The Language of Science

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Abstract Science is what scientists do and, especially, what they say about what they do. Science is a way of talking about the world that enables the listener to behave more effectively in that world. Understanding science, then, is a matter of understanding the language of science. Scientific verbal practices are codified and recorded so that they can affect the behavior of all scientists, including those without access to the original controlling variables. What we know about the world is simply the way we have learned to talk about the world. We know best what is most useful about the world, in the sense that what we know enables us to behave effectively in the world. Scientists are unique in that they, more so than non-scientists, have the experience of behaving as effectively as possible—they can predict and control. This is what makes all the difference, in the sense that it makes science different from other ways of knowing about the world. Science is not simply one way of knowing about the world, it is arguably the most effective way of knowing about it. Scientific talk leads to effective action.

Keywords Epistemology · Functional analysis · Knowledge · Language · Verbal behavior · Science · Skepticism

It is wrong to think that the task of physics is to find out how nature *is*. Physics concerns what we can *say* about nature. – Niels Bohr¹

Science is what scientists do, especially what they say about what they do. Science is a way of talking about the world that enables the listener to behave more effectively in that world. Understanding science, then, is a matter of understanding the language of science. Skinner's *Verbal Behavior* (1957) described a functional analysis of language

¹As quoted in Petersen, A. (1963). The philosophy of Niels Bohr. *Bulletin of the Atomic Scientists*, 19(7), p. 12.

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that focused on the relevant controlling variables involved in various environment-behavior relations he classified as verbal. Part of that book (Chapter 18) was dedicated to discussing the implications of such an analysis for understanding logical and scientific verbal behavior. That single chapter is one of the most exhaustive functional analyses of scientific verbal behavior available to date.

Unfortunately, Skinner's chapter is dated, having been published in 1957, and it appears at the end of a daunting book. Many readers no doubt give up before encountering the chapter, or are a bit worse for the wear by the time they do. Moreover, if the published literature is any guide, the book has been most impactful in terms of influencing the way that behavior analysts teach language skills, typically in straightforward ways involving relatively simple functional relations. Very little attention has been given to the epistemological implications of Skinner's analysis, especially in the context of present-day concerns. In what follows, I attempt to summarize that material, reorganize and update it for clarity, and modestly expand it to encompass aspects of scientific behavior not explicitly addressed by Skinner, and to describe in more detail the aspects that were explicitly addressed. Discussions of this sort often are long, detailed, and difficult to navigate. My goal is to provide as succinct an exposition as I can manage to meaningfully affect the behavior of as many readers as possible. The style errs toward straightforward description and away from philosophical digression.

Science as Verbal Behavior

When we refer to science we are referring primarily to the verbal practices of scientists (Day, 1969; Hackenberg, 2013; Moore, 2010; H. D. Schlinger, 2013; Skinner, 1953, 1957), which are shaped by a particular kind of verbal community that differs in important ways from the verbal communities of everyday life (Skinner, 1957). All language is established and shaped by a verbal community, but the scientific verbal community differs from most others because it "encourages the precise stimulus control under which an object or property of an object is identified or characterized in such a way that practical action will be most effective" (Skinner, 1957, p. 418). Scientific verbal practices are codified and recorded so that they can affect the behavior of all scientists, including those without access to the original controlling variables. In Skinner's words,

The contingencies of reinforcement which create a special scientific repertoire and sharpen its stimulus control provide for a kind of behavior which serves the listener as (1) an optimally effective discriminative stimulus in evoking any behavior he may already possess with respect to a situation and (2) a fruitful source of instruction in altering his behavior with respect to new situations (Skinner, 1957, p. 420).

