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# OUTLINING A DIALOGUE BETWEEN SIDMAN AND HAYES ABOUT EMERGENT RELATIONS (1982-1994)

## *ESBOZANDO UN DIÁLOGO ENTRE SIDMAN Y HAYES SOBRE RELACIONES EMERGENTES (1982-1994)*

Marcos Spector Azoubel[1]
Nilza Micheletto
Pontifícia Universidade Católica de São Paulo

**Abstract**

Stimulus equivalence, as presented by Sidman and his colleagues, and relational frame theory, proposed by Hayes and his colleagues, are two of the main alternatives for explaining emergent relations between stimuli. The goal of this study is to analyze Hayes's criticisms of Sidman's conceptual contributions and Sidman's criticisms of Hayes's conceptual contributions between 1982 and 1994. Hayes and colleagues deviated from Sidman and colleagues when the former argued the following: contingencies that are systematically arranged by a verbal community seem to be necessary for the emergence of stimulus equivalence; that Sidman's concept of stimulus equivalence fails to explain why nonverbal animals are not capable to demonstrating equivalence;

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Correspondence should be addressed to Marcos Spector Azoubel, Laboratório de Psicologia Experimental, Rua Bartira, 387, Perdizes, São Paulo-SP, Brazil, CEP: 05009-000. E-mail: mazoubel@gmail.com

and that Sidman's concept of stimulus equivalence is merely descriptive and lacks a theoretical explanation for the emergence of the phenomenon. In turn, Sidman confronted some of these issues and argued that relational frame theory is based on hypothetical generalized operant behaviors, without a simple explanation based on known behavioral principles and without the necessary supporting data. He pointed to the various experimental studies that should be carried out to tackle the divergences that had appeared.

*Keywords*: symbolic behavior; stimulus equivalence; RFT; stimulus control; radical behaviorism.

## Resumen

La equivalencia de estímulos, propuesta por Sidman y colaboradores, y la teoría de los marcos relacionales, propuesta por Hayes y colaboradores, son dos de las principales alternativas para explicar la emergencia de relaciones entre estímulos. El objetivo de este trabajo fue analizar las críticas de Hayes a las propuestas conceptuales de Sidman y las críticas de Sidman a las propuestas y críticas conceptuales de Hayes, entre 1982 y 1994. Hayes y sus colaboradores discreparon de las propuestas de Sidman y colaboradores cuando afirmaron que el contacto con contingencias organizadas sistemáticamente por una comunidad verbal parece ser necesario para el surgimiento de relaciones de equivalencia de estímulos; que la propuesta de Sidman no explica por qué los animales no verbales son incapaces de demostrar equivalencia; y que el concepto de equivalencia de estímulos propuesto por Sidman es meramente descriptivo: faltaría una explicación teórica del surgimiento del fenómeno. Por su parte, Sidman abordó algunos de estos temas y señaló que la teoría de los marcos relacionales se basa en conductas operantes generalizadas e hipotéticas, sin una explicación simple basada en principios conductuales conocidos y sin el soporte de datos adecuado. Señala que se deben realizar estudios experimentales para hacer frente a las divergencias.

*Palabras clave*: conducta simbólica; equivalencia de estímulo; RFT; Murray Sidman; Steven Hayes; control de estímulos; conductismo radical.

In 1971, Sidman published a study that opened the way in behavior analysis to a series of new studies, teaching technologies and conceptual proposals (Critchfield et al, 2000). In this study (Sidman, 1971), a participant with intellectual disability underwent a procedure for teaching reading skills involving three sets of stimuli (20 written words, 20 spoken words, and 20 corresponding images). At the beginning of the experiment, the participant was already able to orally name the images and to select the correct image when presented with the corresponding spoken word as the sample. The participant was then taught the relations between spoken and written words and, as a result, was able to name the written words and to respond to relations between written words and images as well as images and written words – emergent relations that had not been directly taught.

Following this, Sidman and colleagues produced new research about stimulus equivalence, although they had yet to present a behavior-analytic concept for the phenomenon (Sidman, 1994). This was finally done in 1982 (Sidman & Tailby; Sidman et al.), when the term "stimulus equivalence" was formally introduced.

Sidman and colleagues described tests to assess the emergence of stimulus equivalence, which consistently predicted the emergence of relations between stimuli: "Appropriate tests can, however, be derived from the three properties that modern elementary mathematics texts specify as the definition of the equivalence relation: reflexivity, symmetry, and transitivity." (Sidman & Tailby, 1982, p. 6). In this perspective, being that A, B and C represent groups of stimuli, given trained conditional relations (if…then relations) between A-B and A-C, relations A-A, B-B, and C-C would be tested to test the emergence of reflexivity, B-A and C-A to test for symmetry, and B-C to test for transitivity.

The appearance of alternative explanations for stimulus equivalence was one of the consequences of these findings and of the concepts proposed by Sidman and colleagues (Critchfield et al., 2000). Relational Frame Theory (RFT), proposed by Hayes and colleagues (e.g., Hayes, 1991; Hayes et al., 2001), is one of the most disseminated alternative theories explaining the emergence of relations between stimuli and has given rise to several studies and behavioral interventions.

