An Introduction to Joint Control

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Lowenkron and colleagues (Lowenkron, 1984; 1991; 1998; 2006; Lowenkron and Colvin, 1992) describe a model that explains complex behavior using only well-established behavioral principles, concepts and terms. The model, called *joint control,* is especially useful for understanding complex and delayed discriminations within a purely behavioral framework and with no appeal to hypothetical concepts or structures. In it the listener is an active behaver rather than a processor of information. In fact, on this account the listener becomes a speaker. Several examples of the relevance of this approach to the explanation of complex behavior are provided, including cases of stimulus selection, conditional discrimination, and generalized identity matching.

Key words: joint control, selection-based autoclitic, self-echoic/tact relation, semantic function, word-object bidirectionality.

It has been observed periodically that behavior analysis lacks a coherent account of those language-related performances that are commonly ascribed to syntactic, semantic, and/or logical relations between words, between objects and words, and between objects (Horne and Lowe, 1996; Sidman, 1990). The goal of this special section is to contribute to such an account by exploring and illustrating the role a particular type of interaction between verbal operants, namely joint control, can play in the interpretation of many such performances.

The Importance of Joint Control

The interaction between verbal operants to be considered here is important for several reasons: First, as is evident from the variety of behaviors mentioned in this section, the interaction is *ubiquitous*. It occurs across a wide variety of different and seemingly unrelated performances. Thus, in Sidener and Michael (2006), joint control functions so as to mediate stimulus selection based on the relative spatial orientation of stimuli (clockwise from) while in Lowenkron (2006), joint control is shown to be instrumental in mediating the selection of complex objects based on their conformance to a spoken description of their features; a process colloquially described as the recognition of an object from its description. Tu (2006) extends the study of this kind of behavior by illustrating the role of joint control in the selection of stimuli from their names.

The second reason the interaction under study is important is that it is *fundamental:* The interaction's structure, relying as it does on the properties of relations common to all stimuli, rather than on the features specific to particular stimuli, fosters performances of regularly increasing complexity thus contributing to a basic account of the development of language in behavior. Thirdly, because it consists solely of verbal operants, the interaction acts in a manner that we may directly observe in our own behavior. It is thus *plausible*.

Ultimately, all of this arises from the fact that the interaction produces a type of stimulus control that is *stimulus-specifying* and thus uniquely suited to the explanation of performances in which one stimulus may be said to specify, describe, or control the selection of a particular corresponding stimulus, as opposed to the traditional role of the conditional stimulus as a stimulus which provides for the selection of another stimulus by controlling the rate of emission of a common selection response such as pointing or pecking.

To more fully illustrate the nature of this new type of stimulus control, the problems that arise from current accounts of stimulus selection are examined here first. The nature and utility of this remedy is then demonstrated by the articles that follow.

The Limitations of Unmediated Stimulus Selection

According to the principle of reinforcement, under appropriate contingencies operant responses followed by strengthening consequences increase in rate. Where the availability of this reinforcement is correlated with the presence or absence of an antecedent stimulus, the strengthening effect is correlated with the state of that stimulus. As a result, a response may be emitted at a higher rate in the presence of a square (the S^D) than in the presence of other stimuli (the $S^\triangle$s). Demonstrations of such a correlation are said to illustrate stimulus control over a response, and the performance would commonly be referred to as a *simple discrimination*.

When an additional layer of stimulus control is added to form a *conditional discrimination* (e.g., on red pick square, on blue pick circle), the correlation between these primary stimuli and the availability of reinforcement is determined by the state of the added stimulus (the conditional stimulus: here, color). The conditional stimulus thus determines which primary stimulus functions as an S^D, and which as $S^\triangle$s. As a result, it is the conditional stimulus that determines which stimulus (i.e., the S^D) is selected in a conditional discrimination, but it is understood that selection of the current S^D is solely a result of the higher response rate it controls in the presence of the conditional stimulus. Stimulus selection is thus a product of relative response rates.

The problem with this is that there is nothing about the features of the conditional stimulus itself that actually corresponds with, or in any sense specifies, the features of a particular S^D. In a conditional discrimination, given the appropriate reinforcement history, virtually any stimulus may act as a conditional stimulus for any S^D.

