Verbal Understanding and Pavlovian Processes

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The behavioral processes through which people react appropriately to verbal descriptions remain poorly understood. I argue here that these processes are Pavlovian. Common objections to a Pavlovian account of symbolic behavior evidence a lack of familiarity with the relevant data or misunderstandings of operant theory. Although much remains to be done to explore the relation between verbal understanding and simpler forms of Pavlovian conditioning, the similarity of these two sets of phenomena has received increasing support in recent years. The difficulties of operant principles in accounting for symbolic behavior have a more general implication: Operant models, which focus on the maintenance of responding, must incorporate principles of behavioral induction that explain the origins of novel environment-behavior relations. Pavlovian processes are likely to contribute.
Keywords: symbolic behavior, functional equivalence, Pavlovian conditioning, humans.

How do words acquire their meaning? The problems associated with meaning and reference involve many dimensions. The fact that we can still refer today to Marco Polo's travel to China involves an initial connection of verbal behavior with a nonverbal referent, and a long chain of behavioral events that preserve meaning across linguistic communities. The issue of meaning therefore transcends the boundaries of psychology to involve social and cultural invariances holding from one generation to the next (Kripke, 1972; Putnam, 1975).

Behavioral psychologists, who deal with the adjustments of individual organisms, cannot address this problem in its entirety. But they can elucidate the processes involved in how a person understands a sentence or reacts to the description of a situation. Behavioral psychologists can study how and why being told that swimming in the river is dangerous leads us to avoid swimming, how and why being told that the pie is delicious leads us to order a slice. In each case, the problem of verbal understanding has clear behavioral dimensions: Exposure to an organized set of verbal stimuli (including words such as "river" or "pie") later leads to a change of behavior with respect to their nonverbal referents.

Verbal understanding has not been explained convincingly within Skinner's (1957, 1969) traditional operant framework, however. Most of the research inspired from *Verbal Behavior* (Skinner, 1957) involves the reinforcement of elementary verbal operants and focuses on the behavior of the speaker (Oah & Dickinson, 1989); verbal understanding, which concerns the behavior of the listener (Parrott, 1984, 1987), has been neglected or addressed in a deficient fashion. In the absence of a coherent specification of the underlying behavioral processes, for example, the concept of rule governance (Skinner, 1969) is merely an empty label. If we agree to call an instruction a "rule," then instruction-following is by definition a case of "rule governance," but pointing out the obvious does not lead us any closer to a scientific understanding of the relevant behavioral phenomena.

The lack of progress in addressing verbal understanding from a standard operant perspective may arise in part from empirical difficulties, but also signal more basic deficiencies with reinforcement-based accounts. Their central deficiency can be understood by contrasting *directly reinforced* with *derived* behavioral functions. In the former case, the response distribution observed conditionally on a stimulus A arises from reinforcement in the presence of this stimulus or physically similar ones. In the latter case, the response distribution observed conditionally on A arises from reinforcement in the presence of a stimulus B distinct from A (and that entertains no formal similarity with A). Until recently, basic behavior-analytic research dealt almost exclusively with the former case, the study of which (Skinner, 1938) was taken as a model for the explanation of verbal behavior (Skinner, 1957). Verbal understanding, however, exemplifies derived, rather than directly reinforced,

behavioral functions. The responses of the swimmer being told that the river is "dangerous" do not exemplify the reinforcing or punishing effects of contacts with the actual river; rather, these responses arise from verbal stimuli ("the," "river," "is," "dangerous"), the influence of which can ultimately be traced back to nonverbal stimuli experienced in the swimmer's past (including, presumably, actual rivers and actual dangers).

The preceding example illustrates an important property of verbal understanding: To a large extent, the behavioral effects of exposing a person to a set of verbal stimuli (such as the sentence, "the river is dangerous") are identical to those of the actual, nonverbal events being referred to (say, witnessing an actual drowning). This observation can be summarized by saying that verbal stimuli tend to be *functionally equivalent* to their referents, two events A and B being functionally equivalent if they have the same effects on behavior (Tonneau, 2001). If functional equivalence between verbal stimuli and their referents did not hold, there would be little point in using descriptions or advice to influence other people's behavior (for example by commenting that the river is "dangerous"). The dependence of verbal understanding on functional equivalence leads to an important question: What produces the functional equivalence of verbal stimuli and their referents?

