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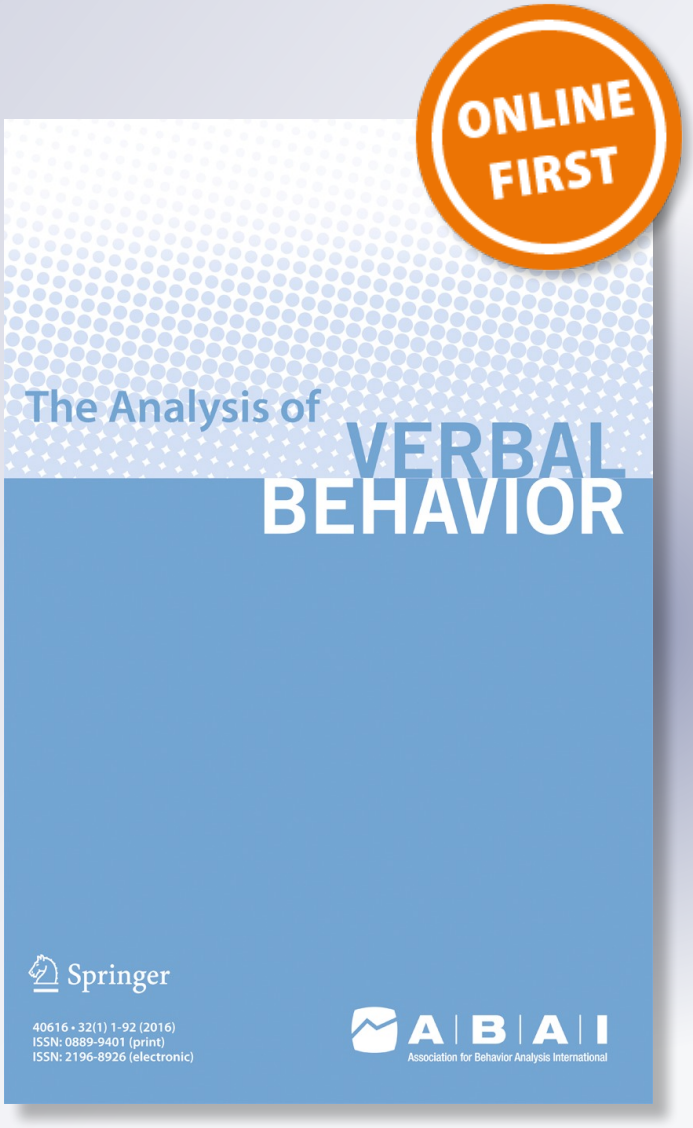

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SPECIAL SECTION: THE INTRAVERBAL RELATION

Verbal Stimulus Control and the Intraverbal Relation

Mark L. Sundberg[1]

Abstract The importance of the intraverbal relation is missed in most theories of language. Skinner (1957) attributes this to traditional semantic theories of meaning that focus on the nonverbal referents of words and neglect verbal stimuli as separate sources of control for linguistic behavior. An analysis of verbal stimulus control is presented, along with its distinction from nonverbal stimulus control and motivational control. It is suggested that there are at least four different types of increasingly complex verbal discriminations relevant to speaker and listener behavior: simple, compound, verbal conditional, and verbal function-altering (Eikeseth & Smith, 2013; Schlinger & Blakely, 1994). Separate but interlocking accounts of how these specific types of verbal stimuli produce different evocative and function-altering effects for the speaker and for the listener are provided. Finally, the effects of weakening verbal stimulus control and the loss of intraverbal behavior are considered, especially as they relate to dementia, aphasia, and traumatic brain injury.

Keywords Aphasia · Dementia · Evocative and function-altering effects · Intraverbal · Skinner · Verbal behavior · Verbal stimulus control

> Intraverbal behavior (is) sometimes dismissed as "spurious language." (It is) not important to the theorist of meaning because the correspondences between responses and controlling variables do not raise important problems of reference (Skinner, 1957, pp. 79–80).

Skinner (1957) presents the only theory of language that specifically identifies and analyzes the intraverbal relation as a type of verbal behavior that is functionally

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different from the other types of expressive language (cf., Bloom, 1974; Brown, 1973; Chomsky, 1957; Pinker, 1994; Slobin, 1973). In the first two chapters of *Verbal Behavior* (1957), Skinner makes the case for a functional analysis of language that is not constrained by structuralism or semantic theories of meaning. He objected to the common treatment of speakers (i.e., expressive language) and listeners (i.e., receptive language) where a speaker is said to use words to express meaning, while a listener is said to understand what words mean. Skinner's (1957) concern was that "Theories of meaning are usually applied to both speaker and listener as if the meaning process were the same for both" (p. 33). Skinner's view is that different contingencies are operating for a speaker and for a listener and must be treated as such. "In accounting for verbal behavior as a whole, effective functional relations must not be overlooked because of a preoccupation with meaning" (Skinner, 1957, p. 80). From Skinner's point of view, the meaning of words is not to be found in a common cognitive processing system or physical referent, but rather in the various environmental contingencies that evoke and consequate speaker and listener behavior.

Structural analyses of language and the "preoccupation with meaning" continue to dominate linguistics (Hedge, 2010). Much of the focus of linguistics is on the physical referents of spoken words, or in Skinner's terms, nonverbal stimulus control. Thus, the intraverbal and mand relations are missed as functionally separate operant relations because they are commonly treated as simply different manifestations of the same cognitive meaning of words and sentences. Skinner (1957) elaborates on this problem in relation to the intraverbal in the following passage:

> Intraverbal behavior...in traditional semantic theory...is more likely to be accepted as a response to a nonverbal state of affairs following the pattern of the tact. What are essentially relations between words and words come to be treated as relations between words and things. When we say that the word *Caesar* refers to Caesar, dead though he has been these two thousand years, we are clearly not talking about the behavior of a contemporary speaker. A response of this form is almost certainly intraverbal, if it is not textual or echoic. A process of educational reinforcement has brought it under the control of various sets of *verbal* circumstances. Theoretically we should be able to trace these circumstances back to an instant in which a response was made to Caesar as a man....But the verbal behavior of the modern historian is still mostly intraverbal. If we exclude pictures, statues, impersonations, and so on, *Caesar* cannot be a tact in the behavior of a contemporary speaker...In the behavior of a speaker in the twentieth century, *Caesar crossed the Rubicon* is a response, not to a specifiable physical event, but to a set of verbal stimuli (pp. 128-129).

