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Natural, Behavioral and Cultural Selection-Analysis: An Integrative Approach

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In *Selection by Consequences*, Skinner (1981) described a causal model that explains human behavior as a joint product of three levels of selection: (i) the contingencies of survival involved in natural selection, (ii) the contingencies of reinforcement involved in the selection of individual behavior, and (iii) contingencies of an evolving social environment. Since then, researchers from behavior analysis and other fields such as biology and anthropology have used an evolutionist/selectionist approach to greatly improve our understanding of those three levels of analysis. As our knowledge of each level has expanded, the borders between them and their belonging to specialized academic domains has become less clear. Even though Skinner (1981, p 502) stated that "each level of variation and selection has its own discipline – the first, biology; the second, psychology; and the third anthropology", we argue that *Selection by Consequences* sets a milieu for behavior analysis to take part in the analysis of the integrated relation among all levels of analysis. In this commentary to Skinner's (1981) paper, we aim to point out some advances in behavior analysis that may contribute to bridging the gap between the three levels of analysis described by Skinner. In doing so, we will briefly describe some relations between natural and behavioral selection and between behavioral and cultural selection. Additionally, we discuss an alternative model to analyze selection of cultures.

Natural-behavioral selection

Let us start with the relationship between natural and behavioral selection. Glenn and Madden (1995) pointed to Skinner (1953) and Campbell (1956) as the first to compare the processes of natural selection and reinforcement. Glenn and Madden argued that if the same processes that explain organic selection were applicable to behavioral selection, the understanding of one would provide valuable insights about the other. In organic evolution through natural selection, genes are the units of retention and replication that are transmitted generation-to-generation, enabling species survival and adaptation to environmental changes. On the other hand, in behavioral selection, reinforcement operates on behavioral variation differentially selecting a behavioral repertoire which will likely result in future reinforcement. While in natural selection, genes are the unit of retention and replication is transmitted through generations, Glenn and Madden suggest that in an individual behavioral lineage, retention and replication take place in the nervous system. For Moore (1997), behavior analytic explanations may be valid without considering neurological variables, just as Mendel's work did without considering DNA analysis. However, knowledge

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from neuroscience may show pragmatic value and open new venues to behavior analysis.

In a commentary article to *Selection by Consequences,* Donahoe (1984) highlighted the importance of looking at the neural basis of respondent and operant conditioning to understand selection at the behavioral level. He argues that Skinner prudently focused on the effects of reinforcement on operant behavior, but that it would also be valuable to study physiological mechanisms that undergo respondent and operant conditioning. In response to Donahoe, Skinner postulated that questions about the physiological mechanisms of respondent and operant behavior should be answered by neurology (Catania & Harnad 1988; Skinner 1988, p 38). Ten years after Donahoe's commentary, he and Palmer published *Learning and Complex Human Behavior* (Donahoe & Palmer, 1994), where a biobehavioral approach is offered to analyze general principles such as extinction, generalization and discrimination. There, findings from neuroscience and neuropsychology are taken into consideration. Behavior analysis has entered in a field previously declared as territory of neurology and biology, integrating knowledge from behavior-environment relations with genetic and neural variables (Kennedy, Caruso, & Thompson, 2001) and contributing to a better understanding of behaviors such as self-aggression (Symons, Fox, & Thompson, 1998).