The Pavlovian Hypothesis

A possible answer is that the functional equivalence of verbal stimuli and their referents involves processes akin to Pavlovian conditioning (Tonneau, 2001). This answer is nothing new. Aside from Pavlov's own views of the topic (1955), the notion that verbal understanding arises from classical-conditioning processes has been a recurrent one in the history of psychology. Classical-conditioning explanations of verbal understanding have often appealed to covert mediators (e.g., Osgood, 1952; Mowrer, 1960; Staats & Staats, 1959), but they can also be formulated at the level of overt performance (Stemmer, 1973). Another way to develop a non-mediational, Pavlovian account of verbal understanding is to adopt a direct-memory standpoint (e.g., Marr, 1983) and replace covert mediators by features of the environment defined over an extended time scale (Tonneau, 2001, pp. 21-23). Irrespectively of the controversies that surround the concept of direct memory (Tonneau, 1990), all Pavlovian views of symbolic responding emphasize the phenomenon of functional equivalence and its dependence on stimulus correlations (Tonneau, 2001).

There are good reasons to believe that such a view of verbal understanding is correct. First, understanding a language requires a history of correlation, however indirect, between components of this language and the nonverbal world; absent such grounding, no verbal understanding would be possible (Staats & Staats, 1959). The nature of the relevant correlations may be a matter of dispute, but not their existence.

Second, the role of Pavlovian factors in promoting functional equivalence has been amply documented (Tonneau, 1993, 2001). Recall that two stimuli A and B are functionally equivalent if they have the same behavioral effects. Extending behavioral effects from one stimulus to another (or, promoting functional equivalence) is basically what Pavlovian conditioning does (apparent exceptions will be discussed below). In Pavlovian conditioning, the eliciting functions of the unconditional stimulus (B) transfer to the conditional stimulus (A) through their temporal and spatial association (Mackintosh, 1983, pp. 68-74); but stimulus pairings also promote the transfer of Pavlovian reinforcement, operant reinforcement, and occasion setting (Holland & Forbes, 1982; Rashotte, 1981; Williams, 1994). Clearly, correlations among stimuli are sufficient to produce a wide range of derived behavioral functions.

Third, stimulus pairings are present in many circumstances of language training (e.g., Ninio, 1980), and children's verbal understanding seems sensitive to the same temporal and correlational variables that modulate Pavlovian conditioning (cf. Rescorla, 1968, 1972). In a study of Whitehurst,

Kedesky, and White (1982), for example, children's symbolic behavior (such as picking the appropriate object when instructed to "show the wick") depended on the correlation that the experimenter imposed between objects and their names (such as the name "wick"). As Whitehurst (1996) pointed out, Pavlovian views of verbal understanding have the advantage of not requiring the emission of specific responses and their reinforcement during the pairing phase; mere exposure to stimulus patterns can modify the functions of target stimuli (e.g., Staats & Staats, 1957; Staats, Staats, & Heard, 1959).

Finally, the steady progress of Pavlovian research has made it increasingly relevant to symbolic behavior (e.g., Turkkan, 1989). The range of temporal variables that promote Pavlovian conditioning is more extended than previously suspected (Savastano & Miller, 1998), the relevant environmental relations include more than merely temporal ones (Rescorla & Cunningham, 1979), and function modification may be complete in no more than one or a few trials (Rescorla, 1988). Also, function transfer from A to B does not require pairing A with B, since transfer can occur through networks of indirect stimulus pairings (AC and CB for example), as in second-order conditioning and sensory preconditioning (e.g., Rizley & Rescorla, 1972).

Especially important is the fact that correlating two stimuli A and B can make them functionally equivalent, not only with respect to the behaviors that they modulate, but also with respect to further Pavlovian conditioning (Hall, 1996). Imagine for example that a stimulus B is paired with another stimulus A. If A is later paired with some unconditional stimulus U, the AU pairings will be functionally equivalent to BU pairings; therefore, the responses evoked by U will transfer to B, even though B and U are never paired with each other. Experimental demonstrations of this effect or similar ones have been provided by Holland (1981, 1990) and Ward-Robinson and Hall (1996, 1999), among others.

Pairing two stimuli A and B to render them functionally equivalent with respect to further conditioning is only one step away from what Mowrer (1960) described a a "sign-sign" procedure (p. 151). In a sign-sign procedure, a cue X is paired with a target stimulus A and another cue Y is paired with an unconditional stimulus U; then X is paired with Y. If the initial pairings (that is, XA and YU) make X and Y functionally equivalent to A and U with respect to Pavlovian conditioning, the behavioral effects of pairing X with Y should be identical to those of pairing A with U; thus, A should acquire the behavioral functions of U, even though these stimuli are never paired with each other. A successful sign-sign procedure would document the nonhuman analog of a two-word utterance such as "river dangerous"(which some languages admit as a form of predication).