Skinner (1957) identifies a similar problem regarding the mand where the traditional focus on the physical referent has distracted attention from motivational sources of control. He notes, "Traditionally, (the mand) has been explained by arguing that the speaker acquires a word, in its meaningful relation to a thing and then *uses* the word to ask for something. This is not only an inaccurate account of the acquisition of many mands, but there are many examples which cannot be so explained" (p. 128). Skinner (1957) maintains that,

> In a behavioral formulation of semantic relations we are under no compulsion to account for all verbal behavior with a single formula. The tact is obviously an important type of verbal response, particularly in its special effect upon the listener. We do not therefore conclude, however, that it is the only genuine kind of verbal behavior or that it establishes a pattern according to which all verbal behavior must be explained (p. 128).

The foundation of Skinner's (1957) functional analysis of verbal behavior is his distinction between the speaker and listener, and between the echoic, mand, tact, intraverbal, textual, copying a text, and transcriptive verbal relations that he collectively terms the simple or elementary "verbal operants" (p. 21). However, it is important to note that these distinctions are by no means the endgame of the analysis; rather, they are just the beginning (see Skinner, 1957, Chapter 9). Skinner (1957) identified three separate types of antecedent events, along with their related consequences, that control verbal behavior: (1) motivating variables, (2) nonverbal discriminative stimuli, and (3) verbal discriminative stimuli. These independent variables commonly interact with one another as types of multiple causation (Michael, Palmer, & Sundberg, 2011; Skinner, 1957).

The distinction between motivative variables (Skinner used the terms "deprivation, satiation, and aversive stimulation") and stimulus control in general is well established in the foundational literature of our discipline (Keller & Schoenfeld, 1950; Skinner, 1938, 1953, 1957), as well as in the extensive work by Michael (1982, 1993, 2000, 2007). The mand is primarily evoked by motivating operations (MOs) rather than discriminative stimuli (S^Ds). The primary distinction between the other verbal operants is in terms of the different types of stimulus control. Skinner (1957) first distinguishes between two general types of stimulus control: "In analyzing the stimulus control of verbal behavior, it is convenient to distinguish between instances in which the controlling stimuli are themselves verbal and those in which they are not" (p. 55). The tact is not controlled by verbal stimuli, rather it is controlled by the physical aspects of the speaker's environment. Skinner (1957) makes the point that nonverbal stimuli constitute "nothing less than the whole of the physical environment—the world of things and events which a speaker is said to 'talk about'" (p. 81) and, in reference to the tact relation, "A given response 'specifies' a given stimulus property. This is the 'reference' of semantic theory" (p. 83).

Skinner (1957) identifies five types of elementary verbal behavior controlled by verbal S^Ds: echoic, intraverbal, copying a text, textual, and transcriptive. He also described a type of listener behavior that can be multiply controlled by both verbal and nonverbal S^Ds: listener discriminations, although the case could be made for classifying this type of behavior as speaker behavior under some circumstances (see Michael, 1985; Sundberg & Sundberg, 1990). The intraverbal is distinguished from the other types of verbal behavior controlled by verbal stimuli by its lack of point-to-point correspondence between the form of verbal antecedent and the form of the verbal response (Skinner, 1957). The other verbal operants controlled by verbal stimuli all demonstrate different types of point-to-point correspondence between the antecedent event and the behavior of interest.

Verbal Stimulus Control

Verbal S^Ds are ubiquitous in today's society, and they frequently interact with nonverbal S^Ds and MOs. We encounter verbal stimuli in many forms and antecedent configurations in our day-to-day interactions with the environment. In fact, it is nearly impossible to avoid contact with verbal stimuli given that they occur so frequently and in varied contexts such as in the speech of others, print media, emails, texts, TV, radio, Internet, books, signs, and educational activities. Thus, it is worthwhile to provide a behavioral analysis of these discriminative stimuli as they relate to behavior, especially complex (and often covert) behavior such as thinking, problem solving, intelligence, and perception.

Verbal S^Ds have the same causal status as nonverbal S^Ds in that they both acquire discriminative control over behavior through the process of differential reinforcement (Skinner, 1957). Skinner defines a verbal stimulus as "the product of earlier verbal behavior" (1957, p. 65). That is, verbal responses produce some type of response product, and these response products can have a discriminative function evoking other behaviors on the part of listeners, including one's own self as a listener. For example, vocal speech produces auditory stimuli, while texting behavior produces visual stimuli. Skinner notes that when accounting for the behavior of speakers and listeners we have "an interest in what happens to the verbal stimuli created by the speaker" (p. 34). For example, composing a text message produces visual response products that function as verbal S^Ds that may evoke additional behavior from the initial speaker (i.e., the texter) such as self-textual behavior, self-intraverbal behavior, self-autoclitic behavior, self-editing, covert imagery, emotional (i.e., respondent) behavior, or automatic reinforcement for a clever phrase. Receiving a text message is also a verbal S^D, but for the reader. A text can evoke textual, intraverbal, copying a text, and transcriptive responses from a reader, as well as emotional responses, imagery, nonverbal behavior, avoidance behavior, automatic consequences, and a variety of other potential function-altering effects such as establishing new MOs and conditioned reinforcers and punishers (Michael, 1995, 2004; Schlinger & Blakely, 1987, 1994).