The debate between these and other theoretical perspectives remains alive in the behavior analysis community (cf. Belisle, 2020; Critchfield et al., 2000). It is possible that an analysis of the origins and developments of these debates could further our understanding of them (Morris, et al., 1990).

Considering this, the goal of the present study is to analyze (1) Hayes's critical evaluation of Sidman's concepts and (2) Sidman's responses to Hayes's criticism and concepts, between 1982 and 1994. This period corresponds to the interval between the publication of articles in which the concept of stimulus equivalence was formally presented (Sidman & Tailby, 1982; Sidman et al., 1982) and the publication of the book *Equivalence Relations and Behavior: A Research Story* (Sidman, 1994), which summarizes the main experimental findings and theoretical discussions about stimulus equivalence. Furthermore, this period also coincides with the first conflicting interpretations by Hayes and colleagues of the data for stimulus equivalence and with the first experiments based on RFT (Perez et al., 2013).

Some aspects of Sidman's conceptual proposal and his experimental investigations, presented until 1994, underpinned Hayes' criticisms between 1982 and 1994. These aspects are described below.

## Some aspects of Sidman's conceptual proposal for equivalence until 1994

The formal presentation of the concept of stimulus equivalence (Sidman & Tailby, 1982; Sidman et al., 1982) was accompanied by

several conceptual proposals by Sidman up to 1994 (cf. Azoubel & Micheletto, 2021).

In several studies published until 1994, Sidman and colleagues experimentally investigated the possible role of verbal mediation in the emergence of equivalence relations (e.g., Sidman et al, 1974; Sidman & Tailby, 1982; Sidman et al., 1985; Sidman et al., 1986). In general, the studies showed that participants were able to demonstrate the emergence of equivalence relations even when they did not apply the same verbal label to the stimuli that became equivalent.

Additionally, participants with less developed verbal repertoires were able to demonstrate the emergence of equivalence relations (e.g., Sidman, 1971; Sidman, & Cresson, 1973). According to Sidman, this is another aspect that suggests that equivalence relations do not require mediation by verbal repertoires.

Based on this data, Sidman (1986; 1990; 1994, Chapter 10) defended that it does not seem to be necessary to appeal to hypothetical mediational events when dealing with this phenomenon. In this manner, understanding the emergence of equivalence relations would have the theoretical value of allowing for the prediction of which relations would emerge (reflexivity, symmetry, and transitivity) based on teaching certain conditional relations between stimuli – all of which are publicly observable.

If learning certain conditional relations establishes the necessary conditions for the emergence of relations that have not been directly taught, independently of mediational processes, one could expect that nonhuman animals would also be capable of demonstrating the emergence of such relations. To investigate this issue, Sidman et al. (1982) compared the performance of nonhuman animals (Rhesus monkeys and baboons) and typically developing children, after using similar procedures for conditional discrimination, to evaluate whether they would demonstrate the emergence of symmetry between stimuli.

Sidman et al. (1982) were unsuccessful in verifying the emergence of symmetry in nonhumans (Rhesus monkeys and baboons), despite the same procedures having been sufficient to produce symmetry in

typically developing children. However, according to Sidman (1994, Chapter 10), this lack of success in observing symmetry with certain nonhuman subjects did not necessarily indicate that this was an exclusively human phenomenon nor that verbal repertoires were required. According to Sidman et al. (1982), perhaps the procedures should have been more adequately adapted to the nonhuman animals so as to identify possible variables that could have impeded the emergence of symmetry in this population.

In addition, Sidman (1994, Chapter 10) suggests that unplanned contextual controls could also have interfered in the emergence of equivalence relations. His conjecture is supported by data in a study by Bush et al. (1989), which sought to verify if conditional relations put under contextual control could become equivalence relations and, if so, if these emergent relations would remain under the same contextual control as the directly taught discriminations.

Bush et al. (1989) taught conditional relations between visual stimuli according to a contextual stimulus (sound and the absence of sound). They showed that participants demonstrated equivalence classes under contextual control. Since contextual stimuli can control if and when certain stimulus classes are demonstrated, then the "failure of laboratory contingencies to generate contextual control can account for some seeming failures of equivalence classes to develop" (Sidman, 1994, Chapter 12, p. 514). Perhaps certain contextual controls could explain the non-emergence of equivalence relations in experimental situations.

In arguing that the emergence of equivalence relations did not seem to depend on mediational repertoires, Sidman (1986, 1990, 1994, Chapter 10) defended the possibility of stimulus equivalence being a basic process, a product of natural selection, not reducible to other basic processes:

> Given our failure so far to derive equivalence from something more basic . . . it does not seem unreasonable to suspect that equivalence relations emerge from conditional discriminations for the same reason our behavior is reinforceable, and for the same reason our behavior is controllable by discriminative and

> conditional stimuli – because contingencies of survival have made us that way. (Sidman, 1990, p. 113)

Therefore, just as certain differential reinforcement contingencies can produce simple discriminations, some differential reinforcement contingencies establish the conditions for the emergence of equivalence relations. There would be no need for this explanation to resort to mediational processes: as basic behavioral processes, its explanation would reside in the history of natural selection that established such susceptibilities to antecedent stimulus control.