It is important that the scientist respond to stimuli in the same ways that other scientists respond, and that sharp distinctions among stimulus classes are maintained. When someone describes an event as a conditional stimulus, for example, it is important that all listeners respond similarly, as if that event elicits a smooth muscle or gland response resulting from a history of being paired with some other stimulus that

already elicited such a response. The verbal community is at a disadvantage if the speaker describes the event as a conditional stimulus when it actually is a discriminative stimulus, because the listeners will not respond effectively.²

Moreover, it is important that scientists describe what they observe rather than what they want to observe. "Scientific verbal behavior is most effective when it is free of multiple sources of strength; and humor, wit, style, the devices of poetry, and fragmentary recombinations and distortions of form all go unreinforced, if they are not actually punished, by the scientific community" (Skinner, 1957, p. 419). That the language of science is so importantly related to the actions that scientists take is a primary reason that the scientific verbal community emphasizes precise stimulus control. This is especially true of empirical research, basic and applied, where what scientists say controls what other scientists do in the laboratory and in the field. This is not the case in literature, for example, where the listener should expect no practical benefit as a result of responding to what is written and, in most cases, does not respond to what is written other than in an echoic or intraverbal sense. If the writer of a novel provides an inaccurate description of some aspect of the world, the listener is at no great disadvantage. If the scientist provides an inaccurate description of the results of an experimental preparation, that is a very different story.

Scientific writing is often considered dull, but this is not so much a problem as it is a solution. Scientific verbal practices discourage colorful language that can lead the listener to more or less strongly agree with what is written independent of the actual evidence described—the data should speak for themselves. To the extent possible, scientific verbal behavior exemplifies the kind of stimulus control that defines the tact as a verbal operant. When sources of control characteristic of, say, a mand are present, the verbal community withholds reinforcement or might even punish the behavior. To put it colloquially, scientists should say what they see, not what they want to see.

Scientific writing requires the presentation of data and the frequent and clear citing of relevant sources as a practical way to provide the listener with access to some of the same variables that are controlling the behavior of the speaker. Of course, there is more to scientific writing and speaking, as raw data do not control behavior as effectively as summarized data (Michael, 1974). As Gould (1981) put it, "Numbers suggest, constrain, and refute; they do not, by themselves, specify the content of scientific theories" (p. 106). What controls the reader's responses differs from what controls the experimenter's responses. In a published paper, for example, the experimenter has responded to the data under stimulus control characteristic of tact and intraverbal relations (cf. Palmer, 2016). The reader is left to engage mostly in echoic and intraverbal responding controlled not by the experiment but by the experimenter's descriptions (tacts) and explanations (intraverbals) of the experiment.

Summaries of data, including verbal statements controlled by those data, minimize the variability evident in the raw data and obscure the variability of the contingencies responsible for the verbal statements (Hackenberg, 2013; Palmer, 2013). Because the varying stimuli are absent, they cannot control the behavior of the listener. This can be a virtue or a vice, depending on the relevance of the missing data. If the speaker describes the data

² I will refer to *speaker* and *listener* throughout this paper, both for consistency and for clarity. The terms should be taken to refer generally to all forms of speaking (e.g., vocal, written, gestural) and listening (e.g., hearing, reading).

obtained in the presence of the independent variable as higher than data obtained in the absence of the independent variable, none of the variability evident in the dataset remains to influence the behavior of the listener. Even if numbers are used to categorize the data described, say 5 responses per minute versus 20 responses per minute, and those numbers are plotted on a graph or listed in a table, the range of variables available to influence the speaker are absent for the speaker. As Palmer (2013) put it,

A speaker may utter the tact fish in response to a picture of a marlin, a fillet on a slab, a can of tuna, a trout, a goldfish, a haddock, a smelt, or any one of countless other fish as well as countless fish within species, each of which is unique in some respects. That is, the class of idiosyncratic creatures and other stimuli that evoke the response fish is nearly unlimited. But when the response is uttered and serves as a discriminative stimulus for behavior of the listener, all of that potential variability is lost. That is to say, in the absence of other variables, the listener has no way of responding differentially to any variability in stimulating conditions. The verbal discriminative stimulus has filtered away, as it were, all of unique features of the setting, and the listener cannot recover it. (p. 271)

By and large, how we depict and describe the data we collect is what controls our subsequent behavior and, most especially, the behavior of other scientists (Hackenberg, 2013). This is why the reinforcing practices of the scientific verbal community need to be precise; typically, more precise than the practices of our everyday verbal communities. In reality, few scientists have direct contact with much of what they talk about, even things with important influences on what they study. I would bet that most behavior analysts talk about the matching law (e.g., Herrnstein, 1961), and probably discuss it in relation to their work or the work of others, though relatively few behavior analysts have actually conducted an experiment on the matching law. Despite my earlier point that behavior controlled by variables characteristic of the tact is central to scientific verbal practices, echoic, intraverbal, and autoclitic relations (Skinner, 1957), as well as stimulus-equivalence relations (e.g., Miguel et al., 2015; Sidman, 2000; Sidman & Tailby, 1982) and verbal function-altering relations (e.g., Blakely & Schlinger, 1987; H. Schlinger & Blakely, 1987), also are central to what scientists say (Hackenberg, 2013; Palmer, 2013; H. D. Schlinger, 2013).

