On Terms

Stimulus Control Terminology

Samuel M. Deitz and Leslie W. Malone
Georgia State University

One of the most exciting recent developments in applied behavior analysis is the exponential increase in research on stimulus control. The pioneering efforts of Guttman and Kalish (1956), Terrace (1963), Sidman and Stoddard (1967), and many others have lately been receiving their just attention. Many competent scholars are now actively involved in applied research in this most important area.

The study of stimulus control is important for two reasons. The first reason is a quite practical one: Our knowledge of stimulus control is limited. As Sidman (1978) explained, "Our understanding of the reinforcement contingency . . . is considerably more advanced than our understanding of stimulus control" (p. 265).

The second reason is more theoretical and shows how our lack of understanding needs to be overcome. The study of stimulus control provides the behavior analyst with an entrance into areas of psychology typically left to the cognitive scientists, but in which behavior analysts need to become involved (see Deitz & Arrington, 1984). On this topic, too, Sidman (1978) has provided useful insight:

To the extent that behavior is governed by reinforcement contingencies, we may agree with B. F. Skinner that operant behavior is essentially the field of purpose. I should like to take another step and suggest that behavior under stimulus control is essentially the field of cognition. . . . Terms like *cognition* or *knowledge* refer to the control of behavior by its environmental context, by events which, unlike consequences, precede or accompany the behavior; here, it is sometimes said that our behavior expresses *meaning* or *comprehension*. (p. 265)

This line of reasoning, one with which we thoroughly agree, could provide the

unifying principles for the various, diverse lines of stimulus control research. In other words, the analysis of stimulus control could have as its overall purpose the behavioral study of those issues previously called cognitive.

This ought to happen, we believe, but may not. As is often the case when areas of a science are rapidly expanding, new terms are developed even more quickly. The literature on stimulus control now includes such terms as matching-to-sample, delayed matching-to-sample, prompting, superimposition, fading, intrinsic fading, extrinsic fading, stimulus fading, stimulus shaping, delayed cue, and probably many others.

No problems exist if the various terms being developed identify clearly different processes. If they do, then many terms present no problem; one could even argue that they are necessary for extending the analysis. However, when several terms are labels for the same procedure *or* when a procedure labeled by any of the terms is not clear, a form of conceptual confusion can occur. If such confusion serves to inhibit further stimulus control research, by no other means than distorting the arguments in the field, that would indeed be an unfortunate result since current research is not only necessary but of such generally high quality.

We will examine some questions of definition in one area of applied stimulus control research. Our purpose is to point out some potentially confusing practices. We trust that if we are able to provide some clarity on these issues, research in stimulus control can continue in the directions pointed by Sidman: We will move toward both a better understanding of the processes of stimulus control and of what has often been called *cognition*.

ERRORLESS LEARNING PROCEDURES

Much of the most interesting stimulus control research with human subjects is in the area called errorless learning procedures. These are procedures for establishing discriminations through which subjects make few or no errors. While disagreement may exist concerning the actual differences between procedures that limit or do not limit the number of errors (see Rilling, 1977) and the value of learning with or without errors (see Skinner, 1968), studying such procedures in detail seems a worthwhile objective for behavior analysts.

One common factor in errorless learning is that discriminations are established by *transferring* control from an effective stimulus to a different stimulus. In other words, *some* form of control over responding already exists but that control is by a stimulus other than the one of interest to the researcher. The task in errorless learning, then, is to transfer control from one stimulus to another, therefore establishing a new discrimination, but in such a way that the subject makes few or no errors.

Let us look at a common applied problem. A child is being taught to say "circle" in the presence of a picture of a circle.[1] The child can already say "circle" and the S^+,[2] "say 'circle'" reliably controls that response. The problem is, of course, transferring control from the command to the picture. We could add another stimulus (a different picture, for example) which was not a circle so that a specific S^- was established, or even a

set of stimuli that were not circles so that a set of S^-'s was established but for our purposes that is not yet necessary.

The first conceptual problem is related to the command, "Say 'circle.'" This is an S^+; it already controls responding. In this case, however, our instructional goal is to make this command unnecessary to the child's saying "circle" in the presence of the picture. The command is, therefore, "supplemental" to the applied problem; in fact, we could call it a *supplemental* S^+. The picture is a *critical* S^+ in this learning situation.[3] So, the problem is, "What *is* this supplemental S^+ and how does it fit into errorless learning?"