For the radical behaviorist, this account has a unique strength in that it is non-representational: In no sense is the subject said to hold a memory or other mental representation of the stimulus being sought for selection; what is retained is a changed response rate to the S^D (Skinner, 1969, pp. 273–274). But with this strength come some serious limitations, for such an account, although free of any concern with the physical features of the stimuli, except their correlation with reinforcement, necessarily cannot recognize any relations that may exist between such features. Rather, it must treat all stimuli as if they were *arbitrarily* paired and indeed, as we have just seen, it provides an adequate description of performance in just that task. But as a result, this account can in no sense recognize that in an identity-matching task the characteristics of the sample specify the identical comparison, or that the sample and the comparison stimuli share features. As a further result, this account is unable to explain generalized responding based on the identity relation, or indeed, based on any generalizable relation that may exist between two or more stimuli (Lowenkron, 1991).

Furthermore, neither can such an account explain how subjects' report the presence or absence of such relations for relations themselves may of course also be tacted (Lowenkron & Colvin, 1992). Given these limitations, it is surely inevitable that no explanation of a generalized performance, based on conceptual relations between stimuli, and phrased in terms of unmediated stimulus control, has been forthcoming. But as we see in the articles described here, a mediational account, based on the notion of joint control, is readily forthcoming.

How Joint Control Remedies the Limitations of Unmediated Selection

The nature of joint control may be readily understood within the context of a simple task such as locating a particular six-digit number from a page containing many columns of such numbers not in numerical order (e.g., finding the number 939173). To maintain the target number while searching, a subject would need to rehearse the topography: saying 939173 first as an *echoic* of the speaker's response, and subsequently as a *self-echoic* of the subjects own repetitions of the number practiced lest he forget what he is seeking while perusing the columns of numbers.

Ultimately, upon encountering the specified number (and only that number) the next rehearsal of the rehearsed topography would be unique in that the rehearsed topography now would not only be a self-echoic of the prior repetition, but also a *tact* of the specified number. The subject would now be saying 939173 under joint self-echoic/tact behavior: One verbal operant topography occurring *jointly,* under two sources of stimulus control. This discrete stimulus control event we may label the *joint control event*.

And, of course, if, as a result of training, the subject persists in selecting the printed numbers that enter into joint control with the topography of the numbers currently being rehearsed, then the basis is laid for generalized relational matching: Given any spoken number the subject simply needs to select the printed number that evokes, as a tact, the topography currently being rehearsed as a self-echoic. That is, always select the printed numbers that produce the joint control event.

More technically, as described by Lowenkron (1991, 1998), this selection response is actually a *selection-based autoclitic*. By pointing to the specified number, the subject is reporting which printed number enters into joint control with the topography currently under self-echoic rehearsal, thus fulfilling the defining property of an autoclitic: namely, a tact reporting what controls other verbal behavior. Thus, here, pointing to a number reports which number evokes, as a tact, a topography that enters into joint control with the topography currently rehearsed as a self-echoic. Clearly, stimulus selection based on this joint control is quite different from selection based on the unmediated selection account described above. For a less technical introduction to joint control see Sidener's user-friendly version elsewhere in this section (Sidener, 2006).

The utility of the notion of joint control may be understood by appreciating how simply it may be applied to explaining behavior in a variety of different tasks, including those discussed in the various papers contained in this section. Thus, instead of a symbolic matching task, matching spoken words to printed numerals, the notion of joint control may also be applied, with no modification whatever, to the logically fundamental identity-matching task. Thus, suppose instead of spoken words the samples had also been printed numbers; making the task itself an identity matching task. In that case the subject's response to the printed number would be a tact rather than an echoic. But as before, rehearsing this number would make still make the second, and subsequent, responses self-echoics, and selection of the identical printed number would have still occur at the moment of joint self-echoic/tact control. That is, at the moment a self-echoic rehearsal also served as a tact for a particular printed number.

As for generalization, the same principle applies. For any given sample number, spoken or printed (that is, for generalized symbolic or identity matching), the subject merely selects the comparison that enter into joint control with the rehearsed topography.