As a science matures, “Not only does it make statements about the world, it makes statements about statements...which helps to generate new rules very much as the rules themselves generate new practices” (Skinner, 1953, p. 14). Initially, the statements made in response to data and to statements about those data probably exemplify intraverbal control insofar as they have not been made before under those specific conditions. Once emitted, those statements can be reinforced under specific conditions and can be expected to occur again under similar conditions, in which case we would call the operants themselves intraverbal (Palmer, 2016).

False Leads and Misdeeds

Recorded descriptions of events permit future scientists to behave without constructing all of the necessary conditions for a given phenomenon so that they can

tact the relevant relations themselves. A liability arises, however, when attempts to reconstruct those conditions and the effects of those conditions would fail if actually undertaken. This is the reproducibility problem that currently commands so much attention, especially in psychology (Ioannidis, Munafo, Fusar-Poli, Nosek, & David, 2014; Open Science Collaboration, 2015; Pashler & Wagenmakers, 2012). Once descriptions of events are recorded, they can control behavior at great strength, especially if there is no direct contact with the events being described. The matter then becomes one characterized by social contingencies that maintain certain kinds of verbal practices independent of the data or, more importantly, the events giving rise to those data.

Such “rule-governed” behavior (e.g., Blakely & Schlinger, 1987; H. Schlinger & Blakely, 1987; H. D. Schlinger, 1990) can be slow or impervious to change when the actual contingencies differ from the contingencies described (e.g., Catania, Matthews, & Shimoff, 1982; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Joyce & Chase, 1990; Matthews, Catania, & Shimoff, 1985), such as in a scientific paper reporting experimental findings. The problem is compounded when failures to replicate an experimental finding are not published, preventing scientists from coming in contact with revised descriptions of important phenomena. A related problem is that errors are sometimes identified in scientific papers that are so egregious the paper is retracted. The available evidence suggests, unfortunately, that retraction is not enough; the retracted papers tend to live on via existing citations in other papers and new citations (probably from second-hand sources) in new papers (Campanario, 2000; Teixeira da Silva & Bornemann-Cimenti, 2016). This can result in scientists continuing to contact the original, rather than the revised, descriptions of scientific findings and these descriptions exert echoic and intraverbal control over the behavior of the reader.

Scientists also respond to the phenomena they study influenced, at least in part, by reinforcement contingencies arranged by the scientific community that are independent of their interactions with the subject matter they study (Moore, 1984). This seems to be playing a role in the reproducibility problem, noted above. The scientific enterprise has long arranged powerful contingencies for bold, new, and surprising conclusions, almost, it seems, irrespective of the data from which those conclusions are drawn (Meehl, 1967). These generalized conditioned reinforcers—money, fame, prestige—often trump the relatively small reinforcers provided for a job truly well done in the laboratory. Moreover, the successful control of the world, even if illusory, can be a powerful reinforcer for even the most virtuous scientist. To speak loosely, knowing about something and knowing how to do something seem to be powerful reinforcers for most of us, any malicious intent aside. As Skinner noted, there are cases in which “[a] special measure of generalized reinforcement has led him [e.g., the scientist] to misread a point on a scale of measurement” (Skinner, 1957, p. 149). We could call this a distorted tact, where certain motivating operations related to the “special measure of generalized reinforcement” influence the form of the response otherwise controlled by the number on the scale corresponding to the quantity of the thing being measured (Moore, 1984; Skinner, 1957). As suggested earlier, sometimes scientists describe not what they see, but what they want to see, even when doing so is not intended to mislead.

