The Multiple Control of Verbal Behavior

Jack Michael

Western Michigan University

David Palmer

Smith College

Mark L. Sundberg

Sundberg and Associates

Abstract

Amid the novel terms and original analyses in Skinner's *Verbal Behavior*, the importance of his discussion of multiple control is easily missed, but multiple control of verbal responses is the rule rather than the exception. In this paper we summarize and illustrate Skinner's analysis of multiple control and introduce the terms *convergent multiple control* and *divergent multiple control*. We point out some implications for applied work and discuss examples of the role of multiple control in humor, poetry, problem solving and recall. Joint control and conditional discrimination are discussed as special cases of multiple control. We suggest that multiple control is a useful analytic tool for interpreting virtually all complex behavior, and we consider the concepts of naming, stimulus equivalence, and relational frames as cases in point.

Key terms: B. F. Skinner, equivalence, joint control, multiple causation, multiple control, naming, relational frame theory, verbal behavior

Regularities in nature are commonly detected by isolating relevant variables in the laboratory. The laws of macroscopic motion were there for all to see since the dawn of time, but they were only crudely grasped by the intuitive rules of the smith, mechanic, and carpenter until 17th-century scientists began to isolate variables like mass, volume, and distance while keeping everything else constant. Once formulated, the laws of motion could be applied to an unlimited range of phenomena outside the laboratory. Nevertheless, it is no easy matter to trace the workings of the laws of motion when many variables interact. The problem of describing the combined motion of the moon, earth, and sun famously made Newton's head ache. The simplicity of a principle does not protect us from the complexity of nature.

Analogously, the sensitivity of behavior to its antecedents and consequences had long been crudely grasped by proverbs, homilies, and grandmotherly advice, but its lawfulness was understood only when Pavlov, Skinner, and others isolated variables like temporal contiguity, contingency, and deprivation. Outside the laboratory, behavior is commonly the product of many interacting variables, and our interpretations of behavior must be correspondingly complex. For practical purposes, we may be able to ignore the complexity of controlling relationships by making one contingency dominant, either by establishing powerful reinforcers, by simplifying the context, or by manipulating the salience of relevant stimuli. Such simplifications are often necessary in applied settings, but unless acknowledged as such, they invite the charge that behavior analysis is linear and impoverished.

Verbal behavior comprises so many different response topographies, occurring under so many different circumstances, that the complexity of control poses particularly challenging problems for scientific interpretations. As Skinner (1957) observed in the opening paragraph of his chapter on multiple control:

> 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. (p. 227)

The purpose of this paper is to review and illustrate Skinner's concept of multiple control, to point out its relevance in applied settings, and to offer some remarks about its role in complex behavior. One reason for doing so is that, amid the novel terms and careful taxonomy of controlling relationships in *Verbal Behavior* (1957), Skinner's discussion of multiple control is easily overlooked. Readers sometimes fail to recognize that pure forms of the respective verbal operants are rare outside the laboratory or instructional contexts, and a common preoccupation of students is to try to classify utterances as one or another verbal operant on the assumption that the example must be exclusively one or the other. Perhaps more importantly, if one fails to consider multiple control, one's interpretations of verbal behavior are likely to be conspicuously inadequate. As MacCorquodale (1970) said of Chomsky's (1959) review of Skinner's book,

> The review completely ignored much that is central to an understanding, application and assessment of Skinner's position. Most importantly it failed to reflect Skinner's repeated insistence that the full adequacy of his explanatory apparatus for complex cases, including verbal behavior, cannot be assessed unless the possibilities for interaction among its several controlling variables acting concurrently were realized; this is what is different between the laboratory and the real world. In the laboratory, variables are made to act "one at a time", for all practical purposes. The real world simply puts the environment back together again. Multiple causality is never mentioned in the review; it is mentioned throughout *Verbal Behavior*. (p. 98)

Types of Multiple Control

For clarity, we label the two types of control mentioned by Skinner *convergent multiple control* (the control of a single response by more than one variable) and *divergent multiple control* (the strengthening of more than one response by a single variable) as shown schematically in Figure 1. Our discussion will also allude to Skinner's concepts of *formal* control and *thematic* control. We speak of *formal* control when there is an approximate point-to-point correspondence between the topographies of a controlling variable and a verbal response, as in echoic behavior, textual behavior, transcription, and taking dictation. In each case, the topography of the response is tightly constrained by the formal properties of the stimulus. The relationship need not be perfect, of course: in taking dictation or reading aloud, there are features of the stimulus and response that have no correspondence in the other term: The stenographer inserts silent letters not represented in the vocal response, and the reader omits them. Moreover, the relevant response is usually multiply controlled and therefore may be, among other possibilities, faster, louder, higher in pitch, more carefully enunciated, or less legible than the controlling variable, but whereas these properties can vary from case to case, the formal relationship is fixed by convention, regardless of context, the strength of other variables, and the history of the subject.

Insert Figure 1 about here

The concept of formal control is important mainly by virtue of what it excludes: A response under formal control need not be sensitive to the variables that determined the prior stimulus and can therefore be independent of what is conventionally called its meaning. Thus we can echo words we don't know, copy texts in an unfamiliar language, read computer code that is gibberish to us, transcribe an argument that we cannot follow, and so on. Once one has acquired a relatively small atomic repertoire of echoic, textual, transcriptive, and stenographic operants, one can appropriately emit an

unlimited number of exemplars without any other relevant experience. Thus the mere emission of a response under formal control attests only to the strength of the relevant atomic repertoire.

But once emitted, a response originally under formal control can be followed by important consequences and come under control of other ambient stimuli. When Ali Baba first stood before the den of the 40 thieves, he uttered "Open Sesame!" under echoic control, but when the cave door opened, mand control was strengthened, and he later emitted the response without a model. An echoic repertoire, like other behavior under formal control, permits critical variations in behavior to occur on a single trial, therefore bypassing the long process of the shaping of target responses by the reinforcement of successive approximations.

We speak of *thematic* control when there is no point-to-point correspondence with a controlling variable, as in intraverbal, tact, and mand relations. For example, in the tendency to say *dog* in the presence of a dog there is no point-to-point correspondence between the features of the dog and the features of the tact *dog*. Thus the emission of a tact, mand, or intraverbal attests, not to the speaker's atomic repertoire, but to a history of relevant tact, mand, or intraverbal training. Although the relationship between the controlling variable and the response is conventional here as well, there is no formal constraint on the topography of response. Consequently the particular response that is emitted will typically vary according to a complex configuration of controlling variables. One might respond to a dog by saying *dog, chien, Hund, brown, spaniel, barking, friendly,* and so on, according to the strength of many contextual variables. Thus, a particular topography of a response under thematic control often reveals something about the speaker's history and the relative importance of controlling variables in a way that a response under formal control does not.

Convergent Multiple Control

In convergent multiple control, more than one variable potentiates a response of a single topography, whereas in divergent multiple control, one variable potentiates more than one response. As an example of convergent multiple control, consider the hypothetical assignment of getting someone to utter the response *pencil* proposed by Skinner (1957). (See Figure 2.)

> To strengthen a mand of this form, we could make sure that no pencil or writing instrument is available, then hand our subject a pad of paper appropriate to pencil sketching, and offer him a handsome reward for a recognizable picture of a cat … Simultaneously we could strengthen other responses of the same form by providing echoic stimuli (a phonograph in the background occasionally says *pencil)* and textual stimuli (signs on the wall read *PENCIL)*. We scatter other verbal stimuli among these to produce intraverbal responses: the phonograph occasionally says *pen and* ... and there are other signs reading *PEN AND,* ... We set up an occasion for a tact with the form *pencil* by putting a very large or unusual pencil in an unusual place clearly in sight—say, half submerged in a large aquarium

> or floating freely in the air near the ceiling of the room. We indicate our own audience-character as an English-speaking person by the simple device of speaking English. Under such circumstances it is highly probable that our subject will say *pencil.* (pp. 253-254)

In this example we see the simultaneous effect of several types of both formal and thematic sources of control. Auditory and textual stimuli provide formal sources of control over echoic and textual responses, while other auditory stimuli, visual stimuli, and motivational variables provide thematic sources of control over intraverbal, tact, and mand responses, all of the same topography.