Nonverbal and verbal S^Ds have several unique characteristics that distinguish them from each other. Nonverbal stimuli are generally not the products of a speaker's verbal behavior; rather, they are aspects of the physical environment. This is an important behavioral distinction. For example, the nonverbal stimulus of water may evoke any number of different nonverbal behaviors (e.g., drinking, swimming, splashing, pouring, cooling off), across large variations of humans and other species, with a minimal conditioning history required. The verbal stimulus "water," however, can only be produced by a speaker with a specific conditioning history, and its response product can only affect a listener who also has a specific conditioning history, including being a member of the speaker's verbal community. For a native speaker of English visiting a foreign country and not being a speaker of the language in that country, the local verbal stimuli (e.g., speech, signs, directions, menus) may have little or no discriminative function, especially if the languages differ significantly from each other (e.g., English and Mandarin). Thus, intraverbal, textual, and transcriptive behaviors are nearly impossible for the visitor, and even echoic behavior can be quite difficult. Manding would also be significantly affected, but gestures, pointing, and other forms of nonvocal manding may allow one to get his or her basic MOs met. However, nonverbal stimuli, unlike verbal stimuli, would still have a valuable discriminative function for the traveler (e.g., restaurant, police officer, clerk, drinking fountain, the nonverbal behavior of others).

There are other aspects of verbal S^Ds that separate them from nonverbal S^Ds. Overt and covert verbal S^Ds are readily available for a speaker and listener, whereas nonverbal stimuli require the immediate support of the physical environment and may be less available. For example, a keyed lock requires the physical presence of a key, but a combination lock can be opened with verbal behavior. Verbal S^Ds are portable and can be of value to us in many ways in our day-to-day verbal interactions. We can talk about a sailing trip up the coast of Lake Michigan without being on a boat, and the verbal response products of this talk may function as conditioned reinforcers, as well as S^Ds for other verbal and nonverbal behaviors. Skinner makes the point that an important aspect of verbal behavior, and the distinction between verbal and nonverbal stimulus control, is that "Verbal behavior may more easily break free from (nonverbal) stimulus control, because by its very nature it does not require environmental support—that is, no (nonverbal) stimuli need be present to direct it or to form important links in chaining responses" (p. 47).

Verbal S^Ds have some evocative and function-altering properties that are more similar to MOs than they are to nonverbal S^Ds. For example, both verbal S^Ds and MOs can be free from environmental support; thus, they are both portable and readily available to evoke both overt and covert behavior. Also, the response products generated by verbal behavior not only produce verbal S^Ds but they can produce MOs as well. For example, a discussion about an upcoming sailing trip may lead to intraverbals regarding evening dinner plans and instantly generate an MO regarding the failure to obtain restaurant reservations at the marina (i.e., a reflexive conditioned motivating operation).

Another similarity between verbal S^Ds and MOs is that they may both be more fleeting than the often-static nature of the physical environment and nonverbal S^Ds. For example, when a writer sits in an office composing text, the physical environment stays mostly the same, but the verbal S^Ds and MOs are active as the primary evocative and function-altering sources of control necessary for generating effective intraverbal and transcriptive behavior. But, these types of control can also dissipate quickly as sources of control (e.g., the "train of thought" is lost, or a point is "forgotten"), and disruptions, digressions, or competing MOs may especially affect verbal S^D and MO control (Michael et al., 2011).

There are differences between verbal S^Ds and MOs as sources of control as well. The distinction between S^Ds and MOs in general is based on the distinction between reinforcer *availability* and reinforcer *effectiveness* (Michael, 1982, 1993). While MOs are clearly more portable for a speaker than nonverbal S^Ds, they are dependent on the increases and decreases in the momentary effectiveness of consequences. In discourse, the overall frequency of MOs may be far lower than the frequency of verbal S^Ds, but they can be more powerful than current verbal stimuli and block various evocative effects. For example, a person's covert intraverbal behavior regarding the failure to get dinner reservations may block the effectiveness of another person's speaking behavior, and what is said "is not heard." Also, other MOs may be involved as a form of multiple control (Michael et al., 2011; Skinner, 1957) that distort or affect verbal stimulus control evoking any number of possible verbal behaviors (e.g., exaggerating, lying, denying, agreeing). In addition, given that verbal S^Ds are related to generalized conditioned reinforcement rather than specific reinforcement, these antecedents can be effective regardless of any specific state of deprivation, satiation, or aversive

stimulation, and thus are less susceptible to erratic shifts in behavior such as changing the topic or terminating the discussion, which are typically MO effects.

Verbal Stimulus Control and Listener Behavior

Verbal stimuli can evoke both speaker and listener behaviors, but a separate account of the relevant environmental variables for each repertoire is necessary (Skinner, 1957). Regarding listener behavior, Skinner suggests that verbal stimuli can be overt or covert, evoke both nonverbal and verbal listener behaviors, and acquire both respondent and operant function-altering effects. When verbal stimuli evoke verbal behavior on the part of the listener (e.g., covert thinking) the listener becomes a speaker and all aspects of the analysis of speaker behavior now apply. Schlinger (2008) has provided a detailed analysis of the verbal aspects of listener behavior and suggests that the term "listening" be used to identify verbal activity on the part of listeners. In making these various distinctions between behavioral events, Skinner (1957) identifies several different effects that verbal stimuli can have on the nonverbal behavior of the listener. He begins with an analysis of respondent nonverbal listener behavior controlled by verbal stimuli:

> The listener reacts to a verbal stimulus, whether with conditioned reflexes or discriminated operant behavior, as he reacts to any feature of the environment. Conditioned emotional responses to the visual stimulus *DEATH* resemble those to any stimulus associated with death in the practices of a community (such as a funeral wreath or grave stone) or any natural accompaniment of death (such as the appearance of a corpse) (p. 170).

