, and two or more stimulus elements means components of a stimulus that could include abstract qualities (e.g., shape and color).

Typically, to establish a compound discrimination, stimulus control by two stimuli (e.g., a light and a tone) is trained separately. A stable and moderate rate of a responding (e.g., lever pressing) on a variable interval schedule is established, first in the presence of a tone and then in the presence of a light. After stimulus control by the light and the tone has been established separately, a stimulus compounding trial can be administered in which the tone and light are presented together. Under this stimulus compounding condition, response rates exceed those exhibited during the no-compound conditions (Cohn & Weiss, 2007). Hence, in a compound discrimination, the response to the compound stimuli is different from the response evoked by each $S^{D}$ in isolation.

In conditional discriminations, by contrast, the response is evoked by a particular $S^{D}$ (not by the joint effect of two or more $S^{D}$s) and the $S^{D}$ is established by the conditional stimulus.

An example of a discriminated operant involving a compound $S^{D}$ is when the listener responds by clapping quickly, clapping slowly, walking quickly, or walking slowly in response to the instructions; ''Clap fast,'' ''Clap slow,'' ''Walk fast,'' and ''Walk slow,'' respectively. This is provided that these instructions are presented in a random order, and that responding is correct. Correct responding requires the listener to discriminate both elements of the stimulus compound (i.e., clap or walk, and fast or slow). The reason why this is not a conditional discrimination is that one stimulus (i.e., clap or walk) does not determine the function of the other stimulus (i.e., fast or slow). To produce a correct response, the listener's behavior must come under the control of both $S^{D}$s. In other words, the stimulus clap is an $S^{D}$ for clapping no matter if the other stimulus fast or slow is presented.

Compound stimulus control in a conditional discrimination occurs either when the conditional stimulus contains two or more

stimuli (or or two or more stimulus elements) and/or when the $S^D$ contains two or more stimuli (or two or more elements). Several studies have examined outcomes when compound stimuli have been used in conditional discriminations (e.g., Augustson, Dougher, & Markham, 2000; Pérez-González & Alonso-Álvarez, 2008; Smeets, Schenk, & Barnes, 1994; Stromer & Mackay, 1990; Stromer & Stromer, 1990a, 1990b). Consider the study by Alonso-Álvarez and Pérez-González (2006), who taught two P–A and P–B conditional discriminations (see Figure 1). Participants were undergraduate college students. These were analogous to teaching that ''Cervantes'' and ''Balzac'' were writers, and that ''Goya'' and ''Gauguin'' were painters. P1 (writer) or P2 (painter) were sample stimuli; A1 (Cervantes) and A2 (Goya) or B1 (Balzac) and B2 (Gauguin) were comparison stimuli. Next, two more conditional discriminations were taught, with the Q–1 and Q–2 discriminations intended to be analogous to teaching that ''Cervantes'' and ''Goya'' were Spanish and that ''Balzac'' and ''Gauguin'' were French. Q1 (Spanish) was presented as the sample stimulus, A1 and B1 (Cervantes and Balzac) were presented as comparison stimuli. When Q2 (French) was presented as a sample stimulus, A2 and B2 (Goya and Gauguin) were presented as comparison stimuli. This established the following eight relations: P1–A1, P1–B1, P2–A2, P2–B2, Q1–A1, Q1–A2, Q2–B1, and Q2–B2. Upon mastery of these relations, PQ probe trials were introduced, intended to be analogous to the intraverbals ''Name a Spanish writer,'' ''Name a Spanish painter,'' ''Name a French painter,'' and ''Name a French writer.'' During these probe trials, compound sample stimuli were formed with combinations of the P and Q stimuli, whereas A1, A2, B1, and B2 were comparison stimuli on all trials. The comparison stimulus defined as correct was the one that had been previously related to both elements of the compound sample. Thus, in the presence of compound P1 and Q1 (writer and Spanish), the correct comparison was A1 (Cervantes). Results showed that the compound probes were mastered by both participants, but only after the four conditional discriminations had been intermixed during training (such as, for example, a PB training trial, followed by a Q2 training trial, followed by a Q1 training trial, followed by a PA training trial, etc.).