Insert Figure 2 about here

Sometimes multiple controlling variables occur together reliably; for example, if a hungry child goes into the kitchen and sees a loaf of bread on the counter, the subsequent response *sandwich* (usually embedded in an autoclitic frame *Can I have [X]?*) is partly under the control of deprivation and partly under the control of the loaf of bread. In a familiar environment such convergence of controlling variables may be so reliable that the response can be considered a multiply controlled operant no different from any other operant under control of a complex of stimuli, such as the tact *bulldozer*. In such a case there is no point in arguing about whether the response is really a metonymical tact or a mand. Both sources of control are present and contribute to the strength of the response just as the tread and blade of a bulldozer contribute strength to *bulldozer*. If the response is reinforced, it will be more likely to be evoked in the future when all or part of the configuration of controlling variables occurs again, just as with any other operant. However, in many instance of convergent multiple control, the controlling variables come together only once, as in Skinner's example of evoking the response *pencil*. It is important to note that in this case the target response itself is not usefully considered an operant; rather it is a response whose topography is common to a variety of verbal operants, each of which contributes to the emission of the response. It is a unique event evoked by a confluence of controlling variables which are unlikely ever to be repeated. Much verbal behavior is of this sort. At the level of extended verbal utterances, conventionally called sentences, it is the rule rather than the exception, but even at the level of single responses, convergent multiple control is typical. Audience variables, motivational variables, and contextual variables usually supplement other sources of control. As we will show later, convergent multiple control accounts for many familiar features of verbal behavior.

Divergent Multiple Control

In divergent multiple control, a single variable controls a variety of responses. For example, if one encounters a small brown Chihuahua without a collar, a variety of vocal tacts, written tacts, signed tacts, as well as a number of nonverbal responses might be potentiated. One might say, *dog, brown, Chihuahua, small,* among many other things, including the metonymic response, *collar*. Presumably only a subset of possible responses would be potentiated in any individual. The overlap between people is not always perfect, and our

written repertoire is different from our spoken repertoire, but in general one stimulus as a tact variable can control many different tacts. In this example, all of the control is thematic.

Likewise, the auditory verbal stimulus *dog* or the textual stimulus *dog* might exert divergent multiple control on echoic, intraverbal, and stenographic responses, in addition to nonverbal responses. In various circumstances, one might echo the word, read the word, write the word, or say *cat*, *bone*, or *Chihuahua*, among many other responses. In these cases the control would be both formal and thematic. An unconditioned motivating operation, such as water deprivation, would alter the probability of a variety of mands, such as *water, drink,* or *thirsty,* either as vocal responses, written responses, or signs, in addition to nonverbal responses such as searching for water, drinking water, or imagining water.

As many of the responses in divergent multiple control are mutually incompatible, one must assume that, at any moment, all of them are at least somewhat potentiated by the relevant stimulus, with the determination of the emitted response the result of other (convergent) variables. That is, when we see a dog, we cannot simultaneously say, *dog, King, brown, Chihuahua,* etc., and on many occasions we say nothing at all when we encounter a dog or any other salient stimulus. However, we can assume that most people have histories of reinforced responding under the control of dogs, and it is this assumed history that drives the conclusion that there is some increase in response probability across all relevant discriminated responses when a single discriminative stimulus is presented. All behavior within a response system can be thought of as in competition with other behavior in that response system. Thus, many verbal responses may be relatively strong at a particular moment, but only one can be emitted at a time. Presumably one response, the "prepotent" response, is stronger because of its conditioning history, or perhaps because of the confluence of other evocative variables at the moment.

The Summation of Stimulus Control in Verbal Behavior

An important feature of stimulus control is that it is additive. That is, the strength of a response of a particular topography is the integration of the effects of all concurrent variables, be they mutually supporting or antagonistic.

> [It is likely that] any sample of verbal behavior will be a function of many variables operating at the same time. Any response under the control of one variable has a fair chance of being related to other variables also present. Now, it is a well-established principle in nonverbal behavior that separate sources of strength are additive. (Since some variables *reduce* the strength of verbal behavior, the addition must be algebraic.) (Skinner, 1957, p. 228; cf. Skinner, 1938, pp. 30-31.)

The integration of multiple sources of control occurs even in the simplest verbal exchanges. For example, suppose an adult picks up a small, green, rubber ball and says to a child, "What color is this?" Two subsets of verbal responses that one can assume to be strengthened in this context are shown in Figure 3. The auditory verbal stimulus "color" potentiates a variety of intraverbal responses, such as *blue, yellow, red,* and *green,* while the visual nonverbal stimulus

(the ball) potentiates a variety of tacts, such as *ball, small, round,* and *green.* The response *green* is under joint control of both variables and is strengthened accordingly. That it is actually emitted arises from motivational variables and audience control as well.

Insert Figure 3 about here

Impure Tacts

Skinner observed that it is commonly the case that responses that appear to be tacts are often actually under multiple control; in some cases the supplementary sources of control favor responses that do not strictly conform to conventions of the verbal community. Suppose you want to persuade someone on the phone to pay you a visit, but it is raining, and your friend doesn't like to drive in the rain. *Rain* is perhaps the strongest tact under control of the weather, but related tacts will be weakly evoked, such as *downpour, light drizzle,* and a variety of other responses to rain. However, the motivational variable of a potential visit from your friend exerts an opposing, or abative, effect on *rain,* and *downpour.* Under such conditions, the response *light drizzle* might be evoked by a query about the weather. Skinner identifies this as an example of algebraic summation to emphasize that although some variables will have supplementary effects, others will have abative effects.

We call an impure tact a *euphemism* when a weak member of a response class occurs because stronger members have a punishment history in that context. For example, suppose someone dies, and his friend must call the man's wife from the hospital to give her the news. The man's death is a circumstance that controls a variety of responses (divergent control) such as *kicked the bucket, bought the farm, is pushing daisies, died, passed away, went to the other side,* and so on. However, all bits of bad news have a generalized history of punishment, and some of these particular responses are commonly regarded as rude or callous and would be especially tasteless in the context of a bereaved spouse. The man's wife, then, can be considered a discriminative stimulus for punishment for all responses about his death (divergent control), but the algebraic summation of the various effects (convergent control) evokes the most delicate form of the response, perhaps, *Frank passed away at 2:00 AM.*

Audience control

Frank's wife exerted control over just a few of his friend's responses, but different audiences can differentially evoke whole sub-repertoires of responses. The polyglot who speaks a different tongue in many different countries is an extreme example, but most people have somewhat separate repertoires for friends, lovers, parents, and policemen. A nurse, for example, will describe a mark as a *bruise* to the patient but as a *contusion* to the doctor. As illustrated in Figure 4, each potential response entails both divergent and convergent thematic control.

Insert Figure 4 about here

Effects of Multiple Control on the Listener and Reader

So far we have considered the role of multiple control in the behavior of the speaker. To summarize, if two or more concurrent variables each exerts divergent control over a variety of verbal responses, any overlapping responses will be affected, positively or negatively, by all of the variables. All other things being equal, a response under joint or multiple control is likely to be stronger or weaker than competing responses. The effects of multiple control on the listener or reader typically play a role in our enjoyment of esthetic or humorous aspects of verbal behavior.

Our analysis of the effects of multiple control on the listener will entail identifying 1) a critical multiply controlled response, 2) a "carrier" source, 3) a main thematic source, and 4) one or more secondary sources. We will explain these in the context of several examples, beginning with the spoken or written pun.

