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Behavioral Sciences

Interpretation: An Aim and A Method of B. F. Skinner's Science

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ABSTRACT – This paper has the general purpose of presenting Skinner's vision of interpretation, both as aim and method. Besides, it has as specific purposes (a) to define interpretation, according to Skinner; (b) to indicate when and how the author defends its accomplishment; (c) to relate interpretation with other aims and methods proposed by Skinner; (d) to indicate contributions and limits of interpretation, according to the author. In this regard, we examined 35 texts of Skinner related to the subject, published between 1931 and 1990. Both as aim and method, we show that interpretation offers theoretical, methodological, and technological contributions to Skinner's science, although it presents limits related to its inferential and speculative nature, as well as to its plausible and sometimes temporary format.

KEYWORDS: interpretation, Behavior Analysis, B. F. Skinner

Interpretação: Um Objetivo e Um Método da Ciência de B. F. Skinner

RESUMO – Este artigo tem por finalidade geral apresentar a visão de Skinner sobre a interpretação, seja como objetivo ou como método. Além disso, tem como propósitos específicos (a) definir a interpretação, conforme Skinner, (b) apontar quando e como o autor defende a sua realização, (c) relacionar a interpretação a outros objetivos e métodos propostos por Skinner e (d) indicar contribuições e limites da interpretação, segundo o autor. Para isso, examinamos 35 textos de Skinner ligados ao assunto, publicados entre 1931 e 1990. Seja como objetivo ou como método, mostramos que a interpretação oferece contribuições teóricas, metodológicas e tecnológicas à ciência de Skinner, ainda que ela apresente limites relacionados à sua natureza inferencial e especulativa, bem como ao seu caráter plausível e, às vezes, temporário.

PALAVRAS-CHAVE: interpretação, Análise do Comportamento, B. F. Skinner

Contrary to popular belief, the science proposed by B. F. Skinner does not have as its only aims the prediction and control of human behavior. Likewise, it does not adopt experimental analysis as its sole method. Following this line of reasoning, some literature reviews attribute different goals and methods to this science (e.g., Baum, 2011; Donahoe, 1998; Holland, 1992; Moore, 2011), one of which is interpretation. In particular, interpretation is sometimes indicated as an aim (Hayes & Brownstein, 1986) and sometimes as a method (Andery, 2010). Despite Skinner having dedicated a good portion of his work to interpretation, this activity is underexplored by behavior analysts. Therefore, it is worth asking the following: Is interpretation an aim and/or a method for this science? If it is an aim, is it equivalent or secondary to other aims? If it is a method, is it comparable or subordinate to experimental analysis? Furthermore, what does interpretation mean in this science?

In 2010 Hayes considered interpretation to be a method. For the author, it is a means of achieving the main goals of behavior analysis: prediction and control. Morris (1992), on the other hand, included interpretation as one of the aims of this science, giving it the same weight as prediction and control. According to the author, these different aims represent the ways of understanding the object of study. Therefore, one understands a behavior when it is possible to predict, control, or interpret it. Likewise, Donahoe and Palmer (1989) defined interpretation as the act of explaining complex phenomena using principles derived from experimental analysis. The authors defended engaging in it when there is no possibility of investigating an object of study with the prerequisites

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of experimental analysis (e.g., observation, mensuration, and manipulation). However, Palmer and Donahoe (1991) did not consider interpretation secondary to experimental analysis. The latter, in fact, is subordinate to the former. According to them, an adequate interpretation respects its own given scope (e.g., past and private behaviors), as well as the concepts formulated in the laboratory. "We engage in experimental analysis so that we can interpret the world. Our understanding of nature would be slight indeed if it were confined to those phenomena that have been analyzed experimentally. Most of our scientific understanding of the world is interpretation", they wrote (p. 125).

Donahoe (2004) added that interpretation points to new directions for basic and applied research. According to the author, when the principles prove to be insufficient to explain the object of study, we engage in the experimental analyses of simpler phenomena, both to complete the characterization of the principles and to formulate new concepts. In this respect, Palmer (2011) highlighted that interpretation does not reveal the truth of a phenomenon but rather allows for its comprehension based on available principles. This is a common practice in science and useful for solving human problems. In sum, he stated that "practice in normative science, when faced with phenomena that are not amenable to experimental analysis, is to engage in scientific interpretation, that is, to offer plausible accounts that appeal only to principles or observations established in the laboratory" (p. 206).

Given this, it is worth asking, what are the contributions and limits of interpretation in Skinner's science? In addition, *when* and *how* should one interpret? According to Palmer (2009), while experimental analysis is responsible for the discovery and refinement of principles in the laboratory, interpretation extends such principles to daily life – where observation, mensuration, and manipulation of variables are rarely possible, practical, or ethical, but also where incomplete information is available. The author, however, points to its limits:

> Interpretations do not tell us how nature works, but how it might work; they are just plausible scenarios, not facts about the world. Interpretations are only the extension of established principles to domains outside the laboratory and cannot discover anything new. Consequently they should not be advanced when empirical study is possible. Interpretation should be reserved for only those phenomena of which experimental control is impractical, unethical, or impossible. (pp. 14-15)

Considering the relevance of this subject and the limited number of works dedicated to it, this article has the primary purpose of presenting Skinner's view of interpretation, whether as an aim or as a method. In addition, it has the specific goals of (a) defining interpretation according to the author; (b) indicating *when* and *how* Skinner recommends engaging in it; (c) relating interpretation to other goals and methods proposed by the author; (d) indicating contributions and limits of interpretation, according to Skinner.