## Hayes's critical evaluation of Sidman's equivalence

To select material for the analysis of Hayes's criticisms of concepts proposed by Sidman, we organized a list of publications that cited studies by Sidman (1971) and Sidman and Tailby (1982), between 1982 and 1994. Citations of these works were searched on Google Scholar and Scopus. We found that McIlvane and Hayes were the authors with the highest number of publications, both with 22 articles citing at least one of these studies.

Among the works authored by Hayes, eight (Devany et al., 1986; Hayes, 1986, 1989, 1991; Hayes et al., 1988; Hayes & Hayes, 1989; Steele & Hayes, 1991; Wulfert & Hayes, 1988) cited both studies by Sidman (Sidman, 1971; Sidman & Tailby, 1982) and, because of this, they were selected for the present study. Due to the large number of publications by Hayes during this period, this selection criterion was applied to make the study viable.

Each selected text was read in its entirety. To analyze Hayes's responses to Sidman's positions, we identified excerpts in which Hayes made direct statements about them.

The first publication by Hayes to be analyzed was a book review (Ericsson & Simon, 1984) that discussed, from a cognitivist perspective, the use of verbal reports as data. The main point of Hayes's discussion (1986) of the reviewed book was to suggest that behavior analysts

needed to study the control of verbal behavior over the listener, because the defense that verbal stimuli functioned like any other discriminative stimulus did not seem to be backed by new data. Among the data that, according to the author, showed that antecedent verbal stimuli did not act like any other discriminative stimulus were those produced by Sidman (Sidman, 1971; Sidman & Tailby, 1982), which showed the emergence of stimulus equivalence relations. This article (Hayes, 1986) contains brief mentions Sidman's works (Sidman, 1971; Sidman & Tailby; 1982) to buttress the assumption that stimulus equivalence relations frequently occur in verbally competent humans, but not in humans with no language or in other animals, suggesting that verbal stimuli are different to other stimuli.

Although Hayes (1986) did not explicitly criticize Sidman's concept of stimulus equivalence, he hypothesized that the emergence of stimulus equivalence depended on contingencies systematically arranged by a verbal community. More specifically, Hayes (1986) stated that learning "relational frames" could be responsible for the emergence of the stimulus relations found in studies about stimulus equivalence. The author stated that a relational frame is "an ability to respond to arbitrary relationships between arbitrary stimuli" (Hayes, 1986, p. 356) – an operant behavior. He then hypothesized a history that could have taught a "synonymic frame", one of the operants that would explain the emergence of equivalence relations:

> For example, in the presence of stimuli indicating a synonymic frame (more so than in the absence of such stimuli), reinforcement has consistently followed responding symmetrically to two stimuli. New stimuli can now be put into this relation and symmetry may result without explicit reinforcement in this particular case. The proper combination of two or more such frames will yield the phenomenon of stimulus equivalence. (Hayes, 1986, p. 356)

This position is offered as a criticism to Skinner (1957), who described the listener's behavior as nonverbal. According to this notion, to classify an antecedent stimulus as verbal and, consequently, to classify the listener's behavior as verbal, one would have to analyze the behavior of the speaker who produced said stimulus with their verbal

response. In defending the position that the listener's behavior also depends on verbal behavior, Hayes (1986) also opposed the hypothesis that stimulus equivalence relations do not seem to depend on the naming behavior of the subjects who demonstrate such relations, as defended by Sidman after analyzing data from different studies (Sidman, 1986; Sidman & Tailby, 1982).

Devany, et al (1986) conducted an experiment in which they applied a procedure for training conditional relations between visual stimuli on four typically developing children considered verbally capable, four children with atypical development considered verbally capable, and another four children with atypical development who were considered verbally incapable. Participants were classified as verbally capable or incapable as a result of classroom observations by three independent observers, and a speech pathologist categorized them as possessing functional speech or lacking functional speech. All the children considered to be verbally capable demonstrated the emergence of equivalence relations, as described by Sidman and Tailby (1982), and none of the children considered verbally incapable demonstrated the emergence of these relations. Although Hayes et al. (1986) highlighted the results in Sidman and Tailby (1982), in which verbally competent participants demonstrated the emergence of equivalence relations, there are studies (e.g., Sidman, 1971; Sidman & Cresson, 1973) indicating that participants with less developed verbal repertoires were able to demonstrate the emergence of equivalence relations. These results brought back the hypothesis (cf. Hayes, 1986) that verbal behavior could be a pre-requisite for the emergence of equivalence behavior; learning certain conditional discriminations alone would not be enough.

In 1988, Hayes et al. conducted an experiment with the goal of discovering whether gustatory stimuli could comprise equivalent stimulus classes and if, due to a greater linguistic experience involving visual stimuli, the emergence of equivalence relations involving only visual stimuli would occur more readily (would demand fewer trials during training) than those involving both gustatory and visual stimu-

li. The authors stated that it is common for participants to have gone through a larger number of discriminative trials involving auditive and visual stimuli, since traditional languages are largely based on spoken and written words. In this experiment, a group of six university students were exposed to a conditional discrimination procedure for teaching relations between three sets of visual stimuli (each composed of three Mandarin characters), and a second group of six students were exposed to a conditional discrimination procedure involving a set of three gustatory stimuli (salt-saturated water, sugar-saturated water, and unsweetened lemon juice concentrate) and two sets of three visual stimuli (Mandarin characters). Afterwards, three participants from each group switched conditions: those who had undergone training with only visual stimuli were now exposed to the procedure with gustatory and visual stimuli, and those who had gone through the procedure with gustatory and visual stimuli were now exposed to one with only visual stimuli. All subjects were tested for the emergence of transitivity (cf. Sidmand & Tailby, 1982) and demonstrated the emergence of that stimulus relation. And, contrary to the initial hypothesis, the procedure with gustatory stimuli required, in general, fewer trials for the emergence of transitivity, casting doubt on the hypothesis that equivalence relations with visual stimuli are facilitated by prior linguistic experience (Hayes, et al., 1988).