Consider the following example: *The instructor in a biology class says, "Today we will dissect a fetal pig. Some of you may be apprehensive, but go ahead and take a stab at it."* (1) The critical response is that part of the verbal response that will be analyzed in terms of multiple controlling variables, in this case, *take a stab at it.* (2) The carrier source (on the analogy of the carrier frequency of a radio signal) is the physical source of the listener's, or reader's, response. In this case, the pun is in written form, so the carrier source is a textual stimulus, and the reader makes textual responses out loud or covertly. But just as we can read text in many unfamiliar languages, as well as incomprehensible jargon in our own tongue, the mere emission of a textual response does not ensure that our behavior will change relative to the variables that controlled the behavior of the speaker or writer. It simply "gets the behavior out" so that these other variables can exert their effects, if any. (3) The main thematic source is the variable that evokes the critical response in the speaker or writer because of its relevance to the practical effect that such responses have had in the past on a listener's or reader's behavior. If this variable is missing or different, the practical effect of the verbal stimuli will be absent or different. In the present case, the main thematic source is the set of variables that also strengthen *give it a try,* or *try to do the dissection;* that is to say, it is a context in which the consequences of failure are benign and the potential rewards substantial. Because of the listener's history with the expression, it evokes a set of discriminative responses appropriate to that context and we say that the listener "understands" what has been said. A measure of that effect might be an increased tendency to engage in the dissection. (4) Secondary sources are variables that also strengthen the critical response, or some portion of it, but which do not contribute to the practical effects of the response on the listener. They may be diverting or amusing, but they do not alter the practical value of the response. In the present case, the intraverbal relation between *dissect* and *stab,* and the relation between wielding a scalpel and stabbing, are the secondary sources of strength that make the example a pun. To the extent that the verbal response evokes discriminative responses in the listener relative to these secondary sources of control, the listener can be said to "get" the pun. Any tendency on the part of the listener to wield the scalpel like a knife and jab the fetal pig or to engage in any related verbal responses or conditioned perceptual responses would be examples.

The humor of an utterance is typically determined by competing response tendencies evoked by the main and secondary sources of control and perhaps also by differences in latencies of the competing responses. Inevitably this will vary somewhat from person to person according to the idiosyncrasies of individual histories. The humor of an expression will also vary according to how natural the secondary source of control is in the context. We regard a pun as "bad" if the secondary source of control has been introduced by the speaker simply in order to make a pun. Someone who utters the tired cliché, *Make like a tree and leave,* is likely to meet with stony silence, or worse, for the secondary source of control (*tree*) has no strength at all in the context and has been introduced by the speaker solely in the hope of getting a laugh. In contrast, in a "good" pun, the secondary source of control is strong in the context but does not exert discriminative control over the behavior of the listener until the pun is uttered. Ben Jonson is said to have offered to make a pun on any subject. When someone suggested the King, Jonson replied, *The King is not a subject.* This is so surprising and apt a riposte that one is inclined to doubt the accuracy of the anecdote.[1]

In a pun, the discriminative responses to the primary and secondary sources of control compete with one another, but many literary effects depend upon the supplementary or complementary effects of multiple sources of control. In rhyming metrical poetry, for example, responses are always under both formal and thematic sources of control. Indeed, poetry is the art of using formal and thematic control to bring to strength responses that would otherwise be quite weak. Consider Shakespeare's ode to the delay of reinforcement gradient in *Twelfth Night*:

> What is love? 'Tis not hereafter;
> Present mirth hath present laughter;
> What's to come is still unsure:
> In delay there lies no plenty,—
> Then come kiss me Sweet-and-twenty,
> Youth's a stuff will not endure.
> (II, 3: 45-50)

It is safe to say that the address *Sweet-and-twenty* would ordinarily be weak in anyone's repertoire, but here it is brought to strength by the carrier source (the textual stimulus), and is strengthened further by the formal contributions of the way it scans and rhymes, and by the themes of love, youth, impulsivity, and whimsy. In the end, we are charmed that such an unlikely phrase should seem so apt.

As a final complex example of multiple control in literature, we will consider another passage analyzed by Skinner (1957, pp. 239-240). In Shakespeare's play, *Cymbeline*, the elegy for the slain Cloten includes the following couplet

> Golden lads and girls all must
> As chimney-sweepers, come to dust.
> (IV, 2: 262-263)

Come to dust is a figure of speech partly under control of the formal contributions of both meter and rhyme. Some intraverbal strength arises from the term *gold dust*, and the phrase is further strengthened by the thematic control of the inevitability of death, with biblical, liturgical, and colloquial antecedents (*dust to dust*). It gets some strength by its antithesis to *golden lads and girls*; indeed that antithesis is the very point of the couplet, giving it power and poignancy. But it is given a further boost, and a conspicuous one, by the antecedent reference to chimney-sweepers, commonly poor children who worked amidst clouds of dust and, notoriously, died young. But what accounts, in turn, for the strength of *chimney-sweepers* in the passage? Skinner dismissed the reference as contrived:

> The chimney-sweeper in the quotation from *Cymbeline* is dragged in to give *come to dust* a second source of strength." (Skinner, 1957, p. 240)
>
> "*Come to dust* has obviously strengthened *chimney-sweepers*, for which there is no other relevant variable, instead of the other way around as a good pun requires." (Skinner,1948, p. 86)

But here Skinner erred. For Shakespeare's contemporaries there was a conspicuous secondary source of control: In 16th-century England *golden lad* was a colloquial term for a dandelion, and *chimney-sweeper* for a dandelion gone to seed (Ackroyd, 2005). So rather than being a jumble of incongruous images, the couplet is extraordinarily elegant, with multiple formal and thematic sources of control interwoven among all of the terms.[2]

We have shown that the skillful writer and the clever speaker can manipulate multiple sources of control to bring about a subtle interplay of variables in the reader and listener respectively, and this interplay is relevant to both humor and esthetics. But contingencies differ for speaker and listener, and the multiple sources of control for the one may not be the same as those for the other. Multiple control in the behavior of the speaker is ubiquitous, but most secondary sources of control pass unnoticed by the listener, whose behavior often comes under control of the main thematic source of control only.

The Role of Multiple Control in Problem Solving and Recall

Multiple control plays a central role in complex behavior. As we have had occasion to discuss this role elsewhere (e.g., Donahoe & Palmer, 2004; Michael, 2004; Palmer, 1991; Sundberg, 2007), we will allude to it only briefly here. In both problem solving and recall (which can be viewed as a special case of problem solving) people learn to manipulate controlling variables to successively strengthen a target response. If the target response is directly evoked by the statement of the question—*What is 6 times 8?* or *What is your Social Security number?*—then there is no problem to be solved, and there is no need to speak of recall; the target response is simply a discriminated operant under control of the question. We speak of problem solving and recall when the strength of the target response must be supplemented by additional sources of control.

For example, if asked for the next largest prime number after 23, many educated adults will pause for a bit and then respond, *29.* Typically such a response is not a simple discriminated operant under control of the question but is under multiple control of the question as well as the stimulus properties of a host of other verbal responses, usually covert, including perhaps the following:

larger than 23
24—even
25—divisible by 5
26—even
27—divisible by 3
28—even
29
divisible by 2?—no;
3?—no
5?—no
7?—no
The square root of 29 is 5-something
It's prime

Among this list of multiple controlling variables is the response *29,* emitted as an elementary intraverbal response to *26...27...28...* Notice that, although it has the same topography as the target response, it is not the "same" response. The latter is a response under a unique confluence of multiple variables exemplifying both intraverbal and self-echoic control.

Something of this sort occurs when we are asked questions about the past. We "close in" on the answer by providing ourselves with supplementary stimulation that is often, though not inevitably, cumulatively sufficient to evoke the target response. Despite the ease with which we recall some events, both recall and other problem solving behavior are apparently acquired skills, for the systematic manipulation of variables to exploit multiple control must be context-specific. A strategy for recalling a name would not necessarily be appropriate for recalling the date of an appointment, much less for finding one's keys or determining the next prime number in a series. Consequently, we should expect considerable individual differences among people in the skill with which they manipulate supplementary variables. These differences are taken for granted for mathematical problem solving, hypothesis testing, and the solving of puzzles, but our analysis suggests that we should find them in all the relevant domains. If we seem to recall some events effortlessly, without marshalling supplementary stimuli, perhaps we do so because our practice with such tasks is so extensive that the component responses have become so fluent as to escape notice.