Most often these supplemental S^+'s are called "prompts." When one of these prompts is presented we often say the researcher (or the stage manager in a theater, for that matter) is prompting the response (or the actor's lines). Mosk and Bucher (1984), for example, have said that prompting consists of presenting "extra cues to guide the response" (p. 23). They talk of instructional cues, gestures, models, and physical guidance as prompts. Touchette and Howard (1984) have a similar explanation of prompts: "Prompting is the substitution of an effective but inappropriate stimulus for an ineffective but appropriate stimulus. Prompts are stimuli that control the desired behavior, but that are not functionally related to the task" (p. 175). These authors help us remember that a prompt is an S^+ which, for some applied purpose, is inappropriate. It is *any* supplemental S^+ and that is all it is. An S^+ could be labeled a prompt if it controls but is not critical to a "correct" response. "What is this?" is a prompt. "Say 'circle'" is a prompt. The circle itself, once control has been established, is *not* a prompt; it is a critical S^+ in this learning situation.

Most of this seems quite obvious; it

---

[1] The example of the circle was chosen for this paper since it is so well explained in Etzel and LeBlanc (1979). When stimulus fading or stimulus shaping is discussed, the circle example follows their examples as closely as possible. Any errors are due to our interpretation and will not be found in the original article.

[2] An S^+ will be the term used in this paper to categorize a discriminative stimulus which increases the likelihood that a particular response will follow it. An S^- will designate a discriminative stimulus which decreases the likelihood that a particular response will follow it.

[3] Our first contact with the terms "supplemental" and "critical" was in the text by Sulzer-Azaroff and Mayer (1977). We agree that these terms are useful descriptors of this aspect of stimulus control. A similar distinction is made by Engelmann and Carnine (1982) in their discussion of stimulus and response prompts.

fits rather nicely with how the term is used in ordinary language and with how it is commonly employed in behavior analysis. The only problem is that sometimes prompting is talked of as if it were a learning process; as we have tried to show, prompting is *not* a learning process. Rather, it is a procedure used because learning has not yet occurred. Prompting, however, most often is an integral part of all the errorless learning procedures. Within those procedures, prompts are used to evoke the correct response, but some other set of procedures facilitates the transfer of control from the supplemental S$^+$ to the critical S$^+$.

If we agree that prompting, itself, is not a learning process, we are still left with the problem of transferring control from "Say 'circle'" to the picture of the circle. Until fairly recently, the only system for such transfer was called "fading" (Terrace, 1963). Fading has been used as a generic term to identify any procedure in which "a property of a stimulus is gradually changed on successive trials to transfer control of responding from one property of a stimulus to another" (Rilling, 1977, p. 466) or from one stimulus to another.

It is interesting to us, and probably a source of some confusion, that of the three most commonly studied and discussed errorless learning procedures in applied behavior analysis—delayed prompting, stimulus fading, and stimulus shaping—only one of them violates that definition. One of those which does not violate that definition, however, is still distinguished from fading in both terminology and definition. To help resolve some of these issues of definition, we now turn to an examination of several issues relevant to these procedures.

The first of the three errorless learning procedures we will discuss is the delayed prompting procedure (Touchette, 1971; Touchette & Howard, 1984). In this procedure, "the discriminitive stimuli are presented at the beginning of a trial. A prompt is presented after a delay" (Touchette & Howard, 1984). In other words, first the picture of the circle is presented, then, after some delay, the prompt, "Say 'circle'" is presented. Reinforcement usually follows the child's response whether that response occurs after the critical S$^+$ or after the delayed, supplemental S$^+$.

This procedure is properly distinguished from fading; no "property of a stimulus is gradually changed on successive trials to transfer control" (Rilling, 1977, p. 466). In fact, successive trials are essentially identical. Even if the delay changed in successive trials, it would be sufficiently different from what is commonly called fading to distinguish this procedure easily from fading. There are many interesting empirical questions concerning which factors in delayed prompting are responsible for the transfer of control, but discussion of those issues is not the purpose of this paper. As we said earlier, new terms are legitimate and useful when they identify clearly different processes. It appears to us that delayed prompting is a term which fulfills that requirement and is therefore a useful addition to the literature.

The two remaining errorless learning procedures we will discuss, stimulus fading and stimulus shaping (Etzel & LeBlanc, 1979), fit very nicely with the earlier definition of fading. Both are procedures "in which a property of a stimulus is gradually changed on successive trials to transfer control of responding" (Rilling, 1977, p. 466). In fact, stimulus fading is essentially the same procedure we have always called fading. There are two issues Etzel and LeBlanc present for differentiating these procedures. Both of these issues have to do with the manner in which a stimulus is changed over trials. One of the issues leads to some confusion; the other, however, shows a distinction to be quite useful.