Recent results with rats (Dwyer, Mackintosh, & Boakes, 1998) have confirmed the existence of the phenomenon hypothesized by Mowrer (1960, pp. 137-152). In the study of Dwyer, Mackintosh, and Boakes (1998), a cue X was paired with peppermint and a context Y was paired with sucrose; then X was paired with Y. Test results showed function transfer from sucrose to peppermint, as indicated by the rats' increased preference for the latter (also see Dwyer, 2000). One might say (Mowrer, 1960) that the rats changed their behavior with respect to peppermint through exposure to the elementary *sentence*, "XY" (or, in English, "peppermint sucrose").

Obviously, many features of full-fledged language comprehension are missing in this example. A Pavlovian account of verbal understanding must assume that human behavior is sensitive to pairings between verbal and nonverbal stimuli, but also to pairings between verbal stimuli and relational properties of the environment (such as the property to-the-left-of), and to pairings between syntactical relations among words and such environmental properties. Also, it is unlikely that Pavlovian conditioning of this complex kind could proceed in rats with enough speed and precision to support communication in real time. The data of Dwyer, Mackintosh, and Boakes (1998) are nevertheless

exactly those one would expect if Pavlovian processes, conserved through evolution, had been coopted for symbolic understanding in humans (e.g., Stemmer, 1973).

From this perspective, the (perhaps unique) behavioral outcomes characteristic of verbal understanding arise from processes that are widespread among species, but proceed with a higher efficiency in *Homo sapiens* and involve more complex networks of correlations (e.g., Tonneau, 2001, pp. 121-123). Minor quantitative differences in the parameters of multiple, interacting Pavlovian processes could result in a striking difference of behavioral outcomes.

Objections To a Pavlovian Standpoint

Although the sensitivity of animal operant behavior to Pavlovian correlations has been amply documented (e.g., Estes & Skinner, 1941; Lovibond, 1983; Nevin & Grace, 2000; Rescorla & Solomon, 1967; Rescorla, 2000), Pavlovian views of verbal understanding have been met with recurrent objections in behavior analysis. These range from conceptual criticisms of the use of Pavlovian conditioning concepts in explaining human behavior (e.g., Barnes-Holmes & Hayes, 2002) to empirical criticisms about stimulus pairings and functional equivalence.

Association in behavior analysis. Sidman (1994, p. 140) and Barnes-Holmes and Hayes (2002, p. 91) have criticized the use of associative concepts in behavior analysis on the ground that their explanatory usefulness with respect to complex human responses has not been established. An issue on which behavior analysts should be clear, however, is that the concept of association has multiple meanings. Psychologists usually invoke associations between mental or neural elements, but "association" can also refer to temporal and spatial correlations among environmental events. The existence of associations in the latter sense cannot be denied (Skinner, 1977), and they affect human and nonhuman performance in ways that are often comparable (e.g., Escobar, Arcediano, & Miller, 2001; Gluck & Bower, 1988; Wickens, 1973). Such facts will need to be addressed in any comprehensive version of behavior analysis.

Complexity and flexibility. The notion that reinforced responses are somehow more complex than the behavior governed by Pavlovian processes is a belief that dies hard. Barnes-Holmes, Hayes, and Roche (2001), for instance, defend an operant approach to complex human behavior on the ground that explaining emergent performance requires something more "flexible" (p. 37) than a mere Pavlovian process. Apparently, the missing flexibility is provided by operant reinforcement; yet these authors do not explain how and why reinforcement is supposed to make behavior more flexible. Actually, any such outcome would be inconsistent with the concept of reinforcement, since to "reinforce" a behavior means nothing more than to increase its *rate* by providing appropriate consequences (Tonneau, 2001). Operant reinforcement does not increase complexity or flexibility, and responding can only be as complex as non-operant processes allow. Neither have operant procedures a monopoly on complexity, as can be appreciated by consulting the recent Pavlovian literature (e.g., Barnet, Cole, & Miller, 1997). The complexity of a phenomenon is no argument against its being governed by Pavlovian processes.

The absence of stimulus pairings. Echoing earlier remarks by Hayes, Kohlenberg, and Hayes (1991, p. 126), Blackledge (2003) has argued that Pavlovian processes cannot explain some cases of derived functions. In Blackledge's example (2003), being told that there are "snakes in the woods" makes one careful, even though one "never once encountered a snake in the woods," and thus (according to Blackledge) "never had the opportunity for wooded areas to become classically conditioned to snakes" (p. 424). The argument assumes that Pavlovian conditioning requires direct pairings of conditional and unconditional stimuli. This assumption is false, however, since a large Pavlovian literature (mentioned above) documents function transfer between stimuli that have never appeared together (e.g., Sawa & Nakajima, 2001; Ward-Robinson & Hall, 1996, 1999).