The Jargon of Science

There is a rub, however. It is not simply a matter of providing access to raw or summarized data, else there would be little need for introduction, results, or discussion sections of scientific papers. Most readers of scientific papers do not have the relevant history with respect to the data newly reported or the relevant data collected in previous experiments, which can limit the effectiveness of their responses.³ That different listeners will respond differently to what is said by a speaker reflects differences in the histories of those listeners. That is, the variability of listener responses is not—indeed, cannot—be related to the variability of the variables controlling the speaker's behavior (Palmer, 2013). Another problem arises in that the variables controlling the behavior of the speaker, in addition to the raw data, can result in descriptions that differ markedly from what another observer would say in response to the same events.

The jargon of science, although not always a boon, is a solution to a problem. "To dispose of irrelevant controlling relations," scientists introduce "new forms of response as arbitrary replacements for the lay vocabulary—not only the special vocabulary of science but graphs, models, tables, and other ways of representing the properties of nature" (Skinner, 1957, p. 418). The jargon police, like the grammar police, punish deviations from codified verbal practices in order to maximize the common effects on the behavior of listeners. When a term common to the vernacular is used to describe a specific scientific phenomenon, the verbal community begins at a serious disadvantage with respect to establishing tight stimulus control over that verbal response. This is because the speaker already has a long history of contacting reinforcement in other various, if not contradictory, circumstances when uttering the same term. Even if the scientific community reinforces the term only under specific conditions, the amount of reinforcement in those specific conditions is weighted against the reinforcement contacted previously in more varied circumstances. Moreover, it is quite likely that the speaker will continue to contact reinforcement in varied circumstances when uttering the term in the general verbal community, thereby blunting the degree of stimulus control established by their scientific verbal community.

Subjective Objectivity

Because scientists are products of their verbal communities, both scientific and non-scientific, they will respond to the circumstances they encounter as a scientist influenced by their experiences outside of the scientific community. We use the term bias to refer to cases in which the reinforcement contingencies arranged by the nonscientific community conflict with those arranged by the scientific community and, more importantly, when they alter the way the scientist responds to the discriminative stimuli produced while conducting their research. Sometimes, the scientist can describe the contingencies that lead them to respond in ways other than the ways they would if, for example, their behavior was controlled primarily by the discriminative stimuli

³ Of course, ignorance can sometimes be a virtue, as when "a fresh set of eyes" or an impartial observer sees a problem in a new way, but those exceptions probably prove the rule and are beyond the scope of the present discussion.

produced by an experiment. In such cases we say that they are aware of the bias, and the problem is proportional to the degree to which they take actions to minimize the extraneous sources of control. The problem is greater when the scientist cannot describe the extraneous sources of control. In such cases, we would say that they are unaware of the bias and, hence, are unlikely to arrange the experimental situation so as to minimize the impact of the bias.

We tend to view scientific description as objective (unbiased), whereas opinion and anecdote are viewed as subjective (biased). Objectivity and subjectivity can refer only to statements we make about the world, including our own behavior. The terms do not refer to properties of stimuli, they refer to the reinforcement histories that give rise to the verbal statements controlled, in part, by those stimuli. Objective statements are those for which the controlling variables are shared among most members of the verbal community and depend relatively little on idiosyncratic experiences. The origin of the term *objective* is found in the Latin *objectum*, meaning object. That is, a physical feature of the natural world to which all people have access. For example, a statement such as, “The apple is red” is objective when made in response to the presence of a red apple because all members of the verbal community have access to the most critical controlling variables and, given common verbal histories in that verbal community, would respond the same under similar conditions.

In contrast, subjective statements are controlled mostly by variables whose function was established because of experiences specific to the history of the speaker. The origin of the term *subjective* is found in the Latin *subiectivus*, meaning “of the subject,” with *subject* meaning literally, “person under control or dominion of another.” In this context, something that is subjective is dependent on the way a particular individual uses it, or “controls” it. A statement such as, “The apple tastes good” is subjective because many members of the verbal community would respond differently under those same conditions. Of course, the distinction is not always so clear, as there are circumstances in which similar statements would be made by members of one specific verbal community under certain conditions, whereas members of a different verbal community would make different statements under those conditions, with one kind of statement still considered objective and the other subjective.