The authors (Hayes et al., 1988) suggested four aspects that could have influenced the divergence between the results and their initial hypothesis. They stated (1) that it is possible that classes composed by two or more modes of stimuli form more readily than those composed by only one mode of stimuli; (2) that perhaps gustatory stimuli are more discriminable or distinctive than visual stimuli; (3) that the fact that they associated unfamiliar visual stimuli to familiar gustatory stimuli could have facilitated the formation of equivalence classes; (4) that, since the gustatory stimuli were familiar to the participants, these were able to name such stimuli, thus favoring the emergence of equivalence relations.

Wulfert and Hayes (1988) described two experiments that had the goal of determining whether the order function of a stimulus (i.e.,

first and second) would be transferred to other members of the same equivalence class and if these relations could be brought under contextual control. They based their work on a study by Lazar (1977), which was supervised by Sidman. The goal of this study was to determine if the functions of "first" and "second" – ordinal relations – could be part of the same equivalence class. His procedure (Lazar, 1977) was designed to establish sequential pointing responses – with one class of arbitrary stimuli having the function of "first" and another, the function of "second" – as well as new equivalence classes composed by these and other arbitrary stimuli. As a result, two participants demonstrated transfer of the functions "first" and "second" for the other stimuli of the equivalence class. The results aligned with the hypothesis that equivalence relations can establish classes with similar functions among its members. In this manner, it is possible to state that the issue of emergent ordinal relations was already present in Sidman's research group at Northeastern University.

Eight university students participated in the study by Wulfert and Hayes (1988): four underwent Experiment 1, and the other four, Experiment 2. The stimuli were eight images that resembled Greek letters. In both experiments, the participants began with conditional discrimination training, stimulus sequence training (in which they had to select the two stimuli according with a specific order), and testing for the transfer of ordinal relations. In Phase 2, the participants from Experiment 1 were exposed to conditional discriminations under contextual control of two colors (red and green), to stimulus sequence training under contextual control, and testing for the transfer of ordinal function to the other members of the class under contextual control by the colors. In Phase 2 of Experiment 2, the participants underwent conditional discrimination training similar to that in Phase 1, sequence training under contextual control by two auditory tones, and testing for the transfer of ordinal function to other members of the stimuli class under contextual control by the sounds. Finally, in Phase 3, all participants were exposed to the same procedures: second-order conditional discrimination training, sequence training under contextual

control, and testing for the emergence of ordinal and equivalence relations. All participants demonstrated the emergence of ordinal and equivalence relations.

Both experiments (Hayes et al, 1988; Wulfert & Hayes, 1988) contained only brief mentions of Sidman's work (Sidman, 1971; Sidman & Tailby, 1982), which were not explicitly related to the main objectives of these studies (Hayes et al., 1988; Wulfert & Hayes, 1988). In these citations, the authors (Hayes et al., 1988; Wulfert & Hayes, 1988) hypothesized that the emergence of equivalence relations depended on an organism's verbal capacity, diverging from the ideas put forth by Sidman. To defend this hypothesis, the authors argued that, in experiments with verbally competent humans (e.g., Lazar, 1977; Sidman, 1971; Sidman & Tailby, 1982), participants tend to demonstrate the emergence of stimulus equivalence, while the same cannot be said when the subjects are nonhuman animals.

In a later article, Hayes (1989) argued against statements in studies by McIntire et al. (1987) and Vaughan (1988), in which these authors alleged to have demonstrated the formation of equivalence classes in nonhuman animals, according to the criteria proposed by Sidman and Tailby (1982). Hayes's (1989) main argument was that the authors inadvertently directly trained the supposedly emergent repertoires. In the study by McIntire et al. (1987), monkeys underwent conditional discrimination training mediated by differential responses in which, after the presentation of a sample stimulus, the subjects had to emit a pattern of selection responses determined by the researchers, and the selection of the comparison stimulus had to be made according to that same response pattern. According to Hayes's (1989) analysis, the reinforcement of chained behaviors could have established several simple discriminations under the control of differential response patterns – discriminations that were also present in the tested relations. In turn, Vaughan (1988), in a study conducted with pigeons, established functional classes by way of simultaneous simple discriminations involving two stimulus classes. The functions of these classes, composed of discriminative and delta stimuli, were reversed several times. At

the end of the experiment, the reversal of only some stimuli from a class was sufficient for the subjects to respond correctly for all other stimuli in that class. According to Hayes's (1989) understanding, the two classes were directly established by the procedure, which involved all stimuli from both classes, meaning no relation had emerged. Furthermore, he suggested that the biggest problem with the study was the fact that the procedure did not allow for the testing of the conditional relations that characterize equivalence relations (i.e., symmetry, reflexivity, and transitivity).