Multiple Control, Joint Control, and Conditional Discrimination

Multiple control and joint control. Joint control is the control of a response of a particular topography by two concurrent variables and is therefore a special case of

multiple control. Lowenkron (1991, 1998) has shown that the onset of joint control may be an important controlling variable in delayed and symbolic matching to sample, among other tasks. For example, if one were given a page ripped out of a phone book and asked to find the person whose phone number is 367-2123, one would scan down the page while periodically rehearsing the target number. When one reached the matching number, the convergence of textual and echoic control over the verbal response, i.e., the onset of joint control, would be a discriminable event that would control a selection response. Lowenkron found that children who were deficient in either tact or echoic control, or who did not emit the relevant tact or self-echoics, could not do analogous tasks until both sources of control were established and the responses actually emitted. To the extent that such findings are general, joint control is an important interpretive tool, for identity matching is potentially an element of many kinds of complex behavior, including the acquisition of verbal behavior, imitation, countless types of problem solving, searching behavior, and recognition.

Our claim that multiple control is virtually ubiquitous raises the question of how joint control, as a special case, could be so discriminable to a subject that it could serve as a controlling variable for a selection response in a matching task. The answer is that the importance of joint control is conditional on context. Matching tasks, in all their various forms, require systematic scanning or sequential evaluation that is terminated by a selection response. Correct selection responses are correlated with the onset of joint control. Moreover, the selection response occurs in a context in which it is scheduled for reinforcement. The invariant feature of all matching tasks appears to be the saltation in response strength that occurs when two variables converge on a common response under these distinctive motivating conditions, and this saltation eventually becomes the controlling variable for selection responses. The myriad other instances of joint control serve discriminative functions only sporadically and unsystematically and therefore might play no characteristic role in human behavior.

Multiple control and conditional discrimination. In conditional discrimination, the effect of a discriminative stimulus depends on the status of other stimuli. For example, when a traffic light turns green, one steps on the gas pedal, but only if the car in front of one has begun to move. As conditional discrimination entails a relationship between two or more stimuli, it too is an example of multiple control. Conditional discrimination requires a history of differential reinforcement, either reinforcement and extinction or reinforcement and punishment, in order to restrict responding to the conjunction of the relevant stimuli. When all of the stimulus elements of a conditional discrimination are highly correlated with one another, each stimulus element by itself is likely to be ineffective, owing to this history of discrimination training. (The shape, color, and texture of a ripe blueberry signal that picking and eating the berry will be reinforced, but only when they occur together.) In such cases, the evoking of a target response by a compound stimulus does not arise primarily from the summation of the effects of the separate elements but is determined by a specific history with the compound stimulus. That is, unlike some of the other examples of multiple control we have considered, the response of picking ripe blueberries can be considered an operant. It is an operant under control of a particular set of correlated stimuli, arising from a history

of discrimination training, and interpreting it as an example of multiple control adds little to our understanding of the behavior. In contrast, in many instances of multiple control, the constellation of controlling variables has come together for the first time: The strength of the resulting behavior emerges from the summation or integration of the effects of the component stimuli, and one cannot estimate this response strength without considering the evocative control of each stimulus element in isolation. Moreover, just as a rat's first lever-press, before the delivery of reinforcement, is not an operant, the first instance of a response under multiple control is not an operant. Thus conditional discrimination requires multiple exposures to a set of correlated stimulus elements; most other examples of multiple control do not.

Applications and Research on Complex Verbal Relations

Early in *Verbal Behavior* (1957), Skinner states that his interpretive analysis of language "is inherently practical and suggests immediate technological applications at almost every step" (p. 12). His treatment of multiple control is no exception, and in fact suggests both applications and potential lines of important research on complex verbal behavior. Many elements of Skinner's analysis of multiple control have already been applied to language assessment and intervention programs for children with autism or other types of developmental disabilities, but much work remains. Multiple control is pervasive in social behavior, perception, creativity, problem solving, memory, literature, poetry, thinking, the emergence of novel behavior, and generative language, but research on its role in these areas is just beginning. Several applications and lines of research on multiple control and language acquisition and use will be presented below.

Multiple control is the foundation of many of the successful teaching procedures and experimental preparations used with a variety of populations. For example, convergent control can help to evoke and establish a response otherwise not at strength in a given repertoire. Since separate sources of strength are additive, target behaviors can be evoked and established by adding sources of control (prompts) to the target antecedent and then fading those additional sources of control (e.g., Terrace, 1963; Touchette, 1971). Formal prompts, such as echoic or imitative prompts, have long been a staple part of language intervention programs for those with language delays (e.g., Guess, Sailor, & Baer, 1976; Lovaas, 1977; Wolf, Risley, & Mees, 1964). Thematic prompts such as adding verbal (intraverbal), nonverbal (tact), or motivating operations (mands) to target sources of control can also be used to establish new verbal operants (e.g., Carroll & Hesse, 1987; Greer & Ross, 2008; Sundberg, Endicott, & Eigenheer, 2002). The behavioral literature contains studies of a wide variety of skills (e.g., peer interactions, personal and workplace safety, self-care skills) that have been successfully established using convergent multiple control procedures.

Many aspects of teaching children with autism more advanced language and social skills require the establishment of convergent multiple control. For example, in order for a child to correctly answer a question such as "How does that work?" both verbal and nonverbal (whatever "that" is) antecedents must share evocative control. The

antecedents in this case involve a conditional discrimination where the verbal stimulus, among other effects, alters the evocative effects of a particular aspect of a nonverbal stimulus. Thus the resulting response would be partly under tact control, partly under intraverbal control. One verbal stimulus can also alter the evocative effect of another verbal stimulus in an intraverbal exchange. For example, a correct response to the question, *When are you off for Spring break?* contains several verbal stimuli where one word alters the evocative effect of another. Convergent multiple control in the form of a verbal conditional discrimination is necessary for a correct response. If the configuration is altered with different verbal stimuli such as, *Where are you going for Spring break?* a different response should be evoked. Virtually all advanced intraverbal interactions involve verbal conditional discriminations, which can make teaching these skills quite difficult. The failure to appreciate the necessity for multiple control often results in the common problem of rote verbal responding observed for many children with autism (Sundberg & Sundberg, under review).

Establishing divergent multiple control is also an essential component of a language intervention program for a child with autism. Commonly a single stimulus configuration should evoke a variety of different responses. For example, when asked, *Can you name some animals?* it is important that a child be able to verbally provide the name of a variety of animals. If the child provides the name of the same two animals every time the question is asked, it demonstrates rote responding and the absence of divergent multiple control. Much of the social interaction between people also involves both convergent and divergent multiple control which again is what makes establishing these skills for children with autism difficult. For example, initiating a verbal interaction with someone may be multiply controlled by nonverbal stimuli in the form of a potential listener's body posture, other audience variables, current MOs affecting a speaker, nonverbal contextual stimuli, emotional private events, verbal stimuli emitted the other person, and so on. Not only is this a complicated (but typical) antecedent configuration, but if the child emits the same response topography each time, future verbal interactions are less likely.

A common charge against a behavioral position is its inability to account for novel responses and generative behavior (Alessi, 1987). However, Skinner sets the stage for the analysis of more complex behavior and emergent relations early in the book:

> Once a repertoire of verbal behavior has been set up, a host of new problems arise from the interaction of its parts. Verbal behavior is usually the effect of *multiple causes.* Separate variables combine to extend their functional control, and new forms of behavior emerge from the recombination of old fragments. All of this has appropriate effects upon the listener, whose behavior then calls for analysis…a speaker is normally also a listener. He reacts to his own behavior in several important ways. Part of what he says is under the control of other parts of his verbal behavior. We refer to this interaction when we say that the speaker qualifies, orders, or elaborates his behavior at the moment it is produced.