Skinner (1945) drew the distinction between objective and subjective using the moveable line between public and private events. By reframing the distinction in this way, he was able to ultimately dismiss it. Public events are those events that can be observed by more than one person, hence there can be agreement as to what happened. Private events, on the other hand, can be observed by only one person (the person experiencing them); hence, there can be no agreement between observers because there is only one observer. If I say that my tooth hurts, this is a subjective statement because the (private) event is observed only by me. If I say that my tooth is broken, this is an objective statement because others can see the broken tooth (a public event) just as well as I can. The distinction, then, between objective and subjective (or public and private) still is not to be found in terms of any characteristics of the events themselves, but rather in terms of the observability of those events. Something that is unobservable at one point in time can become observable at another point in time, meaning that subjective events can become objective events even though the events themselves do not change. I might shoot a hole in one on the golf course to the applause of the other golfers in my party, or I might shoot a hole in one while practicing by myself. The former event would be public,

and descriptions of it objective, whereas the latter event would be private, and descriptions of it subjective. However, the events would not otherwise differ.

What really matters is not that a statement can be clearly classified as objective or subjective or the relevant events as public or private, but whether the statement is falsifiable. Unlike “the apple tastes good,” “the apple is red” is a scientific statement, primarily because the latter is falsifiable, whereas the former is not. If a green apple is found, most, if not all, members of the verbal community will respond “green,” not “red,” due to common reinforcement histories. There will be considerably more variation in terms of how many would respond “tastes good” even if the same apple is tasted, as there is no real way to falsify the statement. Something is falsifiable to the extent that variables could be manipulated to influence the phenomenon in way that would cause the members of the scientific community to describe new functional relations in place of previously described functional relations. The scientific community should describe new functional relations only if the new descriptions in some way permit better prediction of the described event or, where possible, better control of that event. That is, statements are “not true or false simply according to public agreement about the correspondence between it and other events, but according to the impact that the use of the term, concept, or statement has on dealing successfully with the phenomenon of interest” (Hayes & Brownstein, 1986, p. 177). The truth of a statement is proportion to the degree to which it permits us to behave effectively with respect to what it is a statement about.

But what does it mean to behave more effectively? Generally, it means to behave in ways that maximize contact with reinforcement relative to other ways of behaving. Consider the famous Monty Hall problem, in which a gameshow contestant has the opportunity to choose among three closed doors. Behind one of the doors is a shiny new sports car, while behind the other two doors are haggard old goats. At the outset, the chance of any door being the winning door is .33. The contestant chooses the first door. Now the host, Monty Hall, opens one of the remaining two doors to reveal a goat. The contestant is then given the option of staying with their initial choice, or selecting the other remaining door. What do you do? Many people assume the best option is to keep your door, because nothing has changed about the chance that you chose the winning door on your first try. But something has changed. The door you chose has a .33 chance of being correct, while the other two doors *collectively* have a .66 chance of being correct. Because one of those doors is now out of the mix, the remaining other door now has a .66 chance of revealing the car. If you were able to play the game multiple times, the rule “switch your door” would result in you winning more often than “keep your door.”⁴ This is not obvious to most people based simply on their everyday experiences. The statement about the world (the game, in this case) generated by our understanding of probabilities would lead to more effective action (switching doors) because it would more often result in reinforcement (the car). Scientific statements, derived from careful observation and experimentation, describe the world as it appears when observed carefully, systematically, and repeatedly, rather than

⁴ If you do not believe that it is better to switch and need more convincing, a quick internet search of “Monty Hall Problem” will return many detailed explanations of the problem and, even better, a number of computer simulations that will allow you to play the game again and again to see for yourself.

as it can appear when observed unsystematically, based on unrepresentative samples, and experienced only occasionally.

What It Means to Know Something

Our behavior has been changed, but there is no evidence that we have acquired knowledge. To be "in possession of the facts" is not to contain the facts within ourselves but to have been affected by them. (Skinner, 1977, p. 6)