First, stimulus fading and stimulus shaping are said to be different because they require the stimulus to be changed in *structurally* different ways. In stimulus fading, "the overall configuration or topography of the stimulus" (Etzel & LeBlanc, 1979, p. 369) is not changed. In stimulus shaping, however, the overall topography or configuration of the stim-

ulus is changed. "That is, the initial stimulus does not resemble the final or criterion level stimulus because its topography is to be gradually altered to form the criterion stimulus" (Etzel & LeBlanc, 1979, p. 370). Stimulus fading, then, involves changing some dimension such as size, color, or intensity, while stimulus shaping would change the shape or configuration of the stimulus. To return to our example of the circle, stimulus fading might alter the size of the circle as the prompt in order to help a child learn the difference between a circle and an oval; stimulus shaping would alter the shape of the circle. The circle could, for example, begin as a square and gradually turn into a circle.

Initially, this may seem a useful distinction. If we examine several issues of definition, however, we see that the distinction leads to confusion. Most obviously, our original definition of fading did *not* specify how a stimulus was to be changed. It only states that "a property of a stimulus is gradually changed"; the change could be along any possible dimension. The term, stimulus shaping, violates one of the requirements for adding new terms into the literature and is therefore unnecessary.

A second issue of definition concerns the ordinary use of some of the terms used to make the distinction between stimulus fading and stimulus shaping. *Webster's New Collegiate Dictionary* (1977), for example, defines topography as "the physical or natural features of an object or entity and their natural relationships" (p. 1231). *Any* "physical or natural features" seem to be implied. It would appear, then, that if one gradually changed the size of a stimulus (which according to Etzel & LeBlanc is *not* changing topography, and is therefore stimulus fading rather than stimulus shaping), one would be changing one of its physical or natural features. In that case, the distinction made by Etzel and LeBlanc is not consistent with the ordinary use of the term, topography. It seems to us that a distinction based on what is changed is arbitrary and, therefore, confusing. So far, then, a distinction between stimulus

shaping and stimulus fading, and the creation of the new terms, does not appear very useful.

The second issue Etzel and LeBlanc discuss is quite different; while this issue also presents some problems that need clarification, it is very useful, indeed. In terms of the effectiveness of either procedure, they present the concept of "criterion-relatedness." To present stimulus changes that are criterion-related over a series of trials, "the final discrimination must be based on the . . . critical difference" (Etzel & LeBlanc, 1979, p. 372) between the S^+ and the S^-. In other words, "the cue that initially controls the child's responding . . . is *not* involved in the final discrimination" (p. 372). A criterion-related stimulus change procedure would alter the stimulus along a dimension related to the final discrimination; a non-criterion-related procedure would not.

To return to our circle, the series of trials changing the size of the circle so it could be discriminated from an oval would not be criterion-related. Size is *not* the important dimension that distinguishes circles from ovals. If we changed the circle from a square into a circle over a series of trials, that *would* be criterion-related. Shape *is* the important dimension that distinguishes circles from ovals. If the data support a distinction between stimulus change procedures that are criterion-related or not, and so far that is exactly what is found, an important addition to the terminology of the field is necessary.

A problem arises when one tries to determine what will be a criterion-related stimulus change procedure. How do you know, unless you examine every single stimulus presentation, whether or not a series of changes are in fact criterion-related? If you look at only one trial, it could be anything. If you look at the last trial, it is obvious. If you look at the first trial, it is a mystery. This is not a major problem. What appears to be required is a clear, precise definition of how one decides what is or is not criterion-related.

Since the distinction between stimulus fading and stimulus shaping is not clear, but the distinction between what is cri-

terion-related or not appears critical to errorless learning, we suggest that it might be appropriate to abandon the former distinction and emphasize the latter. Procedures in which "a property of a stimulus is gradually changed on successive trials" (Rilling, 1977, p. 466) could all be called fading. Fading is an adequate term and one with which most behavior analysts are familiar and comfortable. We should, however, distinguish between fading procedures which are criterion-related or not. We suggest the adoption of the terms, criterion-related fading and noncriterion-related fading.[4] We would not oppose, except for ease of transition for most behavior analysts, using the term shaping instead of fading. Given the definition of topography, shaping could be said to subsume fading so that might even be a better long-run solution.