> The mere emission of responses is an incomplete characterization when behavior is *composed.* (p. 11)

Skinner's (1957) chapters on multiple control (chapters 9-11) along with his chapters on the autoclitic behavior (chapters 12-14) provide an extensive analysis of how behaviors emerge without being directly taught (see also Alessi, 1987). Convergent and divergent multiple control are at the heart of his analysis, and Skinner devotes all of Chapter 11 to analyzing how novel behaviors emerge through fragmentary recombinations of previously reinforced responses. Specifically, convergent control by multiple variables determines responding to novel configurations of stimuli and motivational variables when they share some, but not all of the features of an original source of control (i.e., fragmentary recombination). For example, if a child is learning about personal safety and an adult says *Show me what you do when a stranger asks you to get in his car*, it is important that the target responses also be evoked by novel antecedent configurations of stimuli that might share fragments of the original antecedent conditions. The verbal stimulus *What if a stranger offers you money for a video game?* should evoke similar verbal and nonverbal responses as the original verbal stimulus, as should several other novel configurations involving different motivators (e.g., a current strong MO for playing video games), different nonverbal stimuli (e.g., settings, people), different verbal carrier phrases, and so on. This is especially important in training since there is a high probability that the actual antecedent configuration that a child might encounter may contain any combination of novel variables along with the primary source of control (i.e. a threat to personal safety).

Divergent multiple control is also an important element for establishing generative safety repertoires since it will be important that a single stimulus configuration evoke a number of different safety response (e.g., saying *no*, screaming, running away, telling an adult). However, as previously mentioned, should an actual threat to a child's safety occur, there will certainly be additional sources of control present. For example, it is highly likely that a threatening situation elicits respondent behaviors, establishes new reflexive MOs, and evokes a multitude of additional private events such as covert verbal behavior that will enter into the antecedent configuration (e.g., self-mands to stay calm, tacts of the heart rate or situation, intraverbals regarding options, autoclitic mands and tacts, self-echoics). The teaching procedures identified as "multiple exemplar training" (e.g., Greer & Ross, 2008) and "general case" (Becker, 1987) are often effective in establishing these target generative repertoires. However, as Skinner (1957) points out, all of these multiple sources of control are relevant independent variables and still must be accounted for when explaining a particular behavior. He states that

> Neither the fact that a single response may be controlled by more than one variable nor the fact that one variable may control more than one response violates any principle of scientific method. It does not follow that a specific functional relation is not lawful, or that the behavior occurring in any given situation is not fully determined. It simply means that we must be sure to take into account *all* relevant variables in making a prediction or in controlling behavior. (p. 228)

Although he did not use the contemporary term, Skinner discussed the importance of multiple exemplar training in several sections in *Verbal Behavior* (Schlinger, 2010). Convergent and divergent multiple control along with autoclitic frames provide the conceptual foundation for this procedure. For example, in the following passage Skinner describes multiple exemplar training and convergent multiple control regarding the different conditions where the verbal stimulus "out of order" combines with a variety of other verbal and nonverbal stimuli to evoke behavior. He also describes divergent control where the same verbal stimulus "out of order" may evoke different responses. Skinner explains in the following passage how novel responses emerge when fragments of previously acquired relations are combined and occur for the first time in a relational autoclitic frame.

> A sign on a telephone reading *Out of Order* has a simple effect upon the reader: he does not use the phone. If he is told *The telephone is out of order* (say, when the telephone is not present), this pairing of the two verbal stimuli *telephone* and *out of order* with the autoclitic *is* has the same effect: he does not approach the telephone or engage in any behavior appropriate to using it….But when such a response is first effective, *out of order* must already have become an important verbal stimulus, possibly in such responses as *The radio is out of order* or *The car is out of order* **(multiple exemplars and convergent control).** The response *The telephone* must also have been effective in such combinations as *The telephone is ringing* or *The telephone is in use* **(multiple exemplars and convergent control)**. The verbal stimulus *The telephone is out of order,* heard in this form for the first time, brings behavior formerly controlled by the stimulus *out of order* under the control of the stimulus *telephone* and the nonverbal stimulus supplied by the telephone itself (**convergent control)**. As a result of having heard this response, the speaker not only does not use the telephone, he may warn a third party that it is out of order (**multiple exemplars and divergent control**). (Words in bold added) (p. 361)

Research on Complex Verbal Relations

Over the past several decades, research on complex verbal relations has flourished. It has led to separate research traditions and in some cases to new theoretical formulations. We will briefly discuss the possible role of multiple control in three of these research domains, stimulus equivalence, relational frame theory, and naming.

Stimulus equivalence and relational frame theory. Stimulus equivalence research and relational frame research both typically investigate the effect of multiple exemplar training on the emergence of untrained environment-behavior relations. Relational frame theory is the more general approach in that it extends its purview beyond equivalence to all types of verbal relations, such as opposition, relative magnitude, relative position, and so on. As equivalence is common to both domains, and is a paradigmatic example, we will confine our subsequent discussion to that relation, but we believe that our interpretation applies to other relationships as well.

Relational frame theory interprets responding under control of equivalence and other derived relations as generalized operant behavior arising from a history of multiple exemplar training with other examples of the stimulus relation. Thus long experience with the relative values of dimes, nickels, and quarters enables us to infer that if a pound is worth more than a crown and a crown more than a shilling, a pound must be worth more than a shilling, even if we have never been taught the relative value of pounds and shillings. Such inferences are commonplace, and the proponents of relational frame theory are quite right to emphasize the importance of relational behavior and verbal relations, for they are elements of most complex behavior. But for reasons we do not fully understand, their analysis of relational behavior as generalized operant behavior has led some leading relational frame theorists to conclude that Skinner's analysis of verbal behavior is not just incomplete, but fundamentally wrong. They suggest that "… it is now time for behavior analysts to abandon many of the specific theoretical formulations of its historical leader in the domain of complex human behavior … Many of the most prominent Skinnerian ideas about human complexity must be put aside or modified virtually beyond recognition (p. xii)." We do not agree that an understanding of such relations requires abandoning the theoretical formulations of Skinner. To the contrary, we believe that the concept of a generalized operant itself requires explanation and that such an explanation can be found in a more fine-grained analysis of the contingencies from which such generalized operants apparently emerge, an analysis fully compatible with Skinner's formulation. (See Hayes, Barnes-Holmes, & Roche, 2004, and Palmer, 2004b, for discussion of this point.)

The role of multiple exemplar training in establishing relational operant behavior is discussed in *Verbal Behavior* itself. Moore (2008) pointed out that "Skinner coined the phraseology of 'frames' and 'relational responding'" (p. 191), and Schlinger (2010) stated that, "Skinner set the stage for the concept of relational framing in the section of *VB* titled "Relational Autoclitcs" (p. 366). Schlinger and Moore each cited the following passage from *Verbal Behavior* in which Skinner accounted for the emergence of novel behavior as a function of autoclitic frames, multiple control, multiple exemplars, and the fragmentary recombination of established behavioral relations.

> Something less than full-fledged relational autoclitic behavior is involved when partially conditioned autoclitic "frames" combine with responses appropriate to a specific situation. Having responded to many pairs of objects with behavior such as *the hat and the shoe* and *the gun and the hat,* the speaker may make the response the *boy and the bicycle* on a novel occasion. If he has acquired a series of responses such as *the boy's gun, the boy's shoe,* and *the boy's hat,* we may suppose that the partial frame *the boy's* _____ is available for recombination with other responses. The first time the boy acquires a bicycle, the speaker can compose a new unit *the boy's bicycle.* This is not simply the emission of two responses separately acquired. The process resembles the multiple causation of Chapter 9. The relational aspects of the situation strengthen a frame, and specific features of the situation strengthen the responses fitted into it. (p. 336)

Convergent and divergent control is present in a standard equivalence preparation (e.g., Sidman, 1971). Convergent control occurs in the form of a conditional discrimination where an auditory stimulus (e.g., the word spoken word *car* and a nonverbal stimulus (a picture of a car) share control over the selection response. Divergent control occurs when the child is taught to select a picture of a car upon hearing the spoken word *car* and to touch the written word *CAR* upon hearing the same spoken word *car*. The emerging relation is observed when, without direct training, the nonverbal stimulus of the car evokes selection of the written word *CAR* and vice versa.