Teaching complex manded stimulus selection (Michael, 1985) (i.e., complex receptive labels) is an example of an educational program that involves conditional discriminations with compound stimuli. Consider an example where the child selects the blue ball from an array containing a blue ball, a yellow ball, a blue car, and a yellow car, when presented with the verbal compound sample stimulus ''Touch blue ball.'' Here, correct responding requires the child to respond to both elements of the compound sample stimulus (object and color). Initially, the two elements of the compound stimulus have typically been trained separately. First, correct responding to the object (car and ball) has been established by teaching the learner to select the comparison stimulus ball from an array containing a ball and a car, when presented with the verbal sample stimulus ''Ball'' (the object car has been taught in the same way). Second, correct responding to yellow and blue has been established by teaching the learner to select the blue comparison stimulus from an array containing a blue and a yellow object when presented with the verbal sample stimulus, ''Blue,'' and select the yellow comparison stimulus from an array containing a blue and a yellow object when presented with the verbal sample stimulus ''Yellow.''

There are many examples of compound stimulus control in intraverbal behavior. Stimulus control by compound stimuli in an intraverbal relation occurs when two or more verbal stimuli (e.g., ''Big'' and ''Animal'') come together to evoke a particular response (e.g., ''Elephant''). Another example is when the compound $S^D$ ''Red fruit'' is followed by the response ''Tomato.'' Also, responding to the question, ''What do you eat that's red?'' involves compound stimuli because a correct response requires that the speaker's behavior comes under the control of several verbal stimuli, most notably, ''eat'' and ''red.'' The same is the case for the question, ''Name a big animal.''

To determine empirically the extent to which responding is controlled by the stimulus compound (rather than being