"Knowing that" something is a certain way should be distinguished from "knowing how" to do it (Hineline, 1983; Skinner, 1957). The former implies a mostly verbal repertoire, whereas the latter usually implies a nonverbal repertoire. Most of us "know that" you are supposed to keep your eye on the ball, but many of us do not "know how" to do that. The ivory tower academic is accused of too much knowing-that and not enough knowing-how. (After all, those who can't, teach.) This is not necessarily a bad thing, depending on your perspective. A great deal of science involves knowing that certain things stand in lawful relations to other things, even when we do not have the means of doing anything about those relations. Newton could explain the ocean tides, but he certainly could not exert any control over them. That is, Newton knew that the tides were controlled, and by what, but he could not control them in any practical way. He could predict, but he could not control. "Knowing that" something is and "knowing how" to do something, then, is an important part of the distinction between scientific interpretation and experimental analysis (Palmer, 1991). Science prioritizes experimental analysis, and the resulting verbal behavior comprises mostly tact relations, with the proximate controlling variables (i.e., data) evident. Scientific interpretation, however, is to a large extent intraverbal, and extraneous variables can come to control aspects of the scientist's verbal behavior, with those variables sometimes difficult or impossible to identify. The scientific community, then, tends to be less confident about interpretations because they are not easily verified. That is, scientists respond more tentatively (e.g., at longer latencies, at a reduced magnitude) to interpretive statements because it is difficult for independent investigators to identify the controlling variables for those statements.

Similarly, we can know how to do something even if we are unable to describe how we do it. The musician knows how to write beautiful music, but she is unable to tell us how to do the same. Science is a matter of being able to describe how things are done. People could do things long before they could describe how to do them. It was only when people began to describe how to do things that science became possible. Behaving verbally is often easier, possible across a wider range of conditions, and executed in briefer periods of time than nonverbal behavior. This is especially useful for the sciences, particularly the basic sciences, where practical solutions are not always forthcoming. Because of the ease with which we can speak, read, etc., the amount of reinforcement necessary to maintain our verbal behavior is small, because even small reinforcers are relatively large compared to the effort required to produce them (Palmer, 2014). We sometimes talk just to hear ourselves talk. The sight of a coherent sentence on our computer screen can be enough to reinforce the act of writing. Whether other scientists reinforce our writing or

speaking, however, is proportional to the degree to which our descriptions of the world permit them to behave more effectively.

Prediction and Control

...The scientific "system," like the law, is designed to enable us to handle a subject matter more efficiently...When we have discovered the laws which govern a part of the world about us, and when we have organized these laws into a system, we are then ready to deal effectively with that part of the world. By predicting the occurrence of an event we are able to prepare for it. By arranging conditions in ways specified by the laws of a system, we not only predict, we control: we "cause" an event to occur or to assume certain characteristics. (Skinner, 1953, p. 14)

Prediction and control was at the center of John B. Watson's behaviorist manifesto (Watson, 1913). According to Watson, psychology, as a science, was in the business of predicting and controlling behavior, just as the other natural sciences were in the businesses of predicting and controlling their particular subject matters, more or less. Natural science, behavioral or otherwise, is more than the observation of events as they occur, it is the description of functional relations. As Claude Bernard, the founder of modern experimental physiology and medicine, put it, "proof that a given condition always precedes or accompanies a phenomenon does not warrant concluding...that a given condition is the immediate cause of that phenomenon. It must still be established that when this condition is removed, the phenomenon will no longer appear..." (Bernard, 1865/1957, p. 55). When you continue to deliver food following each lever press, the rat continues to press the lever. When you discontinue the food deliveries, the rat discontinues the lever presses. Back and forth, so on and so on. If you can identify the relevant controlling variables for a phenomenon, you can predict its occurrence based on the presence or absence of those variables. If you describe the relevant controlling variables accurately, others can do the same. If the controlling variables are accessible, you can alter them and, in turn, alter the occurrence of the phenomenon, and, again, you can describe to others how they can do the same.

A Radical Epistemology⁵

What we know about the world, in the sense of "knowing that," is simply the way we have learned to talk about the world. The degree to which this talk is "true" or "factual" is determined largely by the reinforcing practices of a verbal community. For Skinner, "meanings, contents, and references are to be found among the determiners, not the properties, of a response" (1945, p. 271). Said another way, "terms, concepts, and constructs do not have an existence independent of the behavior of the speaker" (H. D. Schlinger & Normand, 2013, p. 286). Skinner was not the first to make this kind of argument (see Moxley, 1997), as the following passage from John Dewey's *How to Think* illustrates.