The respondent listener or reader effect is exemplified by the authors of novels who have learned to construct verbal stimuli in a manner that elicits emotional reactions from the reader such as those associated with emotions like fear and love. Stephen King's novels can frighten a reader to elevated states of nervousness, while Danielle Steele has the reader passionately weeping. Understanding the respondent effects of verbal stimuli can be valuable for teaching children, especially children with autism, empathy, sympathy, compassion, and other types of emotional reactions to the feelings, perspectives, and conditions affecting other people.

In addition to the respondent nonverbal effects that verbal stimuli can have on a listener, "verbal stimuli control much of the complex skeletal behavior with which the individual operates upon his environment" (Skinner, 1957, p. 34). This type of nonverbal listener repertoire is exemplified by what is commonly called "understanding words" or "receptive language," and is an important aspect of human behavior, and instruction for individuals with severe language delays (e.g., Lovaas, 2003). Verbal stimuli that can evoke nonverbal listener behavior can be categorized into at least four different types of discriminations (see Table 1): (1) simple, (2) compound, (3) verbal conditional, and (4) verbal function-altering (Eikeseth & Smith, 2013; Schlinger & Blakely, 1994). These same types of discriminations are relevant to speaker behavior as well, but will be addressed separately later. The four types of discriminations can be distinguished from each other in terms of their stimulus configurations and their unique evocative and function-altering effects (Michael, 1995, 2004; Schlinger & Blakely,

1987, 1994). The evocative effects are observed by an antecedent's demonstration of an immediate differential increase or decrease of a behavior, while the function-altering effects involve relatively permanent changes in the behavioral function of stimuli and MOs, and can only be observed at a later point in time.

A simple verbal discrimination for a listener involves a single-component verbal stimulus that evokes a nonverbal response. For example, when asked to "Jump" a child emits jumping behavior, and when asked to "Clap" the child emits clapping behavior. The response could also involve other forms of behavior such as touching a picture in a single stimulus comparison array (i.e., no discrimination component).

A compound verbal stimulus involves two or more S^Ds that each independently evoke behaviors, but when they both occur in the same antecedent configuration, a different S^D is generated. Eikeseth and Smith (2013) provide the example of the compound verbal stimuli "'clap fast,' and 'clap slow,' 'walk fast,' and 'walk slow'" (p. 127). In this example, the listener's behavior must first come under the control of each individual S^D, then come under the functional control of both stimuli when presented in random order. What is important is that "in a compound discrimination, the response to the compound stimuli is different from the response evoked by each S^D in isolation" (Eikeseth & Smith, p. 127). This demonstrates the evocative effect of compound stimuli in a discriminated operant. Eikeseth and Smith (2013) also point out that "Compound stimuli can occur in...a conditional discrimination" (p. 127).

Table 1 Four types of increasingly complex verbal discriminations relevant to speaker and listener behavior

Type of discrimination	Definition	Example
Simple	A single-component verbal stimulus that evokes a response	Speaker: Saying "meow" after hearing "A kitty says..." Listener: When asked to "jump," a child emits jumping behavior.
Compound	A verbal stimulus that involves two or more S^Ds that each independently evoke behaviors, but when they both occur in the same antecedent configuration, a different S^D function is generated	Speaker: Saying "blue" after hearing "Red, white, and..." Listener: When asked to "clap fast" and "clap slow," "walk fast," and "walk slow," the corresponding nonverbal behavior is emitted.
Verbal conditional	A verbal stimulus that alters the evocative and functional effects of another verbal stimulus in the same antecedent configuration	Speaker: Saying "spoon" and "soap" respectively when asked, "What do you eat with?" versus "What do you wash with?" Listener: Pointing to spoon and soap when asked the same questions presented above.
Verbal function-altering	A verbal stimulus that changes the function of other stimuli occurring at a later point in time (Schlinger & Blakely, 1994)	Speaker: Singing at the right time after hearing "When I call your name, sing your part." Listener: After hearing "When the doorbell rings, get your father," the correct behavior is emitted at the right time.

A conditional discrimination (C^D) is a type of multiple control that involves at least two antecedent events that interact with each other. Specifically, one event (an S^D or MO) alters the evocative effect of another event in the same antecedent configuration (Catania, 2013; Michael, 2004). C^Ds can involve various combinations of verbal and nonverbal stimuli, MOs, simple or compound discriminations, and other possible variables as well. A simple type of nonverbal listener C^D consists of a verbal stimulus that alters the evocative effect of a nonverbal stimulus (i.e., much of what is traditionally termed "receptive labeling"). For example, when a child is shown a variety of animals and an adult says "Can you find the tiger?" Through the process of differential reinforcement the verbal stimulus "tiger" eventually changes the evocative and function-altering effects of the nonverbal stimuli in the array with the tiger acquiring an S^D function while the other stimuli acquire an S-delta function. This verbal effect not only demonstrates the evocative properties of conditional discriminations, but also demonstrates how the function of a stimulus can change for clinical purposes as a result of the manipulation of specific variables. Had the verbal antecedent stimulus been "lion," the functional properties of the picture of the tiger would be different, that is, it would now be an S-delta in this arrangement. Thus, conditional discriminations, unlike simple and some compound discriminations, demonstrate both evocative and function-altering effects of an environmental change (Michael, 2004; Schlinger & Blakely, 1987, 1994).