In presenting his conclusions, Hayes (1989) emphasized that his position – that the discussed studies (McIntire et al., 1987; Vaughan, 1988) did not demonstrate the emergence of stimulus equivalence – does not imply that he considers Sidman's concept of stimulus equivalence (which he calls "Sidman's equivalence") adequate to understand the phenomenon of emergent equivalence relations that had supposedly occurred. According to Hayes (1989), the concept seems to have been "driven too much by mathematics and not enough by psychology" (p. 390), meaning the concept had characteristics that did not sufficiently describe the psychological phenomenon, grouping different types of psychological relations without justification. This problem was demonstrated, according to Hayes (1986), by the fact that the concept involved a property (type of psychological relation) definable by the formal properties of stimuli (reflexivity) as well as two properties unrelated to their formal characteristics (symmetry and transitivity), which represents a second type of psychological relation. Similarly, he pointed to a second problem: the grouping of unidirectional and bidirectional properties. Transitivity is a unidirectional property, because the stimuli maintain their function (acquired during the training phases) as sample and comparison in the emergent class. On the other hand, mutual transitivity (i.e., equivalence or symmetry of transitivity) is bidirectional due to the modification of the sample and comparison functions that were directly trained. Although the author only briefly presents this criticism and does not explain why the fact that the concept of stimulus equivalence groups different types of rela-

tions is a problem, he promises to delve deeper into this discussion and to offer an alternative theory in future articles.

Explicit criticisms and an alternative theory to that of Sidman and Tailby (1982) appeared more clearly in Hayes and Hayes (1989) and Hayes (1991). In general terms, the first text (Hayes & Hayes, 1989) resumes criticism of Skinner regarding the behavior of the listener, which was previously presented in Hayes (1986). While Skinner (1966, 1969) held the position that the listener's behavior, when under the control of rules, should be understood as any other behavior under discriminative control, without the need for special treatment, Hayes and Hayes (1989) defend that the listener's behavior is necessarily verbal. The authors argued that antecedent verbal stimuli are characterized by bidirectionality: if a word is used to name something in the world, it comes to mean that thing, and said thing is then called by its name interchangeably. In this manner, the listener's behavior, under the control of verbal stimuli, possesses bidirectionality as a defining characteristic when compared to discriminations under the control of non-verbal stimuli. The second text (Hayes, 1991), which will be discussed below, had the objective of presenting an alternative to Sidman's position on the emergence of equivalence relations.

In those works (Hayes & Hayes, 1989; Hayes, 1991), the authors (1) returned to the hypothesis presented in Hayes (1986), in which the data seemed to indicate that language is necessary for there to be stimulus equivalence; (2) stated that Sidman's theory, that stimulus equivalence is the product of reinforcement contingencies, does not explain why other animals or nonverbal humans do not demonstrate stimulus equivalence after learning conditional relations; (3) argued that responding to equivalence relations in nature could have caused problems for the survival of a species (e.g., a primate could have learned the relation "given lion, select thicket over open savanna", but it would not make sense to respond symmetrically "given thicket select lion"; Hayes & Hayes, 1989, p. 164); (4) pointed to the lack of an explanation for why the fifth (or larger) term of the contingency does not enter the equivalence class.

Based on his own analysis of existing data (e.g., Sidman, 1971; Sidman & Tailby, 1982; Wulfert & Hayes, 1988) and on his critique of Sidman's and other authors' positions, Hayes (Hayes & Hayes, 1989; Hayes, 1991) offered what he called "a relational control theory of stimulus equivalence", which later would be named RFT. In general terms, the author hypothesized that certain histories of reinforcement, with multiple exemplars involving certain relations between stimuli, could select higher order operants or "arbitrarily applicable relational responding". The types of arbitrarily applicable relational responding are called relational frames. A history of reinforcement in which a child is systematically reinforced in treating several pairs of stimuli with arbitrary relations among themselves as similar, relating them in the presence of certain contextual stimuli, can produce coordination frames between stimuli ("__=__"). Once this frame is established, the child should treat two new arbitrary stimuli that are presented in the presence of contextual stimuli, before which relating by coordination had been systematically reinforced. Other relational frames include opposition, distinction, and comparison (cf. Hayes, 1991). Each frame is established by a reinforcement history with specific characteristics.

For a relational frame to be classified as such, emergent relations should have three central characteristics (Hayes & Hayes, 1989; Hayes, 1991): mutual entailment (if A is related to B, then B is related to A), combinatorial entailment (is A is somehow related to B and B is related to C, then A and C are somehow related), and transfer of function (if A, B, and C are mutually and combinatorically entailed, then a certain function of A implies underlying functions of B and C). This would be valid for all relational frames. Therefore, in an example of a comparison relational frame, "_____ is larger than _____", if A was established as larger than B and B as larger than C, then, by mutual entailment, B is smaller than A and C is smaller than B; by combinatorial entailment, C is smaller than A; by transfer of function, if A elicits a reflexive response, then B will also have the function of eliciting reflexive responses of a smaller magnitude than A, and C will have the function of eliciting reflexive responses of a smaller magnitude than B.