Although behavior analysis involves a theoretical domain, this domain does not exist in opposition to experimental research (whether basic or applied). On the contrary, it has its foundation in research and extends it to other phenomena. As highlighted by Leigland (2010), theoretical research (such as this) contributes to the development of a science by critically reviewing its practices. With this article, we expect to collaborate in this direction. Focusing on the importance of interpretation in Skinner's work is a way of clarifying potential misunderstandings about his science, as well as a way of stimulating new research about the topic, since the author himself, in several different moments, indicated the theoretical, methodological, and technological contributions of interpretation to behavior analysis.

Given Skinner's vast bibliographic production, it was a challenge to select texts connected to the objectives of this study. However, the previously cited literature reviews allowed us to compile a list of keywords used to identify some of these texts. The criteria used to include a term in the list was the word's recurrence. In this manner, the list was composed of the following words: description, explanation, prediction, control, interpretation, knowledge, understanding, theory, concepts, principles, science, behavior analysis, experimental analysis, aims, and methods. After constructing the list, we examined a compilation of Skinner's publications made by Andery, Micheletto, and Sério (2004). After adopting the classification suggested by the authors, we chose, as the first criteria for inclusion, *theoretical* articles and book chapters (e.g., historical, conceptual, and interpretative), given the nature of the present study. We therefore excluded both *empirical* articles and book chapters (e.g., research reports, equipment descriptions, and discussions about research conducted by third parties) and *others* (e.g., reviews, interviews, and letters to editors). Once the theoretical articles and book chapters had been selected, we consulted the keyword list to thoroughly examine each publication. As the second criteria of inclusion, we selected the presence of at least one of the keywords in the title, abstract, descriptors, subtitles, or in the body of the pre-selected texts. To identify them, we used the *Find* tool in the digitalized files of the articles and book chapters. After finding at least one of the keywords in the pre-selected texts, we read the corresponding paragraphs in order to check their compatibility with the theme of this study. When reading the paragraphs permitted us to answer at least one of the questions mentioned in the present article – which constituted the third inclusion criteria –, we added the text to the sample of this study, resulting in 35 of Skinner's texts, published between 1931 and 1990.

The term *aim* refers to the traditional meanings of *goal*, *purpose*, and *end* (cf. Caldas, 2011). *Method*, on the other hand, as suggested by Andery et al. (1988/2003), refers both to the *procedures* (e.g., observation, mensuration, and manipulation) employed by scientists to achieve their aims as

well as to the *philosophical premises* that underpin a certain science (e.g., conception of the object of study, model of causality, and the validity criteria of knowledge). With that said, we will show how Skinner introduced and developed the concept of *interpretation* throughout the years.

Initially, Skinner's (1931/1999) science had the aim of *describing* behavior. The description was not limited to action; it included the functional relationship between environmental stimuli and the organism's responses. According to the author, this type of description is synonymous with *explanation*, a notion inherited from the philosopher Ernst Mach (1838-1916). To explain his object of study, Skinner called for the creation of new concepts or the redefinition of old concepts. According to him, this requires identifying functional relationships by way of experimental analysis. This includes procedures such as the manipulation of independent variables, observation, and mensuration of potential effects on the dependent variable. In *The Behavior of Organisms*, Skinner (1938/1991c) stated that behavior analysis should go beyond identifying regularities. It needs to offer a simple and economical description of the object of study, that is, with the least possible number of concepts.

Beyond explaining behavior, Skinner's (1938/1991a) science had the aims of prediction and control. The three aims are connected, given that (a) prediction requires the identification of functional relationships and that (b) control requires the manipulation of variables of which the behavior is a function. For Skinner (1938/1991b), identifying relevant variables – reached via experimental analysis – permits prediction and directs control. At the end of the book, the author stated that he did not, in effect, extrapolate data obtained with simpler organisms in the laboratory to human behavior in daily life. Nevertheless, he added a caveat: "The importance of a science of behavior derives largely from the possibility of an eventual extension to human affairs" (p. 441). This extension, as will become clearer further on, refers to the *interpretation* of behavior – whether in the domain of knowledge production (e.g., formulating a theory) or in the context of technological application (e.g., solving daily problems).