Conditional discriminations can become more complex in a number of ways. The use of compound verbal stimuli and more complex nonverbal arrays is a common path for many intervention programs for children with language delays (e.g., Leaf & McEachin, 1999; Sundberg & Partington, 1998). For example, when presented with the verbal stimulus "Find a yellow fruit" and a comparison array of multiple nonverbal stimuli, both parts of the verbal antecedent (i.e., "yellow," "fruit") combine to alter the function of a yellow banana, establishing it as an S^D evoking selection behavior, while say, a green banana and a red apple, take on S-delta properties. Had the verbal stimulus been "Find a red fruit," the banana's functional properties would change to an S-delta, while the red apple acquires S^D properties. Much of the formal instruction process for a child with language delays involves bringing together multiple verbal and nonverbal S^Ds and the careful sequencing and randomizing of these stimuli in order to ensure that the proper discriminations are being acquired. These types of procedures have been termed "listener responding by feature, function, and class" (LRFFC) as a way to distinguish them from other types of listener discriminations (Sundberg, 2014; Sundberg & Partington, 1998).

Another level of complexity of verbal stimulus control involves the function-altering interaction of multiple verbal stimuli within the same antecedent condition, termed a "verbal conditional discrimination (VC^D)" (Axe, 2008; Eikeseth & Smith, 2013; Sundberg & Sundberg, 2011). In a verbal conditional discrimination, one verbal stimulus alters the evocative and functional effects of another verbal stimulus in the same antecedent configuration. For example, in a listener discrimination involving an array of nonverbal stimuli and the verbal stimulus "Which one is not a fruit?" the word "not" alters the discriminative function of the word "fruit" allowing it to function as a new S^D that participates in a second conditional discrimination with the comparison array, and that event evokes selection behavior. This arrangement demonstrates both the evocative effect as well as the function-altering effect of a stimulus change, and also constitutes a type of LRFFC teaching procedure for children with language delays.

Eikeseth and Smith (2013) suggest that the distinction between a verbal conditional discrimination and a compound conditional discrimination is subtle, but important. In a VC^D, a verbal stimulus alters the function of another verbal stimulus in the same antecedent condition, whereas in a compound C^D, the multiple verbal stimuli in the same antecedent do not alter the function of each other. Eikeseth and Smith (2013) note "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^Ds) and the S^D is established by the conditional stimulus" (p. 127). Thus, if one word changes the evocative function of other words in the same antecedent condition (e.g., "*not* a fruit"), the relation could be termed a VC^D. If the words do not change the function of each other, but still act as a type of convergent multiple control (e.g., "big animal"), Eikeseth and Smith (2013) suggest these effects be termed compound C^Ds. Relatively little discussion or research is available on this distinction; however, it certainly seems warranted, given the importance of these types of complex verbal discriminations to human behavior.

Schlinger and Blakely (1994) suggest a fourth type of verbal discrimination they termed "verbal function-altering effect" (p. 48). Verbal stimuli can change the function of other stimuli occurring at a later point in time, or what Skinner identified as "rule-governed behavior" (Schlinger & Blakely, 1987, 1994; Skinner, 1969). Skinner (1957) describes this function-altering effect on the behavior of the listener with several examples including "The verbal stimulus *When I say 'three', go!* may have no immediate effect classifiable as a response, but it changes the subsequent behavior of the listener with respect to the stimulus *Three.* We are...concerned here...with the operant behavior of 'going' evoked by the discriminative stimulus *three*" (pp. 358–359). Skinner notes that this function-altering effect can occur under a variety of circumstances, for instance, "In a slightly different example, the later effect of a nonverbal stimulus is changed. Thus, *When the fire burns out, close the damper* leads to subsequent behavior under the control of a nonverbal stimulus arising from the condition of the fire" (p. 359).

A more detailed description of how verbal stimuli can change the function of future stimuli and MOs might help to facilitate discussion and research by identifying the potential variables necessary for this function-altering effect to occur. Figure 1 contains a diagram of an example of the possible delayed behavioral effects on a listener of hearing the verbal stimulus "When the doorbell rings, get your father" (verbal S^D_1). Perhaps of most interest in this example is explaining how the function of the doorbell changes from an S^D for answering the door, to an S^D evoking a tact, and finally, to an S^D evoking the behavior of getting the father. First, there are two possible initial effects of verbal S^D_1 (Fig. 1), one is an immediate evocative effect, while the other is a delayed function-altering effect. The evocative effect might consist of an overt or covert echoic response (verbal response$_1$), while the function-altering effect is that the doorbell sound (e.g., a chime), occurring later in time, is altered to function as an S^D for a tact (nonverbal S^D_1), such as "There's the doorbell," and now an S-delta for answering the door. The tact is important to the sequence of events, because it provides the necessary information for the listener as to when to proceed with acting upon the initial instruction. However, several additional behavioral events must occur in order for the initial verbal S^D to evoke the target response of getting the father at the right time.

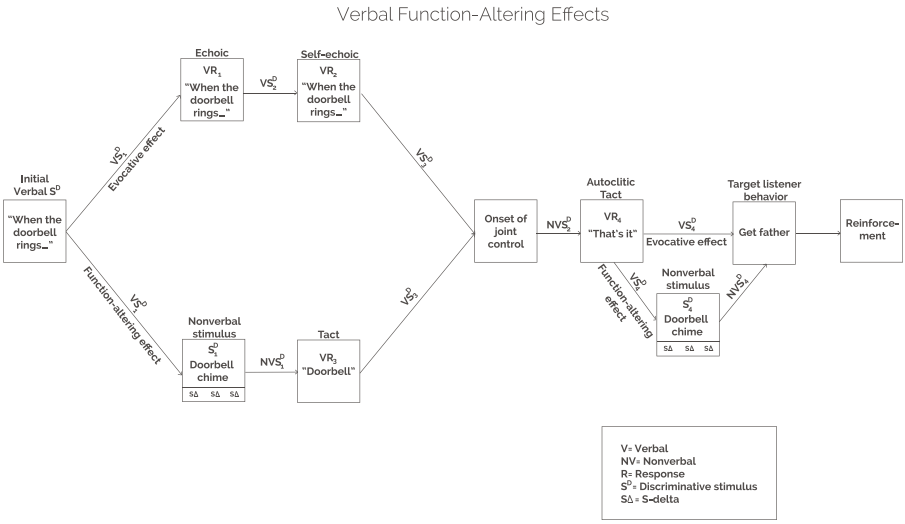

Fig. 1 The verbal function-altering effects occurring between the initial presentation of the verbal stimulus "When the doorbell rings, get your father" and the terminal response of getting the father at the right time (see the text for a complete description of this chart)