Thus, in addition to using natural selection processes as insight to better understanding behavioral selection, knowledge from physiological mechanisms may be of great value to explain behavioral principles that undergo the learning of new repertories. Here, we are making a distinction between a) using natural selection as a metaphor to explain behavioral selection (Glenn & Madden, 1995), and b) using the knowledge of responses and mechanisms acquired by natural selection to better understand a repertoire acquired during an individual life span (Donahoe & Palmer, 1994). Skinner (1981, p 501) prompted this interaction when writing: "Through respondent (Pavlovian) conditioning, responses prepared in advance by natural selection could come under control of new stimuli. Through operant conditioning, new responses could be strengthened (reinforced) by events that followed them." Accordingly, Donahoe and Palmer have worked to understand how contingencies of survival selected a neural system responsible for respondent and operant conditioning. Donahoe (1984) also argues in his commentary to Skinner (1981) that respondent and operant conditioning may be distinguished simply in terms of procedures to study behavioral changes, but they share a selecting environment and physiological mechanisms. Again, Skinner (Catania & Harnad, 1988; Skinner 1988, p 38) did not agree with Donahoe, affirming that the two types of conditioning (respondent and operant) are differentiated by the contingencies under which they occur, not by their procedures to study behavioral changes.

A behavioral-organic approach has been used by behavior analysts, in several applied settings, for example in the treatment used on self-injuring behavior in individuals with developmental disability. Self-injuring can be maintained by a) medical conditions, b) functional/ecological variables and c) psychiatric illness. If the self-injuring behavior is controlled by a sinus infection, medical treatment will be recommended (a), as it will be a recommended behavioral intervention if it is maintained by environment variables (b) and psychiatrist would be recommended if the behavior is the result of a brain and/or chemical abnormality (c). However, medical, operant and psychiatric variables often covariate, and a functional analysis of medical and psychiatric treatment, together with functional/ecological variables, may be the most effective alternative (Pyles, Muniz, Cade, & Silva, 1997).

As for the relationship between behavioral and genetic selection, it may go beyond their possible interdependence to determine human behavior (Donahoe & Palmer, 1994) and selection analogies (Glenn & Madden, 1995). As it turns out, behavioral and genetic selection has more in common than many would have known when *Selection by Consequences* was published in 1981. It was only in the mid-1970s that two rather speculative articles by Holliday and Pugh (1975) and Riggs (1975) suggested the epigenetic inheritance system, in which DNA function is modified and transmitted in response to environmental changes during an organism's life span. As most biologists knew at the time, every cell of a given organism shares the same DNA code, and genes are turned *on* and *off* during developmental periods when cells acquire specialized functions (e.g. liver and skin cells). Those genes and their functions are selected from mutations and population genetic pools and then transmitted to offspring. The maturation of functions would be determined through inheritance. However, the so-called epigenetic inheritance systems call attention to the process in which genes are turned *on* and *off* in response to local environmental changes during individual life span and how these functional changes are transmitted through generations (Jablonka, Lamb, & Zeligowski, 2014). The epigenetic inheritance system is a clear example of an interaction of natural and behavioral selection, showing how fragile the frontiers between levels of selection can be. Nonetheless, the extent to which behavior analysis can both contribute to and benefit from understanding of the epigenetic processes is still a question to be answered.

Behavioral-cultural selection

For Skinner the third level of selection began when individuals were under control of the same sets of contingencies of reinforcement. When an individual's behavior becomes a practice that benefits the group, a selection of culture takes place. Thus, it is the effect of consequences for the group, not individual reinforcement that maintains the cultural evolution (Skinner, 1981). However, the object of selection at the cultural level was not clearly defined in *Selection by Consequences*. Whereas the objects of natural and behavioral selection were described as genes and behavior respectively, the object of selection on the third level remained unclear. In a commentary to Skinner (1981), Dawkins (1984) questioned if the *entities* selected through cultural evolution are cultural practices or whole societies with their cultural practices. In response, Skinner writes that there should be a distinction between what is selected and the selecting consequences. *Within groups* practices are selected and transmitted, whereas *between cultures* features such as social systems and technological methods (e.g. agriculture) are the object of selection (Catania & Harnad, 1988; Skinner 1988, p 36).