In the area of knowledge production, Skinner (1945/1999) rejected truth by agreement between observers. Pitting himself against the operationalists, the author stated that a valid concept permits the scientist to act effectively upon the object of study (e.g., prediction and control). According to him, the psychological systems that base the formation of concepts on reported private events present limits. For Skinner, "any attempt to talk about one's private world (as in psychological system making) is fraught with self-deception" (p. 337). After all, how does one teach an individual to emit verbal responses under the control of private stimuli when that privacy hinders the differential reinforcement of these responses by the verbal community? The author indicated some possibilities. Here, we will only highlight the *inference* of private stimuli based on correlating public responses. We believe that this procedure, adopted by the verbal community, is sufficient to illustrate how *interpretation* – as a method for the inference of functional relationships between public and private events – contributes to the production of (self) knowledge. In this case, interpretation favors the process of learning verbal behavior under control of private stimuli. However, Skinner pointed out the limit of this method: "The inference is not always correct, and the accuracy of the reference is again limited by the degree of association [between the private stimulus and the correlating public response]" (p. 421). In this manner, he concluded that "It is, therefore, impossible to establish a rigorous scientific vocabulary for public use, nor can the speaker clearly 'know himself' in the sense in which knowing is identified with behaving discriminatively" (p. 422).

In addition to explanation, prediction, and control, another aim of Skinner's (1947/1999) science is *understanding*. According to the author, understanding could possibly be synonymous with explanation, given that both require discovering how the behavior relates to other events. In particular, this requires the demonstration of functional relationships. These relationships, Skinner observed, represent the facts of the science. "But the cataloguing of functional relationships is not enough" (p. 301) for understanding. The latter requires surpassing them and building a theory. For the author, building such a theory is a job mainly for experimental analysis, and it involves three stages: (1) identifying basic data; (2) formulating laws, that is, relationships between data that reach generality; (3) refining concepts "derived" from the laws about individual behavior. Although based on facts, a theory is not limited to them; it transcends them. "A theory is essential to scientific understanding of behavior as a subject matter", he highlighted (p. 348). In organizing, articulating, and transcending facts that were discovered experimentally, *interpretation* contributes to the development of a *theory* of behavior and to *understanding* the object of study beyond the limits imposed by the experimental method, such as the need for observation, mensuration, and manipulation. In this manner, as will be developed further on, experimental analysis and interpretation complement each other as methods of Skinner's science regarding not only practical aims (i.e., prediction and control) but also theoretical purposes (e.g., explanation or understanding).

As with interpretation, prediction and control both relate to a theory of behavior. Skinner (1951/1999) wrote the following about this topic:

> When we extend an experimental analysis to human affairs in general, it is a great advantage to have a conceptual system which refers to the single individual, preferably without comparison with a group. A more direct application to the prediction and control of the individual is thus achieved. (p. 105)

According to Skinner (1951/1999), the results observed in the laboratory can be extrapolated beyond it, both for

theorical (e.g., explanation or understanding) and practical goals (e.g., prediction and control). On this subject, he stated the following:

> What we transfer from our experiments to a casual world in which satisfactory quantification is impossible is the knowledge that certain basic processes exist, that they are lawful, and that they probably account for the unpleasantly chaotic facts with which we are faced. The gain in practical effectiveness which is derived from such transferred knowledge may be, as the physical sciences show, enormous. (pp. 106-107)

To extend laboratory results to daily life, or to transfer knowledge about basic processes to the world at large, is to *interpret*. This activity offers methodological (Skinner, 1945/1999), theoretical (Skinner, 1947/1999), and technological (Skinner, 1951/1999) contributions. However, interpretation faces objections. There are those who question the extension of experimental findings to more complex situations. While recognizing the difference between the laboratory and daily life, Skinner (1953/1965a) defended this extension. At the same time, the author acknowledged the limits of his science in explaining past facts. In these cases, the impossibility of conducting an experimental analysis leaves room for only "plausible guesses" (Skinner, 1953/1965b, p. 40), that is, interpretations about the controlling variables. For him, an example of this is clinical practice. In the absence of adequate information about a client's genetic and environmental histories, the therapist interprets their behavior based on currently available information.

Therefore, for Skinner (1953/1965b), interpretation is a plausible guess. It does not constitute a fact since additional information would be necessary to confirm it. Even so, it will be valid if it allows the scientist to take effective action upon the object of study or, in the case of clinical practice, if it helps the client engage in effective action in their daily life. In this situation, interpretation mediates the relationship between experimental analysis and technological application. At the same time, interpretation involves *inference* about the processes of variation and selection at the three levels (i.e., phylogeny, ontogeny, and culture), given that facts of the past cannot be observed, measured, nor manipulated (Skinner, 1953/1965a). As the author developed the model of selection by consequences, experimental analysis and interpretation became even more allied as *methods* for explaining and intervening upon the object of study.