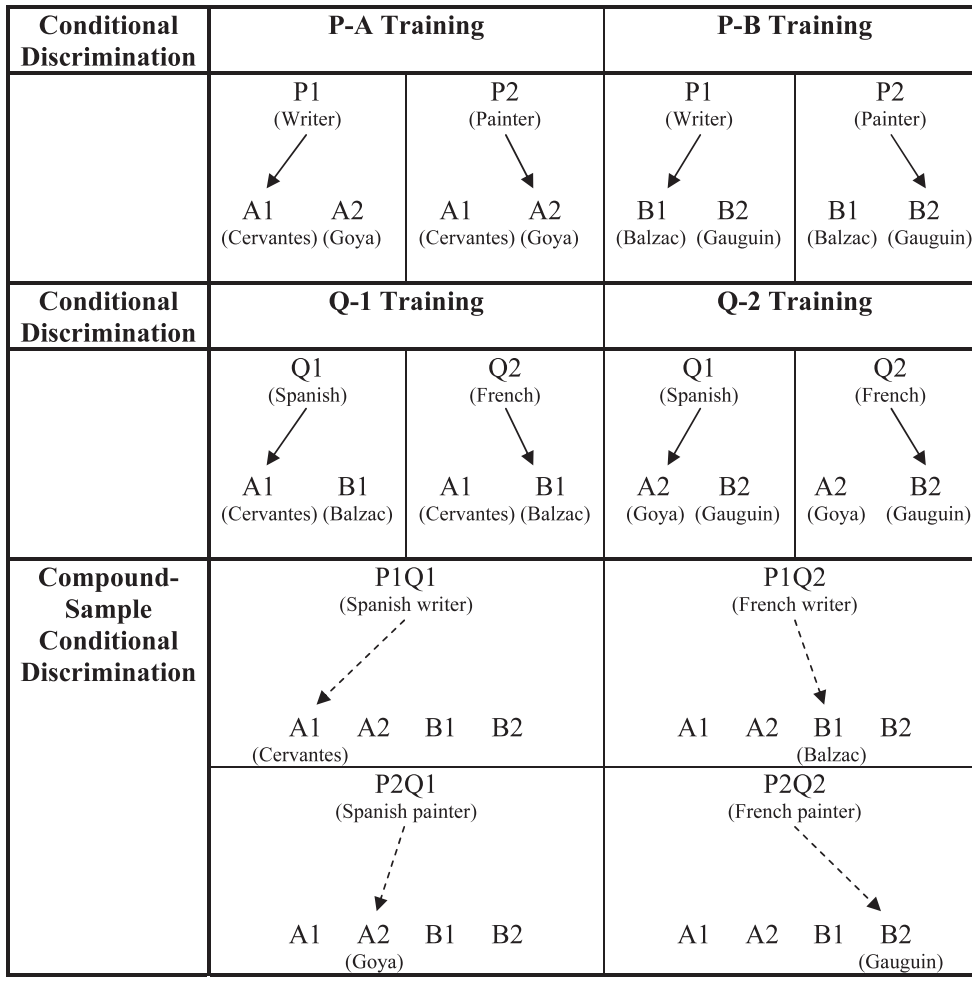


*Figure 1.* The P–A, P–B, Q–1 and Q–2 conditional discriminations taught (solid lines) were analogous to teaching that ''Cervantes'' and ''Balzac'' were writers and that ''Goya'' and ''Gauguin'' were painters, and that ''Cervantes'' and ''Goya'' were Spanish and that ''Balzac'' and ''Gauguin'' were French. PQ probes (dashed lines) were analogous to assessing the intraverbals ''Name a Spanish writer,'' ''Name a Spanish painter,'' ''Name a French painter,'' and, ''Name a French writer.'' (Adapted from Pérez-González and Alonso-Álvarez [2008] with permission).

''rote'' responses), the speaker must respond correctly to a number of intraverbals when the questions are presented in a random order. For example, to determine whether the verbal operant ''Elephant'' has been established as an intraverbal behavior controlled by compound stimuli, the child must respond correctly not only to the question, ''Name a big animal,'' but also to the questions ''Name a small animal,'' ''Name a big vehicle,'' and ''Name a small vehicle,'' when such trials are presented in a random order. The most convincing evidence is when the speaker can respond appropriately to novel combinations of stimuli in the compound.

The reason why intraverbal responses such as ''What do you eat that's red?'' are not conditional discriminations is that the different words involved in the stimulus complex do *not* determine the function of the other, as required in the definition of a conditional discrimination. That is, the first verbal stimulus ''Eat'' does not determine the function of the second verbal stimulus ''Red,'' and vice versa. Rather, correct responding requires the child's response to come under control of both

elements of the compound stimulus (e.g., *eat* and *red*).[1] According to this analysis, responding to the question, ''What do you eat that is red?'' is a discriminated verbal operant (i.e., a three-term contingency), where the intraverbal response is evoked by a compound verbal stimulus complex.

Other examples of complex intraverbal operants evoked by compound $S^D$s are: ''What grows on your head?'' ''When do we set the table?'' ''What day is it today?'' and ''What is your last name?'' Examples of even more advanced intraverbal operants evoked by verbal compound $S^D$s are responding to the questions: ''Describe Einstein's Law of relativity'' or ''Sing the first phrase of Beethoven's Symphony No. 5 in C minor, Op. 67.'' In the latter two examples, perhaps the largest challenge is establishing the response rather than bringing it under the desirable stimulus control, but a further discussion of this issue is beyond the scope of the present paper.

Some intraverbal responses may involve conditional discriminations where both the conditional stimulus and the discriminative stimulus contain compound stimuli. An example is, ''if-then'' and ''when'' intraverbals. Responding correctly to the verbal stimuli, ''If you are wearing blue, say your name'' is an example where the conditional stimulus (i.e., If you are wearing blue) contains four elements (if, you, wearing, blue), and the discriminative stimulus contains three elements (say your name).