Recently, the field of behavior analysis has seemed to highlight the selection of within groups, focusing on selection of cultural practices. For example, the metacontingency concept (Glenn 1986; Glenn 1988; Glenn and Malott 2004; Malott and Glenn 2006) was developed as a new conceptual tool to analyze the third level of selection (cultural). A metacontingency describes a functional relation between interlocking behavioral contingencies (IBCs), their aggregate product and selecting environment (see Figure 1). Thus, while in natural selection (i), genes are selected and in behavioral selection (ii), classes of responses are selected, in cultural selection (iii) the IBCs and their aggregate product is the object of selection.

The metacontingency model encompasses selection of cultural practices (within groups) but does not consider the selection of cultural-social environments (between groups) described by Skinner (1981). Here we would like to offer an alternative unit of cultural analysis that accounts for selection of cultural practices and selection of cultural-social environments. From Skinner (1981), we may highlight at least

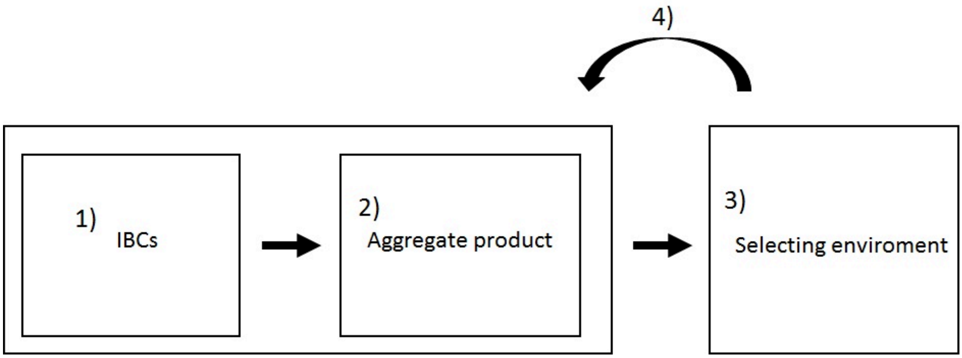

Figure 1. Metacontingency model. Interlocking behavioral contingencies (1) produce an aggregate product (2) which has an effect on the Selecting environment (3). Selecting environment influence future probability of IBCs and aggregate product (4).

two selection processes involved in cultural evolution: 1) *selection of cultures* and 2) *cultural-selection*. The selection of cultures refers to the selection of cultural-social environments (we will refer to it as *environmental settings*) whereas cultural selection refers to how those environmental settings selects behavior of individuals and practices within this culture. Thus, individual behaviors and practices are selected by and are under the control of environmental settings (cultural-selection). An external environment selects environmental settings, which are possibly competing with other settings. Besides the cultural-selection control on individual behavior and practices, environmental settings also coevolve with gene selection. For example, it is known that sexual preference and/or dispersal adaptation influenced extremity selection (skin pigmentation, hair thickness, eye and hair color, and freckles) and development of cooking techniques and diet influenced jaw musculature and tooth-enamel thickness (Laland, Odling-Smee, & Myles, 2010). Sexual preferences and cooking techniques are environmental settings selected by external conditions and between group competition (selection of cultures). In its turn, environmental settings participate in the cultural selection of sexual and cooking behavior/practice and genetic selection.

Thus, a cultural phenomenon would involve selection of cultures (environmental settings) and cultural selection of genes, individual behavior and practices. In Figure 2 we suggest a model of analysis that encompasses both selection of cultures and cultural selection.

Separately, selection of cultures and cultural-selection guide a functional analysis of each of the three levels of analysis illustrating their interaction. Taking as example behaviors or cultural practices that lead to misuse of vaccines and consequently resurgence of diseases. At a cultural level, environmental settings that control a population's practices will need to be engineered in order to provide the correct stimuli control of the appropriated practices. The evolving history of this environmental setting and population repertoire will need to be taken into consideration when programing the most effective intervention. At the individual level, a doctor may arrange verbal contingencies in order to favor correct behavior towards vaccination. Accordingly, if an environmental setting is proven to be well-designed and deviant behavior or practices occur, intervention may focus on the individual or group adaptation to the environmental settings. In turn, if the environmental setting does not provide the necessary contingencies to select individual behaviors and practices, intervention will