Knowledge about the object of study is yet another aim of this science. There are two types of behaviors labeled as knowledge. One of them results from direct exposure to reinforcement contingencies. The other stems from the formulation of rules, that is, descriptions of contingencies. In the book *Verbal Behavior*, Skinner (1957/1992) is clear in this regard: the closer the scientist's verbal behavior is to a *tact*, the better. For this reason, he wrote the following:

> The theory of evolution cannot be confirmed by a set of tacts to the actual events taking place in the remote past, but a single set of verbal responses which appear to be tacts to such events is made more plausible – is strengthened – by several types of construction based upon verbal responses in geology, paleontology, genetics, and so on. Only a current event of the same nature (for example, the appearance or production of a new species under the proper circumstances) would generate a tact of the same form and convert the theory into a fact in that sense. (pp. 426-427)

The theory of evolution is an interpretation and not a fact. Paraphrasing Skinner (1957/1992), the closer an *interpretation* – taken to mean a *plausible statement* about functional relationships between stimuli in a past environment and an organism's responses at the time – is to a *tact*, the better. Or the closer an *interpretation* – taken to mean an *inference* about the three levels of variation and selection – is to a *fact*, the higher the probability of it contributing to an effective action. If the interpretation promotes such an action, it will be valid. In this manner, it will contribute to the theoretical development (e.g., explanation, comprehension, or knowledge) and to the technological application (e.g., prediction and control) of behavior analysis.

As a plausible and (sometimes) temporary assertion, interpretation represents *a part* of the scientist's verbal behavior. Such behavior is shaped by a specific community, which is responsible for refining the stimulus control of statements made by its members. According to Skinner (1957/1992), the scientific community punishes or extinguishes occasional figures of speech but tolerates certain "generic extensions" (p. 419). At the same time, it promotes the use of *autoclitics* to reveal the nature of the statements' *nonverbal* (p. 420) or *verbal* (p. 422) stimulus control. That is because scientists describe contingencies based on (a) experience with the objects of study (e.g., shaping by contingencies) and on (b) the experience of other scientists with their objects of study (e.g., control by rules). However, any scientific statement (e.g., interpretation) requires confirmation, especially "when the emerging [verbal] response has never been possessed as a tact or as an intraverbal" (Skinner, 1957/1992, p. 426).

In both the laboratory and daily life, the interpretation of the object of study has its origin in the experimental analysis of nonhuman behavior. Relating it to other aims, Skinner (1958/1999) stated the following:

> Beyond the prediction and control made possible by recent research in reinforcement lies the broader field of interpretation. And it is a kind of interpretation so closely allied with prediction and control that positive and successful action are frequently within easy reach. (pp. 173-174)

However, Skinner (1958/1999) warned that "The parallel between the contingencies now being studied in the laboratory and those of daily life cry for attention – and for remedial

action" (p. 171). According to the author, in any social situation, it is necessary to determine *who* is reinforcing *who*, with *what*, and with *what effect.*

In the book *The Analysis of Behavior: A Program for Self-Instruction*, Holland and Skinner (1961) highlighted three aims for this science: "A science of behavior has as its goal the prediction, control, and interpretation of the behavior of living organisms" (p. 279). The connection between the aims becomes clear in the next statement: "Knowing a set of conditions, we can predict behavior; manipulating a set of conditions, we can control behavior; knowing an effect, we might be able to interpret it in relation to its causes" (p.276).

For Holland and Skinner (1961), the three stated aims – prediction, control, and interpretation – are connected to explanation. The authors argued that to deem a phenomenon as scientifically explained, we must be able to "predict, control, or interpret it" (p. 280). Regarding interpretation, in particular, the authors clarified that **"**When we show that an [experimentally] established relation between behavior and a given set of conditions may be exemplified in a given case, we engage in interpretation" (p. 279). According to Skinner (1966/1969a), questions, plausible guesses, and provisional statements (i.e., interpretations) mark the investigation of a scientist. About the difference regarding the hypotheses of the deductive method, the author noted the following:

> In addition to the systematic manipulation of contingencies, the interpretation of human affairs is a rich source of suggestions to experiments. Do conditions identified in some episode of daily life actually have the effects observed when more carefully controlled? Can a certain history of reinforcement be shown to be responsible for a current performance? What changes in contingencies will have different and possibly more acceptable results? The guesses and hunches with which the experimenter proceeds to answer questions of this sort are not the formal hypotheses of scientific method; they are simply tentative statements for which further support is sought. (pp. 82-83)

At the same time, Skinner (1966/1969a) warned: "The use of concepts and laws derived from an experimental analysis in the interpretation of daily life is also a source of misunderstanding" (p. 100). According to the author, the goal of interpretation is to "give a plausible account of facts which are not at the moment under experimental control" (p. 100). In some cases, such an explanation cannot be demonstrated in the laboratory. Even so, he argued, it is preferable to alternatives that are not based on experimentally derived concepts. The extrapolation of laboratory results to human matters, Skinner underlined, offers another view of the object of study. In this manner, "We extrapolate from relatively simple conditions to relatively complex, not to confirm what someone claims to have seen in the complex case, but to begin for the first time to see it in a new light" (p. 103). Compared to ontogenetic contingencies, Skinner (1966/1969b) added, phylogenetic contingencies can hardly be submitted to experimental analysis. After all, the remote character of the latter imposes obstacles to experimental methods. Not by chance, the author restated that "The natural selection of a given form of behavior, no matter how plausibly argued, remains an inference" (p. 181).