## SKINNER'S ANALYSIS

Skinner himself (1957) focuses on compound stimulus control when describing stimulus control of intraverbal responses. In *Verbal Behavior*, Skinner discussed complex vocal antecedent stimuli in relation to the intraverbal in the following way:

> The nature of the stimulus control in intraverbal behavior is shown by responses to verbal stimuli containing more than one word. The stimulus *red* in the usual word-association experiment may yield *green*, *blue, color,* or any one of many other responses, for there are many different circumstances under which it appears as part of the occasion for the reinforcement of such responses. Similarly, the stimulus word *white* will yield *black, snow,* and so on. But in an American verbal community, in the absence of other specific determiners, the compound verbal stimulus *red, white*… will yield *blue* in preference to any other. The compound stimulus is a much more specific occasion than either part taken separately, and it is an occasion upon which the response *blue* is characteristically made and reinforced.… The more complex the stimulus pattern, the more specific the verbal occasion, and the stronger the control exerted over a single response. (pp. 75–76)

In this description of the intraverbal, Skinner (1957) clearly defines complex verbal antecedent stimuli as compound stimuli. In Skinner's example above, each speaker has a history of reinforcement for responding to the word *red* with a variety of different words, and the same is true for the word *white.* Combining (compounding) the words into the antecedent, ''Red, white …'' simply provides the speaker with a more specific context in which to respond and therefore results (in an American verbal community) in the one response that has previously been reinforced (*blue*). This point is made in other writings, too, such as in Skinner's (1953) description of memorizing multiplication tables and where ''the stimulus '9 × 9' is the occasion upon which the response '81' is appropriately reinforced'' (p. 109). The speaker's history of reinforcement for responding to the verbal stimulus ''nine'' and the verbal stimulus ''times'' is almost irrelevant when considering the much more specific occasion of presenting the compound stimulus ''nine times nine.'' The compounding of the individual words results in a new (single) stimulus and therefore a new occasion for reinforcement.

Skinner's account of stimulus control of intraverbal behavior should be seen in a historical context, however. One of the reasons for this is that most of the experimental literature on stimulus control, such as that on conditional discriminations, emerged after Skinner published *Verbal Behavior*. Yet

[1] To be more precise, the sentence: ''What do you eat that's red?'' has a third and fourth element, namely the words ''what'' and ''you.'' Consequently, the compound stimulus in this sentence consists of the following four elements: What, You, Eat, and Red.

it is interesting to note that Skinner's account is in many ways consistent with that of the current paper.

## IMPLICATIONS FOR PRACTICE

Discriminating verbal stimuli of different complexities is a prerequisite for learning complex intraverbal behavior. This is the focus of the current paper. In addition, however, learning complex intraverbal behavior involves complex verbal topographies, such as saying, ''The capital of Norway is Oslo'' in response to the question, ''What is the capital of Norway?'' (or in the example mentioned above, describing Einstein's law of relativity or singing Beethoven's Symphony No. 5). Consequently, intraverbal behavior involves both the discrimination of complex verbal stimuli and the production of complex verbal responses. Both likely contribute to the difficulty many learners have in acquiring complex intraverbal behavior.

To simplify the learning of intraverbal behavior it might be an advantage to teach the discrimination of complex antecedent verbal stimuli and the production of complex verbal topographies separately. Teaching the discrimination of complex verbal stimuli may start even if the learner has a limited or no vocal repertoire. This is because the discrimination of verbal stimuli can be taught as a *listener* behavior. Listener behavior involves responding to antecedent verbal stimuli typically by either touching or pointing to object/picture stimuli or by performing simple actions, which are nonvocal, nonverbal responses. Obviously, the nonverbal listener response of say, pointing is less complex than a vocal verbal response, such as answering questions. Thus, working with listener skills might be an effective approach to teaching the learner to discriminate complex verbal stimuli. Using such nonverbal responses, discrimination of increasingly more complex verbal stimuli can be programmed. In what follows, we outline a curriculum sequence of teaching discrimination of increasingly complex verbal stimuli.