⁵ This discussion purposely omits the similarities and differences between Skinner's radical behaviorism and logical positivism and operationism. In brief, Skinner initially embraced logical positivism and operationism, but rather quickly moved away from the mainstream of those positions, such that his radical behaviorism differed in important ways from those philosophical stances, as they are commonly understood (Moore, 1985).

To grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things; to note how it operates or functions, what consequences follow from it, what causes it, what uses it can be put to. (Dewey, 1933, p. 137)

Still, Skinner's is a fairly radical approach to epistemology that follows directly from his functional analysis of verbal behavior. In Skinner's analysis, something is true if the verbal community reinforces statements about it under certain conditions because doing so leads to more effective action. What the verbal community reinforces is governed largely by the benefit accrued as a result of responding in prescribed ways to certain statements. What constitutes a benefit is a more complicated matter, especially as the benefits can vary both within and across verbal communities. Effective behavior is behavior that produces reinforcement, but what functions as reinforcement for any individual can be idiosyncratic or, at the very least, subject to change, at least in the short term. Even food functions as a reinforcer only when relevant motivating operations are in effect.

Because what we learn about the world and all of its parts, including ourselves, from our verbal communities (Skinner, 1945, 1953), what we can know is constrained by the repertoires established by our verbal communities. In all circumstances, there are limits on what aspects of the world can come to control our behavior, verbal or otherwise. If we were very small, gravity would be largely inconsequential to our everyday experience. We would not notice it and we would not ask questions about it. Flies do not know and do not care—they are too small. The world is a different place to them. The average person is the same size as the average scientist, but there are aspects of the world that are hidden from them. Not because they are too small or too big, but because they are never in a position to see them. They never see what the scientist sees, in many cases, because the scientist looks carefully at specific things, has special tools available, and has opportunities to watch things repeatedly. They come to know prediction and control. They see variables that are invisible to the average person. So, for the average person, such control (and such phenomena) are no more real than ghosts.

Some parts of the world, real to the scientist, are not real to the average person. They are not part of their world. If they exist at all, it is only in terms of verbal behavior—what other people (scientists, teachers, and journalists) describe to them. The properties of the verbal behavior, and the history with respect to that verbal behavior, then matter more than the phenomena being described. The behavior is mostly echoic and intraverbal. It most certainly is not tacting, which, again, is so central to science. It is true that not all aspects of our world are detectable by us, so that we are not “knowing” all of the “real” world. But that does not matter. Richard Dawkins put it nicely:

But if solid things are mostly empty space, why don't we see them as empty space? Why does a diamond feel hard and solid instead of crumbly and full of holes? The answer lies in our own evolution. Our sense organs, like all our bits, have been shaped by Darwinian natural selection over countless generations. You might think that our sense organs would be shaped to give us a 'true' picture of the world as it 'really' is. It is safer to assume that they have been shaped to give us a useful picture of the world, to help us to survive. (Dawkins, 1995, p. 31)

Conclusion

David Hume argued that causality, as studied by scientists, was an illusion. The idea of causation was based on a fallacy—the induction fallacy. If we say all apples are green, this really means simply that all the apples we have seen have been green. It takes only one red apple to spoil that bunch. The same holds true for any observations of functional relations. But at the end of the day, Hume was content to conclude that, despite the shortcomings, science worked and causality seemed a useful way of thinking. Causality might be an illusion, but it is a way of describing the world that promotes effective behavior, arguably more than any other way of describing the world. It permits effective action. It allows us to predict and control, with strong consensus that we are predicting and controlling, skeptics be damned. It is useful. Hume was a champion of science. Scientific pragmatism trumps paralyzing philosophical skepticism.

What we know is what we say, and what we say is determined by our verbal communities. Hence, what we know is what our verbal community teaches us to know. We know best what is most useful about the world. It enables us behave effectively. To paraphrase Moore (1984, p. 85), knowledge is not a cause of effective action, it is what we call action that is effective. Scientists are unique in that they, more so than non-scientists, have the experience of behaving about as effectively as possible—they can predict and control. This is what makes all the difference, in the sense that it makes science different from other ways of “knowing” about the world. Science is not simply one way of knowing about the world, it is the most effective way of knowing about it. Scientific talk leads to effective action.

Compliance with Ethical Standards

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

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