The *bilateral* relationship between experimental analysis and interpretation is worth noting. On one hand, the interpretation of behavior outside of the laboratory become possible thanks to the previous formulation of concepts via experimental analysis. On the other hand, interpretation of the object of study in daily life raises questions to be investigated in the laboratory. As counterparts, interpretation and experimental analysis contribute to the theoretical and methodological refinement of this science. One can observe both the movement from the simple (e.g., laboratory, experimental analysis, and nonhuman behavior) to the complex (e.g., daily life, interpretation, and human behavior), as well as the reverse. The exchange between the methods is fundamental in reaching the different goals of behavior analysis.

Skinner (1969) also proposed the use of concepts formulated in the laboratory to improve technology in various areas. For Skinner, behavior analysis has the end goal of building an efficient culture. Regarding this, he stated that "Basic science always leads eventually to an improved technology, and a science of behavior is no exception. It should supply a technology of behavior appropriate to the ultimate utopian goal: an effective culture" (p. 22). It is a fact that reinforcement contingencies planned by the scientist in the laboratory are simpler than those present in daily life. However, experimental analysis in the first setting directs interpretation in the second one.

> It is only when we have analyzed behavior under known contingencies of reinforcement that we can begin to see what is happening in daily life. Things we once overlooked then begin to command our attention, and things which once attracted our attention we learn to discount or ignore. (Skinner, 1969, p. 10)

These statements by Skinner (1969) suggest that experimental analysis in the laboratory alters stimulus control in daily life. This is probably due to the knowledge acquired (e.g., shaped by contingencies and controlled by rules) in a simplified environment. Out of the laboratory, the scientist interprets reality under control of stimuli whose properties have been highlighted by basic or applied research. Interpretation, in turn, directs technological application in several domains (e.g., education and clinical practice), aside from formulating questions for experimental investigation (Skinner, 1966/1969a).

In the book *Beyond Freedom and Dignity*, Skinner (1971/2002) continued to recognize the differences between the laboratory and daily life. For the author, the former is more artificial, simple, and ordered. The simplification of working conditions, he stressed, marks the beginning of

any experimental science. It is no different for behavioral analysis. He wrote the following:

> An analysis of behavior naturally begins with simple organisms behaving in simple ways in simple settings. When a reasonable degree of orderliness appears, the arrangements can be made more complex. We can move forward only as rapidly as our successes permit, and progress often does not seem rapid enough. (Skinner, 1971/2002, p. 159)

Complex behaviors are targets both for experimental analysis and interpretation. In general, its controlling variables are characterized by not being observable, measurable, nor manipulated. Despite this, the scientist speculates using principles derived from experimental analysis. In fact, experimental analysis allows effective interpretation of the object of study. By arranging simpler contingencies and studying their effects in the laboratory, it contributes to the inference of the more complex contingencies of daily life. When reached in this manner, understanding directs, in turn, the application of technology. Regarding this, Skinner (1971/2002) observed that "Beyond interpretation lies practical action. Contingencies are accessible, and as we come to understand the relations between behavior and the environment, we discover new ways of changing behavior" (p. 149). The modification of complex behavior requires, therefore, both inference and manipulation of the variables of which it is supposedly a function.

In the book *About Behaviorism*, Skinner (1974/1976a) also defended the gradual advancement from simple to complex. According to the author, this allows us not only to recognize processes common to different species but also to identify exclusively human characteristics. Skinner (1974/1976b) observed that any information about an organism's genetic heritage and individual history contributes to the goals of prediction, control, and interpretation. However, information about phylogeny and ontogeny are generally inaccessible, which makes prediction and control difficult. In these cases, the scientist resorts to interpretation.

> As in other sciences, we often lack the information necessary for prediction and control and must be satisfied with interpretation, but our interpretations will have the support of the prediction and control which have been possible under other conditions. (Skinner, 1974/1976c, p.194)

Once more, Skinner (1974/1976a) identified a resistance to extrapolating laboratory results to daily life, where prediction and control are not attained with the same precision. However, the author reminds us that interpretation is a common practice. It does not represent a metascience. In his words,

> Obviously we cannot predict or control human behavior in daily life with the precision obtained in the laboratory, but we can nevertheless use results from the laboratory to interpret behavior elsewhere. Such an interpretation of human behavior in daily life has been criticized as metascience, but all the sciences resort to something much like it. (p. 251)

The plausible and (sometimes) temporary character of interpretation represents one of its limits in behavior analysis. Even so, for Skinner (1974/1976b), this approach is preferable to mentalistic explanations.