Stimulus equivalence, according to Hayes and Hayes (1989) and Hayes (1991), could be understood as one of the several possible relational frames, as it involved frames of coordination between stimuli ("___=___"). In this perspective, after establishing the relational operant of coordination, if a subject learns that A is like B and that A is like C, then, by mutual entailment, B will be like A and C like B; by combinatorial entailment, A will be like C and C like B; by transfer of function, the function acquired by one of the members of the new stimulus class will entail similar functions to the other members. In this manner, stimulus equivalence, as proposed by Sidman and Tailby (1982), could be understood as one of the arbitrarily applicable relational operants. The characteristics of symmetry and transitivity would be substituted by the concepts of mutual entailment and combinatorial entailment, and the emergence of these relations would happen after the development of the relational frame of coordination, an operant behavior selected by histories of responding by coordination before multiple exemplars of stimuli.

In 1991, Steele and Hayes described two experiments that aimed to bring three different types of relational responses – same, different, and opposite – under contextual control of arbitrary stimuli. Nine people participated in these experiments. To answer their research question, they exposed four participants to sameness and oppositeness training and three to sameness and difference training. Each relation was based on the formal (nonarbitrary) properties of the stimuli, but each was brought under contextual control of an arbitrary visual stimulus. Two participants served as the control group, not having undergone any training procedure with contextual cues. At the end of the training phases, they tested for the emergence of mutual entailment and combinatorial entailment. Participants in the second experiment had participated in the sameness and difference procedures in Experiment 1. Both participants were initially trained to respond to sameness and oppositeness under contextual control. When testing for emergent relations (i.e., mutual entailment and combinatorial entailment), new visual stimuli, whose formal characteristics were not sufficient for

sameness and difference responding, were added. In general, participants who were trained to respond based on sameness, difference, and oppositeness in the first experiment, under contextual control, showed the emergence of relations that had not been directly taught, and the same occurred for participants in the second experiment, even when presented with new comparison stimuli.

According to Steele and Hayes (1991), Sidman and collaborators (1971, 1986; Sidman & Tailby, 1982) focused on refining testing procedures and on describing the conditions in which stimulus equivalence could occur – they relied too heavily on the description of the behavioral products without offering a theoretical explanation of the process involved. Another difference found in this article (Steele & Hayes, 1991) was the presentation of a hypothesis for the emergence of equivalence relations based on Hayes's work, representing an alternative to what was offered in Sidman and Tailby (1982) and in other studies by behavioral analysts examining the phenomenon. According to them, it is possible that the researchers (e.g., Sidman, 1971; Sidman & Tailby, 1982), in having exposed participants to identity MTS tests at the beginning of experiments, provided contextual cues for responding by sameness and by coordination.

In sum, Hayes and colleagues diverged from what was proposed by Sidman and colleagues in stating (1) that contingencies systematically arranged by a verbal community seemed to be necessary for the emergence of stimulus equivalence relations (Devany et al., 1986; Hayes, 1986, 1989, 1991; Hayes et al., 1988; Hayes & Hayes, 1989; Wulfert & Hayes, 1988); (2) that Sidman's stimulus equivalence fails to explain why nonverbal animals are incapable of demonstrating equivalence (Hayes & Hayes, 1989; Hayes, 1991); (3) that the emergence of stimulus equivalence relations would not have contributed to the survival of a species, seeing as in nature responding to stimuli based on mathematical properties of equivalence would mostly produce neutral or punishing consequences (Hayes & Hayes, 1989; Hayes, 1991); (4) that Sidman's theory lacks an explanation for why the fifth (or larger) reinforcement contingency term does not enter the emerging stimulus

class (Hayes & Hayes, 1989; Hayes, 1991); that the concept of stimulus equivalence proposed by Sidman is merely descriptive as there is a lack of theorical explanation for the emergence of the phenomenon (Hayes & Hayes, 1989; Hayes, 1991); that the concept of stimulus equivalence, according to Sidman, groups different types of relations without an adequate justification for such (Hayes, 1989).

## Sidman's responses to Hayes's concepts and criticisms

The source of information for analyzing Sidman's reactions to Hayes's proposed concepts and criticisms was his book (Sidman, 1994), which contains a selection of texts about stimulus equivalence (published between 1971 and 1994) and additional commentary on these publications. All chapters of the book were analyzed. The choice of this source was due to the fact that Sidman (1994) himself asserted that it contained the most important articles for the development of his experimental and conceptual work in stimulus equivalence.

Each of the selected texts were read in its entirety. In analyzing Sidman's texts (his original work, articles republished in his book, and his commentary about these articles), we identified parts in which Sidman (1994) cited any of Hayes's studies

Sidman defended himself against part of these criticisms and counterargued against some topics put forth by Hayes and colleagues. It is worthwhile highlighting that, in the original texts that were republished in his 1994 book, the author does not explicitly criticize Hayes's conceptual work. Explicit statements against Hayes appeared almost exclusively in his commentary about his previous publications and in the new texts presented in Sidman (1994).