Figure 1 shows that the initial verbal S^D (verbal S^D_1) evokes an echoic response (verbal response$_1$); the response product of the echoic generates for the self-listener a new verbal S^D (verbal S^D_2) that in turn evokes self-echoic responses (verbal response$_2$). The echoic response and subsequent self-echoic responses preserve the initial verbal stimulus over time, even with just occasional rehearsal (Lowenkron, 1998). Without the self-echoic, knowing what to do and when to do it can easily be forgotten over long periods of time, especially if there are distractions. The function-altering effect of verbal S^D_1 can be observed later when the doorbell actually rings and evokes a tact (e.g., "There's the doorbell") (verbal response$_3$), rather than the behavior of answering the door. When the response product of the tact (verbal S^D_3) matches the response product of the self-echoic (i.e., verbal S^D_3) as a type of multiple control, termed "joint control" by Lowenkron (1984, 1998), the confluence of these two events is discriminable to the self-listener and generates a new S^D (nonverbal S^D_2), which evokes an autoclitic tact regarding sameness ("*That's it*, the doorbell.") (verbal R_4). The response product of the autoclitic tact (verbal S^D_4) quickly (i.e., within milliseconds) alters the function of the doorbell again, but this time to nonverbal S^D_3 that sets up the conditional discrimination between the response product of the autoclitic tact (verbal S^D_4) and the doorbell chime (nonverbal S^D_3), and now evokes getting the father, rather than a tact of the doorbell, or the nonverbal behavior of answering the door.

There could be other overt and covert variables involved as well, such as self-intraverbal and self-mand behaviors, but this basic example demonstrates how a single verbal stimulus can and often does have multiple evocative and function-altering effects (Michael et al., 2011; Schlinger & Blakely, 1994; Skinner, 1957). In addition, the current example demonstrates how four separate types of multiple control were necessary for the terminal behavior to occur: (1) the initial divergent multiple control, (2) convergent joint control, (3) divergent multiple control emanating from the autoclitic tact, and (4) a convergent conditional discrimination (Michael et al., 2011).

Verbal Stimulus Control and Intraverbal Behavior

The same four types of verbal discriminations previously described for listener behavior also apply to intraverbal behavior, although the evocative and function-altering effects of the relevant verbal stimuli are different. In addition, the multiple verbal responses and required linguistic structure and grammatical conventions involved in intraverbal behavior are typically more complicated than the responses observed in listener discriminations. The evocative effects differ for a speaker in that a verbal S^D evokes a verbal response in an intraverbal relation, whereas for a listener it evokes a nonverbal (skeletal) response. Both types of stimulus control can occur simultaneously and may even involve the same verbal stimulus (i.e., divergent multiple control). For example, an adult might tell a child his friend Sean is coming to visit. This verbal stimulus could evoke nonverbal behavior such as running to the window to see if the friend is there yet (i.e., listener skills), and simultaneously evoke intraverbal and mand behaviors regarding activities with Sean or his time of arrival (i.e., speaker skills). The same verbal S^D can also alter the function of other events, some of which may evoke or consequate listener behavior, while others may evoke or consequate speaker behavior. For example, the parent's initial verbal stimulus may evoke an intraverbal response from the child such as "Sean likes to play video games," which in turn may alter the function of a Nintendo remote by establishing it as an S^D evoking nonverbal behavior (reaching for it), or as an S^D or MO evoking verbal behavior (e.g., "I better check the batteries").

The four types of verbal discriminations previously described for listener behavior (i.e., simple, compound, conditional, verbal function-altering), can also evoke intraverbal behavior from a speaker. The first type of intraverbal behavior often acquired by typically developing children usually involve simple verbal discriminations (along with MO control), such as saying "Go" after hearing "Ready set...." or saying "Cookie" after hearing "Eat." A primary goal in the early development of an intraverbal repertoire for a child with language delays is to establish these simple intraverbal discriminations, while generally focusing on breaking the targeted verbal responses free from echoic control.

Following a reinforcement history of simple verbal discriminations, more complex verbal stimuli begin to successfully control intraverbal behavior. Compound verbal stimuli present a way to expand the complexity of verbal stimuli by increasing the number of words in a verbal antecedent configuration. Skinner (1957) describes this type of compound verbal stimulus control in relation to intraverbal behavior in the following passage:

> 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...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...The more complex the stimulus pattern, the

more specific the verbal occasion, and the stronger the control exerted over a single response" (p. 76).

It is also of interest to note that in this passage Skinner identifies the function-altering effect that can occur in intraverbal relations where the compounding of known words generates a different verbal S^D and a different intraverbal response.

Another way in which a "more complex stimulus pattern" occurs with the intraverbal relation is through the process of verbal conditional discriminations. In this type of verbal stimulus configuration, as described previously for the listener, one or more words in an antecedent event alter the function of other words in the same antecedent condition. The conditional discrimination is completely among the words presented in the antecedent event, and an intraverbal response is evoked, rather than a listener response. For example, when asked, "What do you eat with?" versus "What do you wash with?" the words "eat" and "wash" differentially affect the functional properties of the word "with." When "eat" precedes "with," intraverbal responses such as "spoon" or "fork" should be evoked, versus "soap" or "water" which would be appropriate for "wash with." This type of verbal stimulus control is ubiquitous in daily discourse but has received relatively little experimental attention (Axe, 2008; Sundberg & Sundberg, 2011).