> When human behavior is observed under conditions which cannot be exactly described and where histories are out of reach, very little prediction or control is possible, but a behavioristic account is still more useful than a mentalistic one in interpreting what a person is doing or why he behaves as he does under such circumstances. (pp. 230-231)

In this manner, Skinner (1974/1976b) goes beyond the facts and speculates about behavior. He considered this an indispensable activity for the development of methods responsible for increasing control over the object of study, as evidenced in the following:

> Every scientific field has a boundary beyond which discussion, though necessary, cannot be as precise as one would wish. One writer has recently said that "mere speculation which cannot be put to the test of experimental verification does not form part of science," but if that were true, a great deal of astronomy, for example, or atomic physics would not be science. Speculation is necessary, in fact, to devise methods which will bring a subject matter under better control. (p. 21)

According to Skinner (1974/1976a), the development of technology often includes a previous exercise of interpretation. Regarding this, the author observed the following:

> Those familiar with laboratory research will be more likely to look for the important things and will know what other things to ask about; they will have a better understanding of what they see. That is why they can more accurately interpret daily life. The laboratory analysis makes it possible to identify relevant variables and to disregard other which, though possibly more fascinating, nevertheless have little or no bearing on the behavior under observation. Many other technological advances derived from the study of operant behavior have had the benefit of that kind of interpretation. (pp. 252-253)

Although he emphasized the contribution of interpretation to the development of technology, Skinner (1974/1976a) made another observation. For the author, the principles – derived from experimental analysis and applied to understanding and solving human problems – do not provide *all* the necessary information for particular cases. The solution to daily problems requires aligning knowledge of general principles with specific and practical situations. In this direction, Skinner (1977/1978a) evaluated that the decisions made in various environments would be more effective if behavior-analytic

principles were applied. According to Skinner (1977/1978b), the final aim of his science is to transform the world in which people live and not their "minds and hearts" (p. 112). Averse to mentalistic explanations, Skinner (1978) stressed that knowledge about phylogenetic and ontogenetic environments allows us to explain the object of study, contributing to its prediction, control, and interpretation. Concerning this, he stated the following:

> The fault lies, I am arguing, with a surviving mentalism. The sooner we abandon explanations of behavior in terms of feelings and states of mind, the sooner we shall turn to the genetic and environmental conditions of which behavior is a function. Enough is already known about those conditions to assure reasonable success in the interpretation, prediction, and control of human behavior. A refuse to take advantage of what is within reach could mean the difference between the survival and the destruction of our civilization or even the species. (pp. 94-95)

In the text *Selection by Consequences*, Skinner (1981/1987) presents an integral view of his model of causality. The author highlighted the processes of variation and selection at the three levels and stressed the importance of history in the determination of behavior. As already mentioned, while the interpretative method involves an inference about a behavior's history, the experimental method includes observation, mensuration, and manipulation of controlling variables in the present. Complex and multidetermined, the object of study requires a constant exchange between experimental analysis and interpretation, without which an explanation would be incomplete.

Despite this, Skinner (1983/1987) assessed that interpretation (a) was not adequately examined by scientific methodologists and (b) was misunderstood by critics in the operant field. Worried about the relevance of his science regarding world problems, the author believed that solutions would be found in the understanding initially provided by experimental analysis and with the application of technology, later directed by interpretation. In the chapter *The Evolution of Behavior*, Skinner (1984/1987) interpreted the evolution of the processes that change behavior. It is a plausible explanation, of an inferential nature, rather than experimentally demonstrated facts. Articulating hypotheses and transcending facts, he "reconstructed" the evolutionary process. Naturally, the author did not observe this historical transformation. He merely guessed how phylogenetic, ontogenetic, and cultural contingencies could have evolved. Thanks to the interpretative method, Skinner was able to produce plausible statements about the multidetermination of the object of study. Such statements can have a temporary character, being either confirmed or refuted by new experimental findings. The fact is that they raise questions to be investigated in the laboratory, just as the data produced in this setting shape new verbal responses for scientists.

In reference to experimental analysis, Skinner (1984/1988b) also observed the following: "It has supplied terms and principles of great practical value and, I believe, of equal value in interpreting human behavior observed under less favorable circumstances outside the laboratory" (p. 253). In this vein, Skinner (1984/1988e) stated that there are several fields "beyond prediction and control" (p. 26). He then posed a question:

> Do we remain silent about them? No, we interpret observations on those fields by using what we have learned from research in which we *can* predict and control. Most educated people accept such interpretations in lieu of the explanations which have come down to us from folk culture and religion. Human behavior is such a field… (p. 26)

In parallel, Skinner (1984/1988a) presented a clear definition of *interpretation*: "The use of scientific terms and principles in talking about facts about which too little is known to make prediction and control possible" (p. 207). Once again, an example of this is the theory of evolution, seen by Skinner (1984/1988b) as an effective interpretation.

> So far as I am concerned, science does not establish truth or falsity; it seeks the most effective way of dealing with subject matters. The theory of evolution is not true or false; it is the best possible interpretation of a vast range of facts in the light of principles which are slowly coming to be better known in genetics and related sciences. (p. 241)

According to Skinner (1984/1988c), the analysis of phenomena similar to those in daily life, conducted in laboratories, allows us to explain behaviors that are not susceptible to prediction or control. Regarding this, the author stated the following:

> As in modern astronomy, a laboratory science will continue to give, I believe, the best possible explanation of facts beyond experimental control – events in the world at large in the case of behavior, the waves and particles reaching the Earth from outer space in the case of astronomy. The depth and breadth of both fields depend not upon improvements in theory, but upon success in the analysis of presumably similar phenomena where some degree of prediction and control is possible. (p. 468)

Therefore, when prediction and control are not possible, behavior analysis resorts to interpretation, that is, the use of concepts and principles established in simpler situations to explain more complex phenomena. At the same time, Skinner (1984/1988d) underlined that "the heuristic value of an interpretation is to be judged by the quality of the theory and research which it leads" (p. 307).