Failures of stimulus substitution. A lack of functional equivalence between verbal and nonverbal stimuli can be used to argue that Pavlovian models of verbal understanding are deficient and, by implication, that an operant model is more appropriate (Skinner, 1957). This objection has been put forth recently by Horne and Lowe (1996), who remarked that "we do not behave toward the name as we do toward the named object or event. We do not sit on the printed word CHAIR when we see it, nor can we sit on [a] spoken word" (p. 235).

Clearly, words and their nonverbal referents often fail to be functionally equivalent. Yet, the most central features of verbal understanding seem to require function transfer from nonverbal to verbal stimuli and vice-versa (see above and Tonneau, 2001, pp. 5-7). How can this apparent contradiction be resolved? From a Pavlovian viewpoint, different factors could explain failures of functional equivalence between symbols and referents. Functional equivalence is always a matter of degree (see Tonneau, 2001), even in classical conditioning preparations, where the forms of conditional and unconditional responses can diverge (Rescorla & Holland, 1982, pp. 292-297). Such divergences may arise from response competition, interactions with contextual variables, or transfer of only some of the behavioral functions of the unconditional stimulus (Tonneau, 2001, p. 112). In Horne and Lowe's example, failure to sit on the word CHAIR may simply arise from a lack of behavioral support for doing so (see Tolman, 1932, p. 329). Thus, it should be possible to increase the degree of functional equivalence between words and objects by providing behavioral supports and manipulating contextual stimuli. These predictions were confirmed experimentally by Tonneau, Kim Abreu, and Cabrera (in press).

One final objection to stimulus-substitution accounts of verbal understanding comes from relational frame researchers, who argue that symbolic behavior exemplifies not only functional equivalence but also phenomena of function transformation (e.g., Dymond & Barnes, 1995). In function transformation, the behavioral effects of a stimulus B differ predictably from those of a stimulus A previously related to B; for example, a person may approach A but avoid B. Function transformation seems inconsistent with a Pavlovian account. I have argued elsewhere, however, that the cases of function transformation from A to B reported in the literature are in fact cases of Pavlovian conditioning where the effects that transfer to B are those of a stimulus C distinct from A. The argument is too lengthy to be discussed here (for technical details see Tonneau, 2001, pp. 121-123), but does establish the possibility of explaining function transformation in Pavlovian terms. A Pavlovian explanation has the advantage of appealing only to functional equivalence and basic processes already documented in nonhuman species.

Operant Alternatives?

Three main approaches to verbal understanding have arisen in behavior analysis: an approach in terms of naming (Horne & Lowe, 1996), another in terms of equivalence-class formation (Sidman, 1994), and a third built around the relational-frame metaphor (Hayes, Barnes-Holmes, & Roche, 2001). All three approaches focus on operant reinforcement. The ways in which they also appeal (or fail to appeal) to Pavlovian processes reveal theoretical tensions that extend beyond the topic of verbal understanding to reach logical issues about the place of reinforcement in behavior theory (e.g., Tonneau & Sokolowski, 1997).

Naming. The naming approach of Horne and Lowe (1996) elaborates on Skinner's theory of verbal behavior (1957). Although Horne and Lowe (1996) have emphasized the importance of studying verbal behavior in its developmental context, they have also showed how naming could mediate the emergence of novel response patterns in matching to sample and similar tasks (e.g., Sidman, Kirk, & Willson-Morris, 1985). The research program of Horne and Lowe (1996) thus

embodies the view that verbal behavior influences human performance in many ways and underlies many of its unique features.

A behavioral theory of meaning, however, cannot forever focus on verbal behavior to explain other behavior. Rather, the theory must explain how verbal stimuli themselves acquire meaning, and the answer necessarily involves their correlation with the nonverbal environment (see Staats & Staats, 1959). Horne and Lowe's (1996) account of how a child who names her mother in her absence "may 'see' her, 'hear' her, 'smell' her special scent, and 'feel' her comforting touch" (p. 203) actually appeals to the Pavlovian conditioning of perceptual responses to verbal stimuli (pp. 203-205). Were in not for Pavlovian processes, verbal stimuli would be meaningless, even in the naming account.