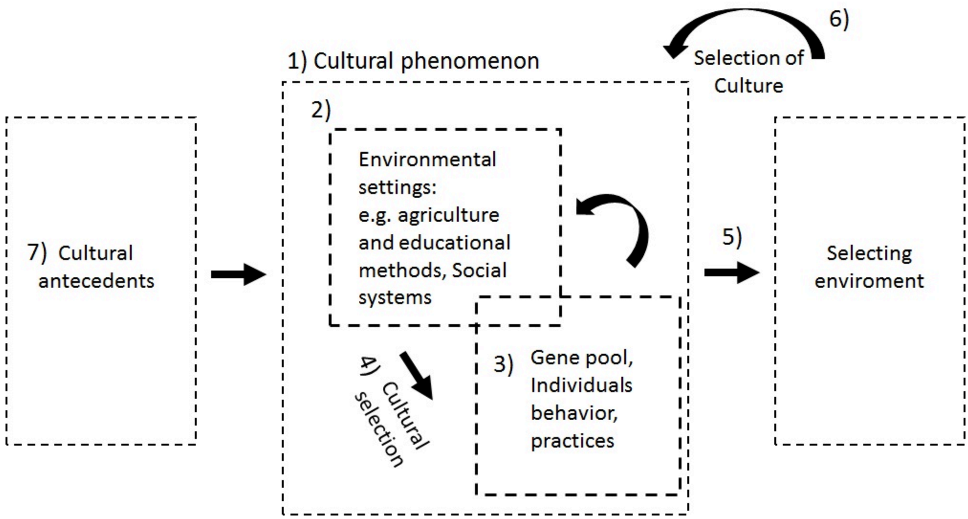

Figure 2. Three term cultural contingency (TTCC) model. A (1) Cultural phenomenon is composed of (2) environmental settings (e.g. agriculture and educational methods, social systems) and (3) gene pool, individual behavior and practices. Environmental setting participates in the (4) cultural-selection of genes, individual behavior and practices and is influenced by its selection. Cultural phenomenon effects the (5) Selecting environment and (6) is selected by the effects of these changes (Selection of culture). The controlling properties of the environmental settings on gene pool, behavior and practices depend on (7) cultural antecedents (e.g. available resources, economy, climate).

take place on environmental settings (e.g. laws, incentives, verbal discrimination of correct practices). Individual behavior and cultural practices will also covariate with physiological responses to vaccines and virus/bacteria's adaptation, and disease and thus natural selection should also be taken into consideration.

Conclusion

Skinner refers to behavioral selection as the only level in which variation is selected in a moment-to-moment manner. For him, "biologists and anthropologists study the process through which variations arise and are selected, but they merely reconstruct the evolution of species or culture" (Skinner, 1981, p502). As we argued throughout this text, behavior analysts have the tools to take part in functional analysis encompassing all levels of selection. Even if not following a clear path, behavior analysts are already using this integrative approach and opening new research areas, as well as developing new models for analysis and intervention. A notable example of an integrated functional analysis of organic and behavioral level is the Multimodal Functional Model (MFM). MFN is a biomedical-psychological-socioenvironmental approach to support assessment and treatment of behavioral problems associated to mental illness (Hunter, Wilkniss, Gardner & Silverstein, 2008). On the functional analysis of behavioral and cultural level, the metacontingency has been an important tool to experimentally investigate selection of IBCs and aggregate product (Ortu, Becker, Woelz, & Glenn, 2012; Tadaiesky & Tourinho 2012; Vasconcelos & Todorov, 2015), and analyze social issues (Machado & Todorov, 2008; Sandaker 2009; Todorov, 2005). In this paper we describe a new conceptual tool (TTCC) to be tested as a complementary approach when analyzing organic, behavioral and cultural selection/evolution in an integrated manner.

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