CONCLUSIONS

We have tried to clarify some instances of possible confusion in the literature of stimulus control:

1. Prompting is not a learning process, but rather a procedure in which existing stimulus control is used to evoke a response.
2. Delayed prompting is not a fading procedure. It is sufficiently different to be included as a new term in the field.
3. The distinction between fading and shaping is unnecessary. One of these terms ought to be selected as *the* term describing the errorless learning procedure in which changes in stimuli are programmed to occur over successive trials.
4. The distinction between procedures that are criterion-related and noncriterion-related is important and should be the basis for differentiating among fading procedures (or shaping procedures, if that term serves more purposes).

Solving these conceptual problems appears useful since applied problems in stimulus control are among the most important areas that behavior analysts study. We recognize that advice on the issues of terms is rarely adopted; what evolves from the contingencies in the

community of researchers in that field has more impact than an "On Terms" column in a journal. Still, clarifying some of these issues could help further the study of these important variables.

It is this last point, furthering the study of the variables of which stimulus control is a function, which brings us to our final recommendation. The goal of this line of research should be to understand more about those variables. As Sidman (1978) reminded us, there is much we do not know. By coming to that understanding, however, we may eventually be able to talk with some authority about "cognition." Some current arguments in the literature, however, are quite different. Etzel and LeBlanc (1979) have discussed the superiority of stimulus fading/shaping over delayed prompting; Touchette and Howard (1984) explained how delayed prompting makes stimulus fading/shaping unnecessary. These arguments, while only a small part of the discussions of these authors, are misguided. We do not need to know which procedure is "better" for some purely applied purpose; rather, we need to know more about stimulus control. The research these authors are conducting is excellent and can tell us about those variables. We hope that those studying this area will continue to concentrate on research that stresses investigation over improvement (Deitz, 1978) and that they will more often discuss their findings under the control of that purpose.

REFERENCES

Deitz, S. M. (1978). Current status of applied behavior analysis: Science versus technology. *American Psychologist, 33,* 805–814.

Deitz, S. M., & Arrington, R. L. (1984). Wittgenstein's language games and the call to cognition. *Behaviorism, 12,* 1–14.

Engelmann, S., & Carnine, D. (1982). *Theory of instruction: Principles and applications.* New York: Irvington.

Etzel, B., & LeBlanc, J. (1979). The simplest treatment alternative: The law of parsimony applied to choosing appropriate instructional control and errorless-learning procedures for the difficult to teach child. *Journal of Autism and Developmental Disabilities, 9,* 361–382.

Guttman, N., & Kalish, H. I. (1956). Discrimina-

---

[4] This would be similar to the terms intrinsic fading and extrinsic fading, suggested by Schwartz, Firestone, and Terry (1971); however, criterion-related and noncriterion-related appear to us to have more value in that they are more straightforward and less potentially confusing.

bility and stimulus generalization. *Journal of Experimental Psychology, 51,* 79–88.

Mosk, M. D., & Bucher, B. (1984). Prompting and stimulus shaping procedures for teaching visual-motor skills to retarded children. *Journal of Applied Behavior Analysis, 17,* 23–34.

Rilling, M. (1977). Stimulus control and inhibitory processes. In W. K. Honig and J. E. R. Staddon (Eds.), *Handbook of operant behavior* (pp. 432–480). Englewood Cliffs, NJ: Prentice-Hall.

Schwartz, S. H., Firestone, I. J., & Terry, S. (1971). Fading techniques and concept learning in children. *Psychonomic Science, 25,* 83–84.

Sidman, M. (1978). Remarks. *Behaviorism, 6,* 265–268.

Sidman, M., & Stoddard, L. T. (1967). The effectiveness of fading in programming a simultaneous form discrimination for retarded children. *Journal of the Experimental Analysis of Behavior, 10,* 3–15.

Skinner, B. F. (1968). *The technology of teaching.* New York: Appleton-Century-Crofts.

Sulzer-Azaroff, B., & Mayer, G. R. (1977). *Applying behavior analysis procedures with children and youth.* New York: Holt, Rinehart, and Winston.

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.

Touchette, P. E., & Howard, J. S. (1984). Errorless learning: Reinforcement contingencies and stimulus control transfer in delayed prompting. *Journal of Applied Behavior Analysis, 17,* 175–188.

Webster's New Collegiate Dictionary. (1977). Springfield, MA: G. & C. Merriam Co.