Equivalence-Class Formation. Sidman's (1994) equivalence-class framework has occupied a prominent role in behavior analysis for nearly two decades. Although the study of equivalence relations in matching to sample has often been assumed to illuminate verbal behavior, recent evaluations of this methodology conclude otherwise (e.g., Horne & Lowe, 1996). Whitehurst (1996), for example, has alluded to matching-equivalence studies as "a tempting garden path" leading into an "inwardly spiraling science" (p. 256). A detailed analysis of the field (Tonneau, 2001, pp. 1-16) reveals misuse of set theory and logic, ambiguities, and confusion over different concepts of "equivalence."

A first concept of "equivalence" is that of *functional* equivalence. I have argued here that symbolic behavior involves functional equivalence at a basic level. Laboratory research since Pavlov (1927) shows that functional equivalence arises from correlations among stimuli (Tonneau, 1993), which in turn suggests that symbolic performance is the product of Pavlovian processes.

For complicated reasons, however (Tonneau, 2001, pp. 7-8), functional equivalence is not what equivalence-class researchers typically study. What they study instead are the (still poorly understood) phenomena of *matching equivalence*, defined as the emergence of reflexive, symmetric, and transitive stimulus choices in matching to sample (p. 10). Despite numerous arguments to the contrary, matching equivalence and functional equivalence bear no logical relation to each other (Tonneau, 2001, pp. 11-15 , p. 108). Most of the claims made on behalf of matching-equivalence research (for instance, that it illuminates symbolic behavior) stem from neglecting this distinction and piling on elementary logical confusions.

Logical issues aside, it is true that the effects of a stimulus matched with another often transfer to the latter, suggesting that *matching* equivalence produces *functional* equivalence (e.g., Hayes, Kohlenberg, & Hayes, 1991). Unfortunately, these demonstrations do not control for the possibility that the observed transfer of function arises from the stimulus pairings implicit in the matching task (see Boelens & Smeets, 1990). A recent study by Tonneau and González (in press) supports the latter possibility: The discriminative functions of a stimulus transferred to another irrespectively of whether the stimuli were matched or merely paired with each other; removing the matching task while leaving stimulus pairings intact left function transfer unaffected. These results are consistent with a Pavlovian account of functional equivalence, and further underscore the lack of relevance of matching-equivalence concepts in explaining derived functions.

The Relational Frame Metaphor. The approach known as relational frame theory (RFT: Hayes, Barnes-Holmes, & Roche, 2001) correctly emphasizes the role of derived functions in symbolic behavior. In spite of some valuable intuitions and methodological advances, however, RFT suffers from serious logical flaws (see Tonneau, 2001, 2002, in press; for other perspectives on RFT see Burgos, 2003; Galizio, 2003; Marr, 2003). Here I will focus on the role of Pavlovian processes in RFT.

Starting from the fact that it is possible to reinforce relational behaviors (e.g., emitting in the presence of a stimulus A whatever response was emitted in the presence of another stimulus B), RFT applies an operant model to derived-function phenomena in which relational behaviors do not exist or cannot be defined coherently (Tonneau, 2001, in press). Interestingly, the phenomena in question may involve *respondent* behavior (Galizio, 2003, p. 167). How can this be if the relevant RFT processes are operant ones? Barnes-Holmes, Hayes, and Roche (2001) affirm that the sort of relational behavior they envision "operates on operant and respondent processes" (p. 39), but this statement is inconsistent with operant theory. It is behavioral processes that operate on behaviors, not the other way round; and no operant behavior operates on respondent processes. The finding that respondent behaviors are modified through RFT procedures suggests that the processes responsible for emergent behavior in these experiments are Pavlovian (Tonneau, 2001).

Conclusion

For historical reasons, behavior analysts have spent an enormous time studying operant reinforcement. The fact remains that reinforcement can only increase the rate of phenomena that already occur for non-operant reasons. Thus, a science of behavior that focuses on the maintenance of responding by its consequences, but does not examine the provenance of the responses that reinforcement maintains, is like a one-sided coin (Staddon & Simmelhag, 1971). In a complete science of behavior, principles of reinforcement are complemented by principles of behavioral induction that address the origins of novel environment-behavior relations (e.g., Stemmer, 2002). The latter could be considered of limited importance only if novel behaviors were random with respect to the environment, which is certainly not the case.

Complex behavioral phenomena, such as verbal understanding, require complex principles of induction. In the case of symbolic performance, I have argued that the relevant principles are Pavlovian and involve stimulus correlations (Tonneau, 2001). This idea has been hardly explored in behavior analysis and is still surrounded by misunderstandings (some of them reviewed above); yet recent Pavlovian studies with nonhuman animals (e.g., Ward-Robinson & Hall, 1996, 1999) reveal an increasing convergence with derived-function phenomena in humans. The similarity might be coincidental, but theoretical parsimony as well as the high degree of conservation in biological evolution suggest otherwise.

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