As the same auditory stimulus is present when reinforcement is presented in both initial training trials, the selection response in both conditions is in part evoked by the same auditory variable. During the test phase, when presented with a sample stimulus and four stimuli in a comparison array, the sample stimulus and only one stimulus in the comparison array share a common antecedent fragment in their conditioning history. The presentation of these two stimuli could evoke a common covert tact or textual response for a verbal organism (i.e., the spoken word *car*) that functions as a controlling variable for selection behavior. That is, the onset of joint control, as the subject scans the comparisons and responds differentially to them, could be a discriminable event that controls the selection response, for only the matching item would evoke the tact required to exemplify joint control (cf. Lowenkron, 1998). This interpretation may seem less plausible when the stimuli are hieroglyphs or other novel stimuli, but in order for the subject to correctly match pairs of such stimuli, he or she must respond differentially to them. (Some subjects emit metaphorical tacts, such as, *looks like a ladder*, or *the box with two arms*, but any reliable nonverbal responses could serve the same end.) The joint control of these differential responses is plausible regardless whether the stimuli are conventional or not.

As much of the research on equivalence is conducted with a match-to-sample experimental preparation and verbal organisms, the results are susceptible to the interpretation that covert verbal behavior and other private events contribute to the control of the selection response that exemplifies emergent behavior. This interpretation is less persuasive when the subjects are nonverbal humans or sea lions, but as we noted, the joint control account only requires a common discriminative response, verbal or not, and it appears that the training sessions, prior to testing, are sufficient to condition such responses. It is true that appeals to multiple or joint control are inferential, but they have an important advantage: They are easily accommodated by well established behavioral principles and require no revision of our conceptual machinery. Subsequent research may force such a revision, but we believe that at present, a joint control account is both simple and adequate. Moreover, it can potentially account for the great variability in proportion of correct responding that is characteristic of most studies of derived relational responding (Moore, 2009).

Naming. In contrast to relational frame theory, the account of naming relations offered by Horne & Lowe, (1996) has the virtue of acknowledging the fine-grained and complex web of interacting discriminative responses and corresponding stimulus products that is characteristic of certain fundamental verbal skills. When all those

elements are in place, learning of new terms and relationships can proceed more rapidly, with less supervision by the verbal community. Convergent and divergent sources of multiple control are part of this complex web. For example, convergent control is involved in an original naming experience where a child with an established listener and speaker repertoire might be exposed to an adult's tact of a novel nonverbal stimulus (e.g., *koala*). The antecedent variables include the verbal stimulus, nonverbal stimulus, motivational variables related to seeing new animals at the zoo, as well as contextual and audience variables. A verbal child may also emit echoic or self-echoic responses under this configuration of stimulus conditions. Later, the child as a listener hears an adult say *koala* and the child, without any specific training, discriminates (by looking or pointing) the koala from other animals that are present. Convergent control occurs again in the form of joint control (Lowenkron, 1991, 1996) when the echoic or self-echoic combine with the initial nonverbal stimulus and evoke a response. It's also possible that under the control of MOs that may have been present during the initial exposure and come to strength later, a child mands *koala* without direct training (Ribeiro, Elias, Goyos, & Miguel, 2010). Divergent control is also observed when under the control of the nonverbal stimulus of the koala the child may emit a number of different behaviors (e.g., pointing, tacting, manding if an MO is involved). Skinner described this effect as follows:

> We pick up the names of objects without autoclitic help when we observe someone manipulating objects while also naming them. Thus we may "learn the name of" a Jones-plug by watching someone working with electrical apparatus while describing his own behavior as he does so (**convergent control**). The same correlation of verbal and nonverbal events plus an autoclitic occurs in the ostensive definition *This is a Jones-plug.* The effect upon the listener is not only to establish *Jones-plug* as an appropriate tact but to set up nonverbal behavior in response to similar stimuli **(divergent control),** for example, behaving correctly when asked *Please hand me a Jones-plug.* (1957, p. 360) (Words in bold added)

We suggest that a consideration of multiple and joint control may flesh out Horne and Lowe's account more fully. Lowenkron (1996), while acknowledging Horne and Lowe's account of the necessary elements of naming, suggested that "joint control is a fundamental process of the naming relation" (p. 255). Michael (1996) also suggested that convergent and divergent multiple control were responsible for the emergence of untrained relations in the naming preparations:

> Without appealing to naming as a higher order relation, one could propose that when a child with an extensive echoic repertoire is taught to locate a new object, she may well make an echoic response when she hears the caregiver say "X," and because she will be looking at the object at the moment when the correct locating behavior is reinforced, that reinforcement may also bring the echoic response form under the control of the nonverbal stimulus of the object, the tact relation … To explain the appearance of the locating type of listener behavior as a result of tact training without a higher order naming concept it is only necessary to appeal to the more sophisticated locating repertoire that develops as the area to be

> visually searched becomes larger and more complex. Under such circumstances one would expect the occurrences of echoic and self-echoic behavior because it permits continued exposure to the critical verbal stimulus (X) during the delay resulting from a prolonged search. Any object that evokes the same response that is being made self-echoically is then the correct object at which to point. (This is the process described by Lowenkron, 1991, 1992 as *joint control*.) (p. 298)

Michael concluded his remarks with a caution about introducing terms that stand for a complex web of events:

> Until the function of the separate repertoires is understood in each instance of verbal behavior, any reference to naming is incomplete, and once they are understood it is not clear what is added by reference to naming. There may be a negative contribution, however, in that an unanalyzed naming concept may seem to render unnecessary the more detailed analysis much as happens with some uses of *rule-governed behavior* and *equivalence*. (1996, p. 298)

Apart from the question whether a new term is necessary, Horne and Lowe's account of naming is appropriately fine-grained and captures much of the complexity of early verbal learning. We suggest that the present account is not incompatible with it and indeed develops it more fully.

Conclusion

The student who, fresh from reading *Verbal Behavior*, puzzles over the classification of snatches of speech or writing can take heart in knowing that pure examples of the elementary verbal operant are rare outside the laboratory or therapeutic setting. The purpose of Skinner's analysis was not to provide a classificatory scheme into which examples of verbal behavior can be assigned but to identify the controlling variables that are responsible for them. The elementary verbal operants exemplify each type of control, but verbal behavior is typically determined by many variables operating concurrently, with effects sometimes supplementing and sometimes competing with one another (cf. Palmer, 2009). The potential complexity of controlling relationships provides Skinner's system with enormous power and scope, but it also challenges our ability to interpret examples in uncontrolled settings in any but the most tentative way. We have suggested that the discrimination of the onset of multiple control may underlie performance in research on complex verbal relations; if so, the account is parsimonious and forestalls the need to posit new theoretical formulations.

But multiple control is more than an interpretive tool. As we have shown, it is an element of almost all verbal behavior in natural environments and therefore must be accommodated by our therapeutic interventions and other applications. An analysis of the role of multiple control will inevitably sharpen and improve such applications. Moreover, the skillful use of multiple control marks the effective writer and orator. In addition, most people learn to manipulate multiple controlling variables in a strategic way to potentiate latent behavior in their own repertoire as in problem solving, recall, and

doubtless in other types of complex behavior, including any kind of matching behavior. Thus multiple control is central to human behavior, so much so that one can speculate that quantitative differences in sensitivity to many concurrent variables might underlie both species differences and individual differences among within our own species. How much of what we call "intelligence" can be more concretely explained as a sensitivity to concurrent variables or as a skill in manipulating them for strategic purposes? How large a role do deficiencies in such sensitivity or skills play in the child suffering from autism or other disabilities? Skinner's concept of multiple control seems to lie at the heart of the most perplexing questions about human behavior and of our attempts to answer them.

References

Ackroyd, P. (2005). *Shakespeare: The biography.* London: Chatto & Windus.

Alessi, G. (1987). Generative strategies and teaching for generalization. *The Analysis of Verbal Behavior, 5,* 15-27.

Becker, W. (1986). Applied psychology for teachers: A cognitive behavioral approach. Chicago: Science Research Associates.