The examination of Sidman's publications shows that, despite there being no direct dialogue with Hayes, the author, whether in his conceptual or experimental work, dealt with several issues brought by Hayes. For example, in the period in which Hayes (Devany et al., 1986; Hayes, 1986) hypothesized that stimulus equivalence could be dependent on verbal behavior, Sidman (Sidman et al., 1985; Sidman

et al., 1986) investigated the necessity of naming behavior and argued that stimulus equivalence did not seem to depend on verbal repertoires. Even before Hayes (Hayes & Hayes, 1989; Hayes, 1991) pointed out the lack of an explanation for contextual stimuli not entering the emergent stimulus classes, Sidman presented the hypothesis that contextual stimuli are excluded from these classes because they are paired with stimuli that belong with more than one equivalence class (Sidman, 1986) and experimentally investigated the role of contextual discriminations in the establishment of equivalence relations (Bush et al., 1986). In the period in which Hayes (Hayes & hayes, 1989; Hayes, 1991; Steele & Hayes, 1991) stated that the concept of stimulus equivalence was merely descriptive, Sidman (1990) theorized that the occurrence of stimulus equivalence could be explained by a history of natural selection, just like the processes of reinforcement and discrimination. In sum, it is possible to say that the issues pointed out by Hayes were being examined by Sidman, even without the explicit presentation of countercriticism.

Below is a selection of direct comments by Sidman (1994) about Hayes's contributions (Devany, et al., 1986; Hayes, 1986, 1989, 1991; Hayes, et al., 1988; Hayes & Hayes, 1989; Wulfert & Hayes, 1988).

In a comment about a study by Sidman et al. (1973), present in his 1994 book (Chapter 2), Sidman briefly discussed the view that the emergence of equivalence relations depended on verbal responses. He cited works by Hayes (1986, 1991) as examples of positions that discuss and seek mediational processes in the emergence of equivalence relations, contrasting this with his own position, which did not assume mediational processes (such as naming) in the emergence of stimulus equivalence. Sidman (1994, Chapter 2) rejected the position attributed to Hayes (1986, 1991) that stimulus equivalence seems to depend on the mediation of linguistic repertoires. The authors stated that it is not productive to attribute mediational, unobservable, and hypothetical causes for the emergence of equivalence relations.

In accordance with Hayes's argument (1991), Sidman (1994, Chapter 5, p. 167) stated that, in fact, reflexivity depends on the physi-

cal resemblance between stimuli, a nonarbitrary relation being as it depends on the relation between the stimulus and itself. However, he did not indicate that this represents a problem for his concept of stimulus equivalence, nor did he present a direct response to the criticism that the concept groups different types of psychological relations. Based on the consideration that reflexivity depends on the physical sameness between stimuli, the author stated that the property of reflexivity is a pre-requisite for other relations: "If, for a subject in the conditional-discrimination context, the relation of physical sameness does not hold between a sample and comparison that we, as experimenters, consider identical, then it should not come as a surprise when the subject fails to show equivalence in that context" (Sidman, 1994, Chapter 5, p. 168). After all, in cases like this, the subject could be under the control of aspects that had not been considered by the experimenter, such as the position in which the stimuli were presented.

Hayes (1991) assumed that, in a symmetry training procedure with sufficient exemplars, which normally occurs in a child's verbal community, one would expect the emergence of symmetrical responding – the purported bidirectionality of verbal behavior. Sidman (1994, Chapter 9) criticized this position when stating that, by definition, arbitrary relations are not definable by characteristics measured by our senses, meaning that it is not clear how generalized relational responding for an arbitrary relation can emerge solely from exemplars. After all, there would be a lack of perceptible aspects, in these various exemplars, that would allow for a new exemplar to be recognized on the basis of such relations:

> Nonarbitrary relations are based on physical attributes like size, shape, color, quantity, and so on, while arbitrary relations like those between things or events and their names are dependent on one's learning history. The defining properties of arbitrary relations cannot be seen, heard, smelled, felt, and so on, or measured in physical dimensions. They are the product of arbitrary contingencies that are set up by the reinforcing community. I can understand how a sufficient number of examples may give rise to generalized nonarbitrary relations like larger, brighter, heavier, more, and so on. But I do not understand how any number of examples can give rise to generalized arbitrary relations like reflexivity, symmetry, transitivity, and so on. Because the exemplars would possess no measurable

> feature in common, it is not at all evident that one might be able to generalize an arbitrary relation solely from exemplars. What aspect of several examples of symmetric event-name relations would permit a new example to be recognized or produced? (Sidman, 1994, Chapter 9, pp. 364 - 365).

Further on, Sidman (1994, Chapter 9) stated that there is no known behavioral principle that could explain how a procedure involving multiple exemplars – if, for example, applied to individuals with little to no verbal repertoires (e.g., nonhuman animals or children) – could produce the emergence of generalized symmetry. This aspect would become even more critical when considering that the emergence of these relations depend on complex verbal repertoire, as suggested by Hayes (1991). Thus, according to the author (Sidman, 1994, Chapter 9), one has to suppose a new behavioral principle: "In attempting to derive equivalence relations from an individual's behavioral history, therefore, "exemplar theory" does not fulfill its intended purpose; it does not avoid the need to specify a behavioral process that is itself not derivable from anything more basic" (Sidman, 1994, Chapter 9, p. 365).

In this manner, Sidman argued that Hayes (1991) substituted the notion that stimulus equivalence is the direct product of reinforcement contingencies, just as other behavioral relations (such as operant discrimination), with the concept of generalized symmetry, which still lacked empirical evidence.