The fourth type of verbal discrimination—the verbal function-altering effect (Schlinger & Blakely, 1994)—is relevant to intraverbal behavior as well. Verbal stimuli can alter the function of other verbal stimuli occurring at a later point in time, and evoke intraverbal behavior at that time (Skinner, 1957). For example, if a child is told by a teacher "When I call your name (e.g., Zac), sing your part." This initial verbal stimulus alters the future evocative effect and the function of hearing "Zac" to a new verbal S^D that now evokes intraverbal behavior consisting of singing his song. Under different circumstances, hearing his name has other functions (e.g., coming to the table, stopping his current behavior). These types of verbal function-altering effects play a role in several aspects of complex behavior such as those mentioned above. However, little research has been conducted on this type of verbal stimulus control, yet its importance to human behavior seems clear.

Intraverbal relations are complicated by other variables as well. Often important verbal stimuli are private for the speaker, inaccessible to others, and thus difficult to account for or quantify. In addition, the response configuration in intraverbal behavior can become quite varied and complicated in a number of ways. For example, longer and multiple sentences can be emitted in a single utterance containing nouns that are modified by verbs, adjectives, prepositions, and other parts of speech. Palmer (2016) also notes "many of the structural properties of verbal behavior that so excite the linguist arise, at least in part, from the prevalence of intraverbals and intraverbal control. In particular, autoclitic frames and grammatical tags are largely intraverbal" (p. 6). Speakers must acquire these intraverbal autoclitic frames and tags because they play an important role in the effective execution of verbal behavior (Skinner, 1957). In addition, novel verbal and nonverbal stimuli are constantly entering the antecedent configurations, contributing to response variability, emerging relations, and a variety of other evocative and function-altering effects.

Verbal S^Ds also participate with other independent variables as causal variables in a variety of human behaviors, especially complex behavior. For example, covert verbal stimuli may supplement other sources of control as types of multiple control in arbitrary

matching-to-sample preparations with verbal participants (e.g., Lowenkron, 2006). The final selection behavior observed in these experiments may actually be under the functional control of multiple variables, only one of which is the experimenter-presented sample stimulus (Michael et al., 2011; Palmer, 2004). In situations where a verbal stimulus participates as a supplemental stimulus in evoking a verbal response (e.g., verbal problem solving), the terminal behavior (e.g., the correct answer to a complex math problem) may be the result of multiple variables, most of which are verbal. Palmer (2016) has suggested that it would be valuable for behavior analysts to refrain from identifying these relations as intraverbal, but rather to talk about them as "intraverbal control," a specific type of verbal stimulus control. Palmer (2016) explains "In cases in which the verbal antecedent is, by itself, insufficient to evoke the relevant response, we should speak of 'intraverbal control,' usually as one of a number of concurrent controlling variables" (p. 4). Palmer (2016) also suggests we should restrict our usage of the term "intraverbal operant" to "a verbal response directly under control of a prior verbal stimulus (of a different topography) as the result of a history of reinforcement for emitting that response in the presence of that stimulus" (p. 2). This distinction is valuable to the current discussion in that it frees up verbal stimulus control to account for a variety of behavioral effects that would not fit Palmer's more narrow definition of an intraverbal relation.

The Loss of Intraverbal Behavior

The preceding analysis of verbal stimulus control and the acquisition of intraverbal behavior not only suggests practical applications for the establishment of intraverbal behavior for children with autism or other intellectual disabilities, but it also can be of value for assessing and treating the deterioration or loss of intraverbal behavior as observed in dementia, aphasia, and traumatic brain injury (TBI) (Baker, LeBlanc, & Raetz, 2008; Gross, Fuqua, & Merritt, 2013; Palmer, 1991; Sundberg, San Juan, Dawdy, & Arguelles, 1990). An adult with aphasia, for example, may call some nouns "things" in conversations involving intraverbal and mand exchanges. But when the noun is physically present, its correct name may be emitted. The tact repertoire can remain stronger than the intraverbal or mand, or vice versa, depending on any number of variables affecting the speaker. What seems increasingly clear is that the loss of language occurs differently across and within the verbal operants (Gross et al., 2013; Skinner, 1957), just as the acquisition of language occurs differently across and within the verbal operants (Esch, LaLonde, & Esch, 2010; Sundberg, 2014). Thus, appreciating the distinctions between the echoic, mand, tact, and intraverbal relations can have clinical benefits for working with those who are experiencing a weakening of their verbal repertoires (e.g., Dixon, Baker, & Sadowski, 2011; LeBlanc, Raetz, & Feliciano, 2011; Oleson & Baker, 2013).

In his discussion of aphasia and the loss of verbal behavior, Skinner (1957) points out "The phenomena of aphasia are difficult to summarize because verbal behavior may be damaged at so many points in so many ways... Damage is usually most severe in verbal behavior receiving generalized reinforcement. The order of damage seems to follow the order of 'difficulty' deducible from the availability of a minimal repertoire. Textual and echoic behavior often survive (unless relevant sensory defects are involved) while intraverbals and tacts appear to be most vulnerable" (p. 219). Skinner's

identification of a "minimal repertoire," which he also calls an "atomic" repertoire, consists of "A bit of behavior as small as a single speech-sound, or even a pitch or stress pattern, (that) may be under independent control of a manipulable variable (we shall see evidence of such 'atomic' verbal operants later)" (p. 21). Palmer (2012) elaborated on Skinner's concept of minimal or atomic repertoires in a number of valuable ways including the following expanded definition:

> By *atomic repertoire* I mean a set of fine-grained units of behavior, each under control of a distinctive stimulus, that can be evoked in any permutation by the arrangement of corresponding stimuli. Like letters on a page that can be arranged to display a great variety of expressions, atomic responses can be arranged to meet a great variety of contingencies" (p. 61).