Chomsky, N. (1959). Review of *Verbal behavior* by B. F. Skinner. *Language*, *35*, 26-58.

Donahoe, J. W., & Palmer, D. C. (2004). *Learning and complex behavior*. Richmond, MA: Ledgetop Publishing (Originally published in 1994).

Greer, R. D., & Ross, D. E. (2007). *Verbal behavior analysis*. Boston: Allyn and Bacon.

Guess, D., Sailor, W. S., & Baer, D. M. (1976). *A functional speech and language program for the severely retarded.* Lawrence, KS: H & H Enterprises.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory: A post-Skinnerian account of human language and cognition*. New York: Kluwer Academic/Plenum.

Hayes, S. C. & Barnes-Holmes, D. (2004). Relational operants: Processes and implications; A response to Palmer's review of *Relational frame theory*. *Journal of the Experimental Analysis of Behavior, 82*, 213-224.

Horne P. J. & Lowe, C. F. (1996). Naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 185-241.

Johnson, S. (1755). *A dictionary of the English language*. London: W. Strahan.

Lovaas, O. I. (1977). *The autistic child: Language development through behavior modification.* New York: Irvington.

Lowenkron, B. (1991). Joint control and the generalization of selection-based verbal behavior. *The Analysis of Verbal Behavior, 9,* 121-126.

Lowenkron, B. (1996). Joint control and word-object bidirectionality. *Journal of the Experimental Analysis of Behavior, 65*, 252-255.

Lowenkron, B. (1998). Some logical functions of joint control. *Journal of the Experimental Analysis of Behavior, 69*, 327-354.

Lowenkron, B., & Colvin, V. (1992). Joint control and generalized non-identity matching: Saying when something is *Not*. *The Analysis of Verbal Behavior, 10,* 1-10.

MacCorquodale, K. (1970). On Chomsky's review of Skinner's *Verbal behavior. Journal of the Experimental Analysis of Behavior, 13,* 83-99.

Michael, J. (1996). Separate repertoires or naming? *Journal of the Experimental Analysis of Behavior, 65*, 296-298.

Michael, J. (2004). *Concepts and principles of behavior analysis (2nd ed.).* Kalamazoo, MI: Association for Behavior Analysis International.

Moore, J. (2008). *Conceptual foundations of radical behaviorism.* Cornwell-on-Hudson, NY: Sloan Publishing

Moore, J. (2009). Some thoughts on the nature and causes of derived relational responding. *The European Journal of Behavior Analysis, 10,* XX-XX.

Palmer, D. C. (1991). A behavioral interpretation of memory. In L. J. Hayes & P. N. Chase (Eds.), *Dialogues on verbal behavior* (pp. 261-279). Reno, NV: Context Press.

Palmer, D. C. (2004a). Data in search of a principle: A review of S. C. Hayes, D. Barnes-Holmes, and B. Roche (Eds.), *Relational frame theory: A post-Skinnerian account of human language and cognition. Journal of the Experimental Analysis of Behavior, 81,* 189-204.

Palmer, D. C. (2004b). Generic response classes and relational frame theory: A reply to Hayes and Barnes-Holmes. *Journal of the Experimental Analysis of Behavior, 82*, 225-234.

Palmer, D. C. (2009). Response strength and the concept of the repertoire. *European Journal of Behavior Analysis, 10,* 49-60.

Ribeiro, D. M., Elias, N. C., Goyos, C., & Miguel, C. F. (2010). The effects of listener training on the emergence of tact and mand signs by individuals with intellectual disabilities. *The Analysis of Verbal Behavior, 26,* 65-72.

Schlinger, H. D. Jr. (2010). The impact of Skinner's *Verbal behavior:* A response to Dymond and Alonso-Alvarez. *The Psychological Record, 60,* 361-368.

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research, 14,* 5-13.

Skinner, B. F. (1938). *The behavior of organisms*. NY: Appleton-Century-Crofts.

Skinner, B. F. (1948). *The William James lectures.* www.lcb-online.org/html/11_verbal_behavior.html

Skinner, B. F. (1957). *Verbal behavior.* New York: Appleton-Century-Crofts.

Sundberg, M. L. (2007). Verbal behavior. In J. O. Cooper, T. E. Heron, & W. L. Heward (Eds.), *Applied behavior analysis* (2nd ed.) (pp. 526-547). Upper Saddle River, NJ: Merrill/Prentice Hall.

Sundberg, M. L. (2008). *The verbal behavior milestones assessment and placement program: The VB-MAPP*. Concord, CA: AVB Press.

Sundberg, M. L., Endicott, K., & Eigenheer, P. (2000). Using intraverbal prompts to establish tacts for children with autism. *The Analysis of Verbal Behavior, 17*, 89-104.

Sundberg, M. L., & Sundberg, C. A. (Under review). Intraverbal behavior and verbal conditional discriminations in typically developing children and children with autism. *The Analysis of Verbal Behavior.*

Terrace, H. (1963). Discrimination learning with and without "errors." *Journal of the Experimental Analysis of Behavior,* 6, 1-27.

Touchette, P. E. (1971). Transfer of stimulus control: Measuring the moment of transfer. *Journal of the Experimental Analysis of Behavior, 15*, 347-354.

Wolf, M. M., Risley T. R., & Mees H. (1964). Applications of operant conditioning procedures to the behavior problems of an autistic child. *Behavior Research and Therapy, 1,* 305-312.

Authors' Note

Portions of this paper, including the new terms that are introduced here, were presented by the first author as an Invited Tutorial at the annual meeting of the Association for Behavior Analysis International in 2003. Correspondence about this article may be addressed to any of the authors: jack.michael@wmich.edu, dcpalmer@smith.edu, marksundberg@astound.net.

Footnotes

[1]Skinner attributes this pun to Samuel Johnson, others to a courtier of Louis XV. The origin has been lost in the retelling, but it appears to antedate the lexicographer. Boswell, who cherished Johnson's witticisms, does not mention it. We have been unable to find an authoritative source.

[2]Various editors of Shakespeare's works have suggested yet another secondary source of strength, namely, that *golden lads and girls* should be read as *children of wealth*, and *chimney-sweepers* as *children of poverty*, and not strictly as those who sweep chimneys. Although this interpretation might strike the casual reader as obscure, it was the one adopted by Samuel Johnson (1755) in his dictionary entry for *chimney-sweeper*.

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

Figure 2. Convergent multiple control. On the analogy with nonverbal behavior, concurrent variables that each evokes a response of a particular topography will supplement one other.

Figure 3. The auditory verbal stimulus *color* and the nonverbal stimulus, a green ball, exert divergent control over a variety of mutually incompatible verbal responses, but the common response *green* is under convergent control and is likely to be particularly strong as a result.

Figure 4. Like most people, a nurse has different repertoires under the control of different audiences. A distinctive discoloration in the presence of a patient evokes the response *bruise.* In the presence of a doctor, the response *contusion* comes to strength.

Figure 1.

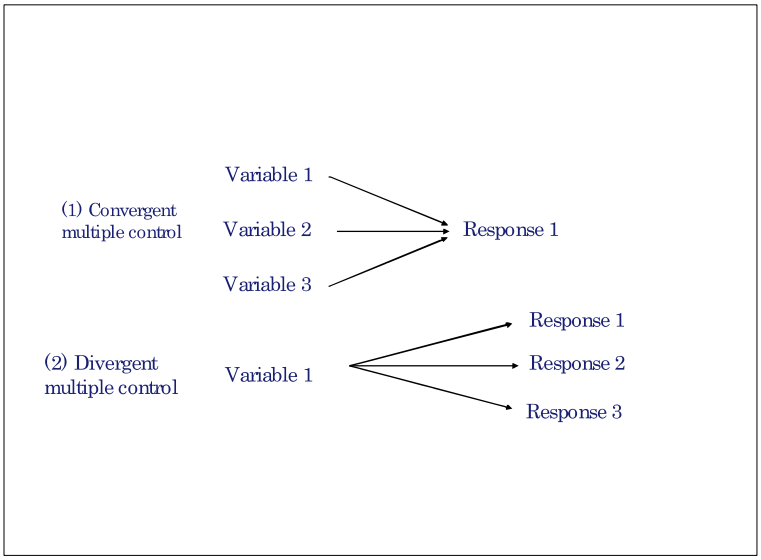

(1) Convergent multiple control
Variable 1
Variable 2
Variable 3
Response 1
(2) Divergent multiple control
Variable 1
Response 1
Response 2
Response 3

Figure 2.