**Discriminated operants.** A basic form of listener behavior is to respond to simple instructions, such as ''clap hands'' and ''jump.'' In this example, the listener's response topography is unique to the particular $S^D$ given (the listener claps when asked to clap and jumps when asked to jump). In addition to teaching the learner to respond to simple verbal stimuli when they are presented alone, responding to more than one verbal stimulus must be acquired. In other words, the listener must learn to respond to verbal stimuli presented as a sentence. This can be achieved by teaching the learner to respond to instructions containing two actions such as ''Clap hands and wave.'' Prior to this, two-step nonvocal imitation (i.e., the teacher claps and then waves, and the learner imitates by first clapping and then waving) is usually taught.

The example of ''Clap hands and wave'' involves two discriminated operants, where both $S^D$s are presented before any of the two responses are emitted. The reason why this is not a compound stimulus is that the two $S^D$s control different responses (the $S^D$ ''clap hands'' evokes clapping whereas the $S^D$ ''wave'' evokes waving).

**Conditional discriminations.** Listener behavior involving conditional discriminations has been described as manded stimulus selection (Michael, 1985) and as receptive labels (Lovaas, 2003). Typically, and for several reasons, receptive labels are more difficult to learn as compared to learning to clap and wave in response to hearing the instruction ''clap'' and ''wave'' (Eikeseth, Smith, & Klintwall, in press). The most basic form of receptive labels is when the learner identifies a particular object in response to hearing its name. More advanced receptive labeling involves verbs, colors, functions, opposites, gender, categories, prepositions, pronouns, etc. These programs teach the learner to discriminate a number of complex verbal conditional stimuli that are required in order to learn complex intraverbals.

The receptive labeling programs just described teach the learner to respond to complex stimuli, but not to respond to several verbal stimuli when presented in a sentence. After learning to respond to two actions (e.g., clap and wave, as described above) the learner can be taught to respond to instructions that contain two objects, such as ''Give me car and book.'' In this case, there must be more than two stimuli available for the learner to select from. Subsequently, the

child can be required to select three objects, such as ''Give me car, house, and book'' (in this case there must be more than three stimuli available for the learner to choose from). By doing this, the learner not only learns to discriminate several verbal stimuli when presented in a sentence, but he or she also learns to respond to them in the correct syntactic sequence (first car, next house, and then book). Responding to verbal stimuli in the correct sequence is required to establish an intact listener repertoire and subsequently to learn intraverbals and other verbal behavior.

An example of a more complex program is to ask for objects, verbs, colors, and functions, such as when asking the learner to, ''Give me running, cup, and what you eat with.'' Here the learner selects the picture of someone running, the picture of a cup, and the picture of a spoon. Prior to this, the learner must have learned the objects, colors, and functions separately.

**Compound stimuli.** An important step is to teach the learner to select items that require him or her to discriminate two stimuli (or stimulus elements), such as selecting the red car based on the instruction; ''Give me the red car.'' This is a conditional discrimination involving a compound conditional stimulus (''Give me the red car''). This is because the learner selects one object in response to a compound consisting of two elements (color and object).

Because a large part of the repertoire of the listener involves conditional discriminations, discrimination of compound stimuli is introduced gradually in conditional discriminations, as follows:

Initially, use stimulus properties that are as simple as possible for the learner, such as color and object name. Each object is used to teach both color discrimination and object discrimination. That is, if there is a yellow car and a blue ball on the table, the learner is, for example, asked to select blue, and the correct response is to select the blue ball. Next, the learner might be asked to select the ball, and again, the correct response is to select the blue ball. On subsequent trials, the learner might be asked to select the car and, later, yellow, and in both instances the correct response is to select the yellow car. By doing this, the learner learns that the same object may have more than one property, and sometimes responding requires the discrimination of one property (i.e., color) whereas at other times the learner must discriminate another property (object name).

Another program to teach the same skill is to teach identification of parts of an object. For example, using a car, the learner may be asked to point to the bumper, the light, the door, the steering wheel, etc.

When identification of multiple properties of objects has been taught, the learner can be taught to respond to compound stimuli by requiring a response to two properties simultaneously (e.g., ''Give me yellow car'').

After mastery of this step, more advanced compound stimulus discriminations may be taught as listener behavior, such as responding to general knowledge questions (e.g., ''What grows that is green?''), and responding to different Wh-Questions (e.g. ''Where do you eat lunch?'' versus ''What do you eat for lunch?''). Here the response would be to point to pictures of restaurants, food, etc.