As Skinner (1986/1987) indicated in the chapter *The Evolution of Verbal Behavior*, "We see the products of evolution, but not much of the process. Most of the story happened long ago, and little remains of the early stages" (p.

75). For this reason, he admitted, "we shall probably never know precisely what happened, but we ought to be able to say what might have happened" (p. 75). Along these lines, he added that "The plausibility of a reconstruction depends in part upon the size of the variations that are assumed to have occurred: The smaller the variations, the more plausible the explanation" (p. 76).

For Skinner (1987), therefore, the majority of explanations for behavior remains a question of interpretation. The human species separates itself from other species because of verbal behavior; in other words, it does not only respond to contingencies of reinforcement but also describes them. In this manner, both in the laboratory and in daily life, human behavior should be seen as a product of the prevalent reinforcement contingencies and of the people who speak about them. However, what people say to others and to themselves results from a personal history that is out of reach. For this reason, the author argued the following:

> For a long time to come, human behavior will probably remain largely a subject for interpretation rather than for prediction and control. Hence, we can see the importance of a science that studies the behavior of organisms whose basic behavioral processes are free of verbal complications – that is, non-verbal species or human subjects who have not acquired extensive verbal behavior" (p. 10)

Still, according to Skinner (1987/1989), interpretation is a legitimate practice:

> Astronomers interpret the waves and particles reaching Earth from outer space by using what has been learned under controllable conditions in the laboratory – for example, in high energy physics. In a similar way, we use what has been learned from an experimental analysis to explain behavior which cannot, at the moment at least, be brought under experimental control, such as covert behavior or behavior observed casually in daily life (p. 63)

DISCUSSION

Following the example of the literature reviews cited at the beginning of this article (e.g., Baume, 2011; Donahoe, 1998; Holland, 1992; Moore, 2011), reading 35 of Skinner's texts allowed us to identify the different aims and methods of his proposed science. Below, we indicate some texts in which Skinner describes these different aims. This is not a comprehensive list of examples. They merely illustrate, between parentheses, moments in which the author referred to the different purposes of his science: *description*, *explanation*, or *understanding* (e.g., Skinner, 1931/1999, 1947/1999, 1981/1987), *prediction* (e.g., Skinner, 1938/1991a), *control* (e.g., Skinner, 1938/1991b), *interpretation* (e.g., Holland & Skinner, 1961), and *knowledge* (e.g., Skinner, 1957/1992).

As an aim of behavior analysis, interpretation presented a status equivalent to that of other aims (e.g., Morris, 1992; Skinner, 1958/1999), establishing a complementary relationship with them (e.g., Skinner, 1990/1999). Defined by Skinner (1966/1969a, 1974/1976d) as a plausible and (sometimes) temporary explanation, interpretation is generally carried out when prediction and control of the object of study are (still) not possible (Donahoe & Palmer, 1989; Palmer, 2009, 2011; Skinner, 1947/1976c, 1984/1988e, 1987/1989). Despite its inferential and speculative nature, interpretation does not constitute unfettered speculation since it is based on laws, concepts, and principles derived from experimental analysis (e.g., Skinner, 1966/1969b, 1984/1988b, 1986/1987). It is *a part* of scientific knowledge (Skinner, 1957/1992), because knowledge produced in behavior analysis is both experimental and interpretative (e.g., Skinner, 1947/1999, 1984/1987). Together, the different aims of this science converge into a larger goal: the development of an effective culture by way of applying technology derived from the principles discovered in the laboratory (Palmer, 2011; Skinner, 1969, 1977/1978a, 1977/1978b).

Regarding the methods of Skinner's science, the reading of 35 of the author's texts revealed an emphasis on both *experimental analysis* (e.g., Skinner, 1931/1999) and *interpretation* (e.g., Skinner, 1945/1999, 1957/1992). Generally carried out in laboratories with nonhuman organisms, experimental analysis seeks to identify and demonstrate functional relationships in order to predict and control the object of study; it is applied, above all, to public, simpler, and necessarily present behaviors (Palmer, 2009; Skinner, 1938/1991a, 1938/1991b). This requires the manipulation of independent variables, observation, and the mensuration of potential effects on the dependent variable. The strength of this method lies in the fact that an organism's behavior is compared to the behavior of that same organism in different experimental conditions. In this manner, it counters the traditional comparison between a control group and an experimental group by way of statistical tests (Skinner, 1951/1999). Thanks to experimental analysis, it is possible to *inductively* formulate laws, concepts, and principles that compose a theory of behavior (Skinner, 1938/1991a, 1938/1991b). The interpretative method, on the other hand, allows for the development of scientific knowledge beyond the limits imposed by experimental analysis and is fundamental for the investigation of past, private, and more complex behaviors (e.g., Donahoe & Palmer, 1991; Skinner, 1945/1999, 1953/1965b, 1987). Applied in the laboratory and in daily life, it involves the *inference* of functional relationships, the *assumption* of controlling variables, and the *speculation* about processes at the three levels of variation and selection (e.g., Skinner, 1957/1992,

1966/1969a, 1966/1969b). As a method, interpretation tends to be adopted when experimental analysis is (still) not possible (e.g., Palmer, 2011; Skinner, 1987/1989).