Skinner (1957) uses the concept of minimal repertoires to further distinguish between the verbal operants that are more or less likely to deteriorate. "The verbal operants least likely to be forgotten are echoic and textual...because we have echoed and read many responses with the same minimal repertoire" (p. 207). He explains that this occurs because "In echoic and textual behavior there is a point-to-point correspondence between properties of stimulus and response which makes possible a repertoire of minimal units" (1957, p. 185). The tact repertoire is more susceptible to deterioration, especially those tacts involving a limited reinforcement history (e.g., proper names, technical vocabulary). However, Skinner explains that "something like a minimal repertoire can be detected in the case of tacts... We may retain such an operant as *intractable* in sufficient strength for occasional use because of the enormous number of other responses with *in* which have to do with the absence of a property" (p. 208). Mands are also susceptible to deterioration, but for different reasons than loss due to the disruption of stimulus control and generalized conditioned reinforcement. MOs can be quite complex for a person with dementia, and as a result, mands may demonstrate more varied and sporadic degrees of deterioration due to a number of possible causes (e.g., extinction, response effort may reduce the evocative effect of MOs, reflexive CMOs may dominate manding, some MOs may remain stronger than others).

Skinner (1957) concludes that of all the verbal operants the intraverbal is the most susceptible to deterioration. He notes "The loss of verbal behavior with the mere passage of time has been the subject of psychological studies of memory. These have generally been confined to intraverbal behavior, partly because...intraverbal behavior is more quickly lost" (p. 207). Skinner (1957) suggests the quicker loss of intraverbal behavior is partly because "there is no minimal repertoire similar to that which approaches mimicry in echoic behavior or permits the skilled reader to pronounce a new word in a text. A novel verbal stimulus may evoke intraverbal responses because of resemblances to other stimuli, but there is no reason why such behavior should be consistent or show any functional unity of small parts" (p. 76).

There are several additional reasons why intraverbal behavior is susceptible to immediate or long-term deterioration and can be the most fragile of the verbal operants. Perhaps the most difficulty in maintaining an intraverbal repertoire involves the complexity of verbal stimulus control and related responses as described above. Verbal stimuli that involve multiple compound and verbal C^Ds and convergent and divergent types of multiple control can be far more difficult to successfully evoke

appropriate verbal behavior than the other types of control. In addition, the verbal stimuli typically occur rapidly and are transitory, thus complicating the discrimination process, especially for an elderly person or a person with dementia, aphasia, or TBI. Skinner (1957) also points out "The control exerted by an audience...which facilitates verbal behavior also declines with the passage of time" (p. 209). This loss of audience may have a significant effect on the intraverbal repertoire, given the absence of contact with verbal discriminative stimuli that have a history of evoking intraverbal behavior (e.g., discussing World War II and events of the time with fellow veterans).

Verbal stimuli commonly interact with other variables during discourse such as nonverbal S^Ds in the physical world, current MOs, respondent relations, medical issues, and other possible variables. These additional sources of control can both facilitate behavior (e.g., talking about objects when they are present), but they can impede behavior as well (e.g., MOs related to pain). For example, an elderly researcher at a conference may be asked about a complex aspect of his previous work and not only might the question be presented fast and contain multiple VC^Ds, but the immediate physical environment may contain many visual and auditory distractions, while multiple MOs may be in effect (e.g., wanting to sit down, escape the speaker, talk to an old friend). The failure to correctly respond to the immediate verbal S^D is multiply controlled, and it may be that the actual target intraverbal would have been at strength in the absence of blocking and competing S^Ds and MOs.

Intraverbal Research

The empirical foundation of the intraverbal relation has been slow in arriving, but now, after six decades, it is in full swing, exemplified by the special focus on the intraverbal in this issue of *The Analysis of Verbal Behavior* and the growing body of intraverbal research that has recently provided a wealth of information regarding the intraverbal relation (e.g., Axe, 2008; Coon & Miguel, 2012; Eikeseth & Smith, 2013; Greer, Yuan, & Gautreaux, 2005; Ingvarsson & Le, 2011; Ingvarsson, Tiger, Hanley, & Stephenson, 2007; Kisamore, Karsten, Mann, & Conde, 2013; Kodak, Fuchtman, & Paden, 2012; Lechago, Carr, Kisamore, & Grow, 2015; Miguel, Petursdottir, & Carr, 2005; Pérez-González & García-Asenjo, 2016; Sautter, LeBlanc, Jay, Goldsmith, & Carr, 2011; Sundberg & Sundberg, 2011; Valentino, Shillingsburg, & Call, 2012).

There have also been several reviews of this robust line of research, beginning with Oah and Dickinson (1989), followed up by Sautter and LeBlanc (2006), and most recently by Aguirre, Valentino, and LeBlanc (2016). The intraverbal relation clearly has become an increased focus of research as shown by Aguirre et al., who identified 53 empirical studies on the intraverbal published during the past 10 years, a 400 % increase compared to the previous 10 years. Thus, the needed research on verbal stimulus control and the intraverbal relation is well under way.

Summary

Verbal stimulus control is pervasive in human behavior, but its pivotal role in language is missed by semantic theories that focus on the cognitive meanings and the physical

referents of words. The analysis of intraverbal behavior is dependent on the analysis of verbal stimulus control which is perhaps why the intraverbal relation is often missed as a separate type of expressive language. Skinner (1957) suggests that verbal stimulus control is functionally different from nonverbal stimulus control and MO control, and must be treated as such. In addition, the evocative and function-altering effects of verbal stimuli are different for the behavior of the speaker versus the behavior of the listener, warranting separate but interlocking accounts of these effects. Several different types of verbal discriminations were suggested as a way to provide a framework for the analysis of verbal stimulus control and its differential effects on the behaviors of speakers and listeners. When verbal stimulus control weakens, intraverbal behavior is most affected and will correspondingly weaken. Appreciating these and other effects of verbal stimulus control may improve intraverbal assessment and intervention for those with language delays and those experiencing a language loss.

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Conflict of Interest The author declares that he has no conflict of interest.

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