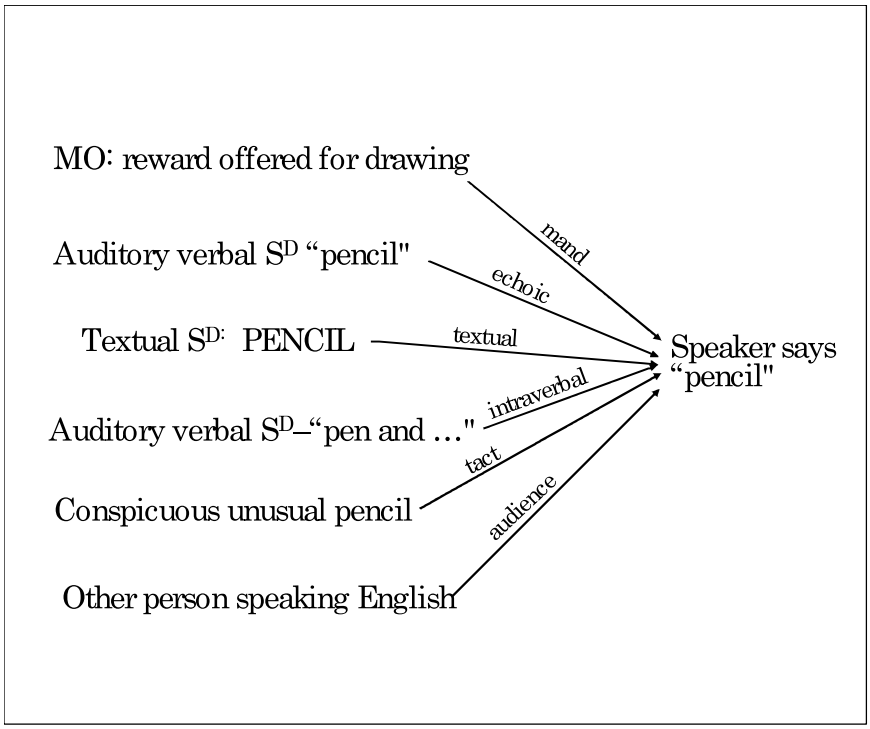

MO: reward offered for drawing
Auditory verbal SD "pencil"
Textual SD: PENCIL
Auditory verbal SD– "pen and …"
Conspicuous unusual pencil
Other person speaking English
mand
echoic
textual
intraverbal
tact
audience
Speaker says "pencil"

Figure 3.

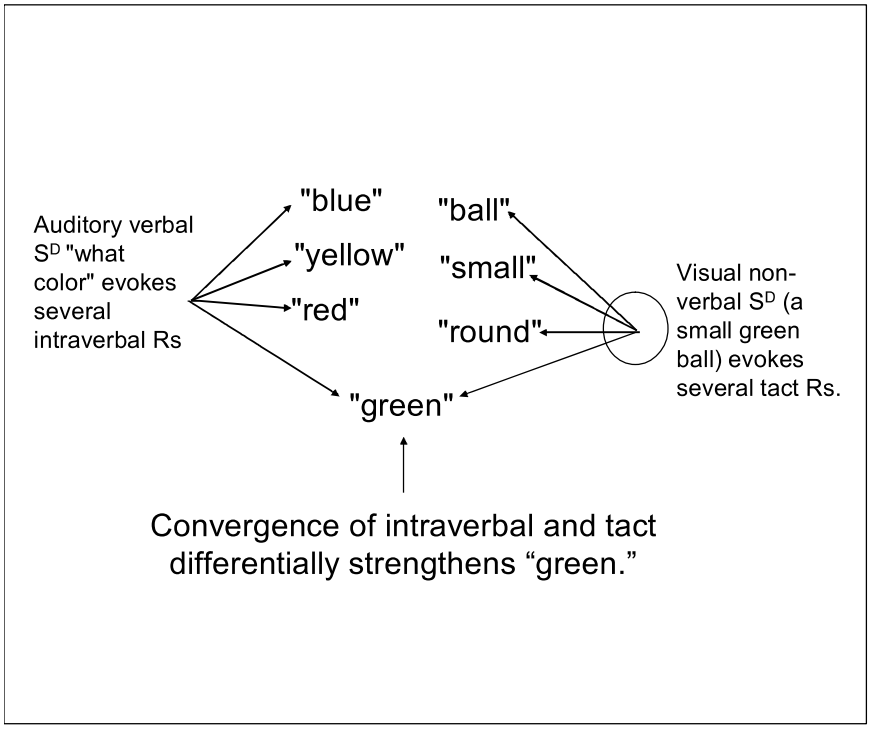
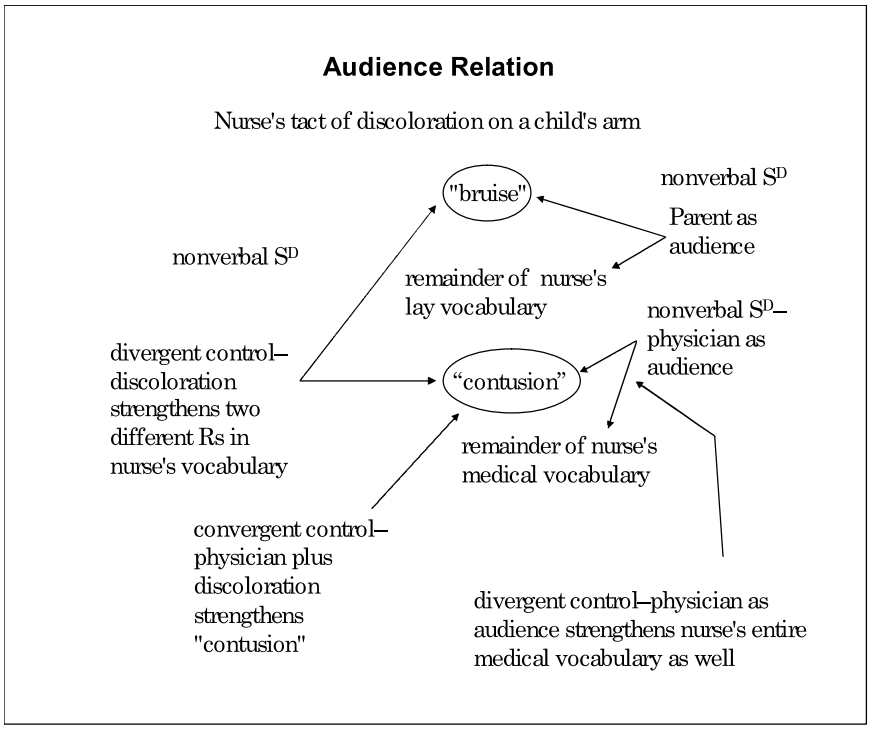

Auditory verbal SD "what color" evokes several intraverbal Rs
"blue"
"yellow"
"red"
"green"
"ball"
"small"
"round"
Visual non-verbal SD (a small green ball) evokes several tact Rs.
Convergence of intraverbal and tact differentially strengthens “green.”

Figure 4.


Audience Relation
Nurse's tact of discoloration on a child's arm
"bruise"
nonverbal SD
Parent as audience
nonverbal SD
remainder of nurse's lay vocabulary
nonverbal SD– physician as audience
divergent control– discoloration strengthens two different Rs in nurse's vocabulary
"contusion"
remainder of nurse's medical vocabulary
convergent control– physician plus discoloration strengthens "contusion"
divergent control–physician as audience strengthens nurse's entire medical vocabulary as well