Skinner's science is marked by the exchange between its methods. After all, as indicated earlier, interpretation required the previous formulation of laws, concepts, and principles derived from experimental analysis. In one sense, the former is subordinate to the latter. In another, interpretation indicated new directions for experimental analysis. In this case, the former subordinated the latter (Donahoe, 2004; Skinner, 1966/1969a, 1974/1976b). It is, in fact, a bilateral relationship (e.g., Skinner, 1981/1987). Some functional relationships inferred via interpretations are demonstrated or verified experimentally as laboratory techniques are refined. In these cases, interpretation has a temporary function. Other relationships may never be demonstrated or verified experimentally – be it because they involve historical aspects, be it because they do not allow for observation, mensuration, nor manipulation of variables. In these cases, interpretation is paramount (Palmer & Donahoe, 1991; Skinner, 1953/1965a, 1953/1965b). In fact, the complementary relationship between the methods becomes indispensable, especially because, as Skinner (1966/1969a) himself admitted, science is not a process characterized by strict order, in which one experiment leads to another, but rather a process in which plausible guesses and provisional statements (i.e., interpretations) guide the search for additional data.

CONTRIBUTIONS AND LIMITS

Either as an aim or as a method, interpretation offers theoretical, methodological, and technological contributions to Skinner's science. From a theoretical point of view, it was responsible for the organization, articulation, and extrapolation of experimentally discovered facts, thus broadening scientific knowledge and allowing for the understanding of human behavior in daily life (Skinner, 1947/1999). In the laboratory, meanwhile, as a plausible guess about controlling variables, interpretation directed experimental manipulation. The latter, in turn, sought to demonstrate the plausibility of the functional relationships guessed by way of interpretation (Skinner, 1957/1992). Thus, it was up to experimental analysis to confirm or refute the temporary nature of the interpretations offered by scientists (Skinner, 1966/1969a). If interpretations promoted an effective action, they were considered valid. Thanks to the exchange between methods, there was a refinement of behavioral theory (Skinner, 1984/1987). Along these lines, interpretation also offered methodological contributions to Skinner's science. This happened in different ways: (a) by *inferring* private stimuli while examining behavior, surpassing the methodological limits in the definition of the object of study (Skinner, 1945/1999); (b) by *speculating* about processes at the three levels of variation and selection, adding to the explanation reached via experimental analysis (Skinner, 1953/1965b, 1966/1969b); (c) by constituting a source of suggestions for new experiments (Skinner, 1966/1969a); (d) by stimulating the development of procedures that increased control over the object of study (Skinner, 1974/1976b). In this manner, interpretation still offered technological contributions to Skinner's science. In extrapolating data obtained with simpler organisms in the laboratory to human behavior in daily life, it established a bridge between experimental analysis and technological application (Skinner, 1969). This transference of knowledge about basic processes to the outside world enabled prediction and directed the control of the object of study (e.g., Hayes, 2010; Skinner, 1951/1999). Moving from the simple to the complex, from nonhuman behavior to human behavior, from the laboratory to daily life, interpretation helped solve problems in different areas and refined a technology of behavior (Palmer, 2011; Skinner, 1974/1976a, 1977/1978a). Turning back from the complex to the simple, from human to nonhuman behavior, from daily life to experimental analysis, interpretation also exposed the laboratory to the challenges of the outside reality, where prediction and control require the constant theoretical and methodological refinement of this science (Skinner, 1984/1988d). In sum, by intervening in the bilateral relationship between experimental analysis and technological application, interpretation fostered an effective action by the behavior analyst, both in the laboratory and in daily life (Skinner, 1958/1999).

One has to recognize, on the other hand, that interpretation also presented limits to Skinner's science. By constituting a plausible and (sometimes) temporary explanation of an inferential and speculative nature, it can be wrong (Skinner, 1945/1999). After all, it does not represent a fact but only a probable account (Skinner, 1953/1965b). From this point of view, interpretation is not responsible for discoveries but for speculations based on laboratory data (Palmer, 2009, 2011). No matter how plausible, such speculations still require experimental confirmation (Skinner, 1974/1976d). Indeed, Skinner (1986/1987) was clear in this respect when stating that interpretations do not describe how facts occur but rather how they could have occurred. Even so, it is worth remembering that the value of an interpretation is in its possibility of generating an effective action on world problems and not in its truth (Skinner, 1984/1988b).

A source of objections and misunderstandings, interpretation fulfills an important function in Skinner's science. It is a complementary aim to prediction and control, as well as a supplementary method to experimental analysis, offering a valuable contribution to behavior analysis (Skinner, 1990/1999).

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