Aside from words and numbers, the account works similarly with physical dimensions. Thus, if a subject were shown a novel object such as a yellow vase with two blue stripes and three red stars, and asked to select, in the absence of the original, a duplicate from a collection of similar objects, a correct response would simply require selection of that vase that evokes, as a tact, the topography (yellow vase with two blue stripes and three red stars) currently being rehearsed as a self-echoic. The pattern of behavior for both tasks is thus the same.

But as we see in the collection of articles published here, there is more. The notion of joint control may be applied across a wide variety of different tasks, thereby demonstrating in various ways the broad utility of the notion of joint control. Thus, in a replication of Lowenkron (1984), Sidener and Michael (2006) illustrate the role of joint control in a task utilizing nonvocal responding and requiring the generalization of relational matching of shapes based on their relative spatial orientation: The correct comparison was always the one oriented 90 degrees clockwise from the current sample. In this case, rather than a vocal self-echoic mediating response, the relative orientation of the sample and comparison was represented by the subject's placements of a paper arrow in the appropriate orientation. But despite this difference, the performance and the conditions of generalization parallel those applicable to the verbally mediated behavior described above. This finding is of considerable significance because it provides for an explicit, directly observable account of matching performances based (jointly) on two sources of stimulus control.

Using the more traditional vocal and visual stimuli, the study by Lowenkron (2006) examines generalized selecting of complex stimuli in response to spoken feature names (essentially in response to their description). Two experiments with children illustrates the need for *both* the self-echoic and the tact legs of joint control to function in order for generalized responding to occur with novel combinations of features. Thus, one experiment demonstrated the dependence of generalized matching on the acquisition of tacts for novel object, and the other demonstrated the effect of blocking self-echoic rehearsal on maintaining accurate matching. Together, the experiments demonstrate the dependence of accurate generalized matching on both of the components of joint control: the tact and the self-echoic.

With yet another kind of behavior Gutierrez (2006) also illustrates the role of response mediation and joint control: This time the task required the placement of common objects in various orders in response to spoken stimuli. As in the previous study, this study also shows that blocking self-echoic rehearsal prevents accurate responding.

In her study with children with autism, Tu (2006) performs an important demonstration as she illustrates the capacity of joint control to mediate word-object bi-directionality, also called the semantic function, wherein acquisition of an object-word naming performance engenders the word-object selection response with no additional training and vice versa. This is a topic of great interest to behavior analysts (Horne & Lowe, 1996). In the experiment reported here, Tu first demonstrates that simply training object-word tacting (see object, say word) does not automatically engender word-object selection (hear word, select object) with novel stimuli *unless* the subject has first learned this performance under joint control with another set of stimuli. If they have, then the mere presence of that performance, trained with one set of stimuli, is enough to produce a generalized performance with novel untrained stimuli such that once subjects have learned to appropriately emit the novel names; that is, to tact these novel stimuli they will then, with no additional training, select those same stimuli in response to their spoken names.

In this one form, then, generalized word-object bi-directionality is thus based on the presence of a history of responding under joint control in the repertoire and accurate tacts for the particular items. The role of joint control in the alternate form of bi-directionality, wherein training in selecting stimuli in response to spoken names automatically produces tacting is described in Lowenkron (1998, p. 337).

Aside from these general issues, Tu's study is also deserving of particular attention because of the use of autistic children. Although more needs to be done, the data nevertheless suggest that joint control may have *particular benefits* in facilitating the development of bi-directional responding in autistic children with all the advantages attendant to that advanced characteristic of behavior.

Wright's (2006) is perhaps the most forward-looking of all the papers reported here because it points the way to a whole new area of concern for joint control: namely, the reinforcing function of joint control. Thus, while all the other research reported here involved the role of joint control in the generalized *selection* of novel stimuli, the fact is that joint control itself is a stimulus event, and like any stimulus event, it can function as a conditioned reinforcer.

Reinforcement, of course, plays a tremendous role in the control of verbal behavior, and the analysis of verbal behavior in terms of both joint control and reinforcement promises great clarifications of complex verbal behavior in the future.

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