Interestingly, the programs suggested here are similar to those often used in early and intensive behavioral intervention curricula (e.g., Lovaas, 2003; Maurice, Green, & Luce, 1996). However, these manuals offer no specific rationale for the curriculum structure, which is what we have attempted in the current paper.

**Speaker behavior.** Concurrently with teaching listener skills, complex verbal responses may be established while keeping the antecedent stimuli as simple as possible. This can be done by using vocal imitation to teach echoic behavior (Skinner, 1957). Echoic verbal operants may subsequently be brought into other verbal operant classes by changing the stimulus control of the verbal operants, such as when learning tacts and intraverbal behavior, or by manipulating establishing operations and reinforcement contingencies to establish mands.

## IMPLICATIONS FOR APPLIED RESEARCH

The programs outlined above are logically and conceptually parsimonious, but as far as we know, no empirical research exists to support the notion that teaching listener skills as described above facilities learning of complex intraverbal behavior (cf., Petursdot-

tir & Carr, 2011). Hence, future studies could experimentally examine whether teaching relevant listener responses facilitates acquisition of intraverbal responses. For example, imagine we are going to teach intraverbal responses answering ''What do you eat that is green?'' ''What do you eat that is red?'' ''What do you eat that is yellow?'' and so forth. The experimental intervention may be to first establish the corresponding listener behavior by teaching the learner to select broccoli, a tomato, and a banana in response to these questions. After the learner has acquired such a listener repertoire, probe trials could be run to assess whether the corresponding intraverbal behavior emerges. Comparison of responding during probe trials that are conducted as baseline, before the listener behavior is taught, and following listener training would reveal the potential impact of teaching listener behavior on corresponding intraverbal behavior. Moreover, assessment can be carried out to examine the extent to which the intervention results in generalization to novel intraverbal behavior (i.e., intraverbal responses that have not been trained), thereby establishing intraverbal frames rather than single instances of intraverbal responses (Palmer, 1998).

Important prerequisite speaker skills may include an echoic repertoire, a repertoire of ''simple'' intraverbals (such as fill-in-the-blank questions and answering simple questions such as what is your name), and tacting of the pictures involved in the training.

If it turns out that teaching a listener repertoire facilitates the acquisition of intraverbal behavior, a next step might be to investigate which components of the listener skills described above are sufficient and necessary to enable the learner to acquire complex intraverbal behavior. Additionally, from a developmental point of view, it would be interesting to map at what point in typical development the various types of complex stimulus control described above emerge.

Research into the acquisition of listener behavior and intraverbal behavior could also examine the effectiveness of different discrimination training strategies. This could include comparing the efficacy of teaching single discriminations in mass trials before teaching them in rotation to ensure that such discrimination is achieved (e.g., Lovaas, 2003) as compared to, for example, using matrix training (e.g., Axe & Sainato, 2010), or teaching using random rotation without initial mass trials (Green, 2001; Grow, Carr, Kodak, Jostad, & Kisamore, 2011; Gutierrez Jr., Hale, O'Brien, Fischer, Durocher, & Alessandri, 2009).

Pérez-González and Alonso-Álvarez (2008) found that repeated practice of individual intraverbal responses, in addition to the employment of systematic and programmed steps to teach the learner to discriminate between intraverbal responses, may be required in teaching complex intraverbals. This study was conducted with typically developing adults, and could be replicated and extended using learners with developmental delays.

## CONCLUSIONS

In this paper we have argued that the difficulties with learning intraverbal behaviors experienced by many individuals with language delays may in part be related to the fact that the stimulus control for such behaviors is highly complex, involving verbal stimuli. Antecedent control of intraverbal behavior may involve discriminative stimulus control, conditional discriminations, compound stimuli, and a combination of those. Programs focusing on listener skills to establish complex stimulus control are outlined in the present paper. Future research could examine whether teaching of advanced listener behavior facilitates the acquisition of intraverbal behavior.

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