Regarding the criticism (Hayes, 1991) that Sidman's concept for stimulus equivalence did not explain the reasons for which nonhuman animals rarely demonstrate stimulus equivalence, Sidman (1994, Chapter 10) stated that contingencies of reinforcement establish the pre-requisites for the emergence of stimulus equivalence. In other words, not all reinforcement contingencies will produce stimulus equivalence: "Additional factors, like the test conditions, contextual control, and a subject's behavioral history will help determine whether and how that potential is realized" (Sidman, 1994, Chapter 10, p. 387).

Sidman (1994, Epilogue) discussed Hayes's (1991) idea that the origin of stimulus equivalence resides in the existence of relational ope-

rant behaviors selected by way of multiple exemplar training and questions whether there is any benefit in abandoning the concept based on mathematical properties (Sidman & Tailby, 1982). The suggestion would be to abandon "the simplicity and the elegance" of the mathematical description of equivalence for a set of interrelated hypotheses:

> a hypothetical act of equivalencing; the presumption that the act can be learned from a set of discriminations (abstractions) that are based on direct experience with mutual and combinatorial entailment in arbitrary relations, and on direct experience with the transfer of functions—itself a hypothetical process; and the postulation of reflexivity, a property unique to equivalence relations (Sidman, 1994, Epilogue, p. 558).

It is worth noting that his last point, about accepting reflexivity, refers to the fact that Hayes's proposal removes reflexivity as a characteristic of emergent relations, making the characteristic exclusive to the mathematical concept of equivalence. As such, Hayes's position would not be able to predict the emergence of these relations.

According to Sidman (1944, Epilogue), results from Steele and Hayes (1991) could be interpreted in consonance with any formulation of equivalence that recognizes the function of contextual stimuli, such as Sidman's own concept of stimulus equivalence, in which equivalence relations can be brought under contextual control. Therefore, it would be difficult to conclude that the study's data "demonstrate the existence of relational frames" (Steele & Hayes, 1991, p. 549).

Regarding the criticism of the alleged theoretical negligence (Steele & Hayes, 1991), Sidman (1994, Epilogue) stated that the concept of stimulus equivalence is part of a descriptive system and does not depend on theoretical entities nor on unobservable processes. However, according to him, the descriptions show the phenomenon's strong regularity and thus can serve one of the main goals of an explanatory theory: allowing for predictions.

Sidman (1994, Chapter 12) disagreed that stimulus equivalence is one case in a network of relational frames, but he agreed with Hayes (Hayes & Hayes, 1989; Hayes, 1991; Steele & Hayes, 1991) that it is contextual control that determines if and when stimuli are equivalent.

Contextual control, in his opinion, can break equivalence relations that would otherwise have formed. In this manner, it would be possible to accept that emergent relations are under contextual control without needing to believe that equivalence is a special type of relational behavior under the control of contextual cues.

In sum, in his critique, Sidman argued that relational frame theory is based on hypothetical generalized operant behaviors, which lack a simple explanation based on known behavioral principles and which is not backed by sufficient data. He emphasized that several experimental studies should be conducted to deal with the existing discrepancies. For example, efforts should continue to be made to verify whether nonhuman animals are capable of demonstrating the emergence of equivalence relations (after all, in his position, it is possible that the emergence of stimulus equivalence with nonhumans could be due to methodological issues), and new studies should be done to clarify the connection between functional and equivalence classes.

## Final Considerations

Organizing some of Hayes's criticisms to Sidman's proposals and Sidman's reactions to these criticisms brought some central aspects of this dialogue to the forefront. Hopefully, this can facilitate our understanding of certain current debates. For example, highlighting the criticisms and countercriticisms allowed us to note that part of the divergence between Sidman and Hayes about the emergence of equivalence relations stems from their differing positions regarding the ways of creating scientific knowledge. After all, Hayes accused Sidman of clinging to the description of phenomena when proposing his concept of stimulus equivalence, and Sidman, in turn, accused Hayes of basing his interpretation of the emergence of stimulus relations on hypothetical behavioral repertoires. Furthermore, Sidman considered that Hayes built his theory without a proper foundation of research evidence. New studies that discuss the role and implications of this

type of theorization for the construction of scientific knowledge could help elucidate the controversies between these two views.

Among other aspects, this study emphasized Sidman's interpretation about the possible emergence of equivalence classes with nonhuman animals stemming from specially designed conditions that would facilitate this. His considerations, partly presented as responses to Hayes's criticisms, could perhaps be used to interpret more recent data about the emergence of equivalence relations in the repertoire of these experimental subjects (e.g., Galizio & Bruce, 2018).

The analysis of a selection of comments by Sidman and Hayes between 1982 and 1994, a period of theoretical construction for both, was based on a selection of works by both authors. New studies could widen our understanding of this dialogue by analyzing a larger number of texts by Sidman and Hayes, including those that have been recently published.

In the present study, Sidman's positions about Hayes's criticisms were analyzed, but the same was not done for Hayes's responses to Sidman's rebuttals. In this manner, new research could complement the current data and clarify the points directly addressed by Hayes and his colleagues, thereby expanding the dialogue outlined here.

Ultimately, the present study offers a methodological tool to analyze part of the contingencies laid out by the scientific community regarding the behavior of scientists, an aspect which characterizes scientific methodology (Skinner, 1957). The procedures used here can be replicated in new research that seeks to analyze dialogues between different authors and to identify possible mutual influences.

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