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"BEHAVIOR STREAMS" VERSUS "BEHAVIOR EXTENDED IN TIME"

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ABSTRACT: Behavior analysis ironically appears to be increasingly at risk for abandoning its historic focus of moment-to-moment behaving, to other disciplines ranging from robotics and the "man–machine interface" to cognitive science where behaving is called "action." The misleadingly labeled "molar" analysis and the concept of "behavior extended in time" both signal this abandonment of behaving. I suggest that it would be premature to assume that moment-to-moment analyses and analyses of "behavior extended in time" are on different and independent levels. I also suggest that behavior analysts might regain their focus on actual behaving by occasionally reading *Pigeons in a Pelican* (Skinner, 1960) and *Farewell, My LOVELY* (Skinner, 1976) and by developing and evaluating behaving theories.
Key words: behavior streams, moment-to-moment behaving

The paper by Field and Hineline (2008) is to be applauded for reminding the reader of several ways in which psychology tends to neglect time and for having the goal of showing how to integrate diverse ways of handling time. The paper is welcome for describing how psychology often confounds the languages of science and of everyday life, and in doing so encourages the invention of unreal, abstract concepts and imaginary theoretical notions—without explicit acknowledgment of having done so, and certainly without explaining why. The paper is also welcome in its several passing references to the need for understanding the behavior of behavioral scientists if we are to develop adequate behavioral methods and theories. Finally, I commend this paper for its being open to multiple meanings of "behavior," which is in accordance with my belief that there is a continuing and pressing need for better understanding of the subject matter of behavior analysis.

Field and Hineline argue that time in psychological science tends, in important ways, to be neglected and its appropriate conceptual role impoverished and misguided. I agree. The language of psychology—ironically, even much of that dealing with timing and remembering—can motivate researchers to develop static pictures of behavior. This tendency misdirects attention away from behaving in *real time* and away from otherwise obvious, important, and dynamic empirical phenomena which historically formed much of the subject matter of behavior analysis. Field and Hineline advocate for a multi-level analysis of behavior, one

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level of which would involve the temporal dynamics of moment-to-moment behavior in real time, which I will refer to in my comments as "real-time behavior." Field and Hineline propose a method to conceptually integrate real-time behavior and "behavior extended in time." I predict, however, that the method would actually have the *opposite* effect. Field and Hineline's method is integration through separation. It would integrate different kinds of analyses by defining them as separate and independent levels of analysis. It would grant independence to the level of "behavior extended in time" from the level of continuous, observable, real, moment-to-moment behaving. The chief hurdle the paper faces is therefore to define these two levels and to legitimize their independence. The paper needs to explain how behavior extended in time, and therefore presumably occurring somehow *in* time at *some* time or times, can be independent of moment-to-moment behavior. A host of questions immediately arise, such as whether behaviors at different levels occur simultaneously. And if they do, how can we tell which behavior is which? At which moment do we know which behavior is which? Or do we know only in some extended-in-time sense?

The difficulty in answering these questions arises in part because behaving involves highly interactive processes, processes interacting on a split-second-by-split-second basis. Take the example the paper gives of moving one's arm. This action might involve moment-to-moment movement of my arm while I move my computer mouse on a moment-to-moment basis to click on various icons to close the file I am now working on. Ample research shows how I move my arm is not independent of what I am thinking, including where I previously moved my mouse and where I plan to move it next, and those plans depend on my language skills and my culture. My typing the previous sentence shows I agree with the paper's statement that "a given arm movement may have many possible meanings. . ." but instead of using this fact to justify different and independent levels of behavioral analysis, I prefer to use it to justify developing an explanation for my arm movement that involves dynamic processes interacting in moment-to-moment time. My typing and the meaning of what I type emerge from the interactions among all these dynamic real-time processes that include control involving the tiniest skeletal muscles and the broadest possible evolutionary and cultural histories. Most of the time Field and Hineline's paper seems to imply that my arm movements while moving my mouse and typing involve what elsewhere "molar" analysts have referred to as "fine-grain detail" and "molecular" behaviors. The paper seems to imply that such behaviors are uniquely subject to change in meaning as a function of context, that they involve contiguous causation, and that they are not relevant to descriptions and explanations of "behavior extended in time." Let us examine these claims.

Real-Time Behavior: Neither Fine-Grain Detail nor Molecular

Consider a metaphor like "the behavior stream." This reminds one that behaving occurs in continuous real time. It reminds those of us old enough to remember of Skinner's cumulative records and of his lament at the disappearance

of them (Skinner, 1976, p. 218). His argument was that cumulative records "suggested a really extraordinary degree of control over an individual organism as it lived its life from moment-to-moment," and

> These "molecular" changes in probability of responding are most immediately relevant to our own daily lives. They seem to me much more useful in the interpretation and design of contingencies which bring about the kinds of changes likely to be of technological interest.

I agree with Skinner on these points. The idea of the behavior stream reminds us of the fluid, moment-to-moment precision displayed when someone swings a baseball bat and in a fraction of a second connects with the baseball and hits a home run in the World Series. It also reminds us of a baby's babbling and how infants respond to statistical patterning in natural language. It is manifested by the unbelievable skills displayed in playing the cadenza in the first movement of Rachmaninoff's 3rd piano concerto, and when a poet reads her latest work aloud. These examples involve skills that enable athletes to make incredible incomes, babies to learn how to talk and communicate, musicians to perform, and poets to display linguistic imagination. Are the people engaging in these skills showing behavior that is small-scale and that could be described in terms of fine-grain detail, molecules, and reductionism? Showing these skills exemplifies what used to be called "behaving" and are still called, in some cognitive circles, "action." While theories of dynamic behaviors in the laboratory have not yet succeeded in being generalized to these kinds of naturalistic behaviors, they are moving in the direction of the dynamics of real-time behavior (e.g., Catania, 2005; Shimp, Childers, & Hightower, 1990; Shimp, 1984, 1992). A goal of these theories is to facilitate our understanding of the kinds of moment-to-moment skills—hitting home runs, babbling, playing the piano, reading poetry—that so impressed Skinner.

Is the Meaning of "Behavior Extended in Time" *not* Subject to Context?

Surely an arm movement can have different meanings in different contexts. Field and Hineline (2008) seem to suggest that it is its reductionist nature that makes the meaning of an arm movement depend on its context. Ample evidence from cognitive psychology, however, suggests that the meaning of an entire narrative can be changed by simply changing its title, so that the effect of context on changing the meaning of an arm movement is not uniquely characteristic of arm movements or of continuous movements in general. It is hard to know in some general sense what is *not* context-dependent. Do Field and Hineline intend to suggest that "behaviors extended in time" are not context-dependent? If so, what are the standards by which we can identify context *independence*, and what is the evidence that this putatively new form of behavior satisfies them? If extended behaviors are different from momentary behaviors in the sense that they do not change meaning across temporal contexts, does that imply that they are timeless,

and that facts about extended behaviors are timeless truths? If not, why not? My guess is that "behaviors extended in time" are no less context-dependent than are moment-to-moment behaviors, and further, that the concept of behaviors extended in time cannot deal with the kinds of moment-to-moment behaviors described above or with the behaviors that were involved in Skinner's (1976) *Pigeons in a Pelican* project, in which pigeons provided moment-to-moment feedback to guide a missile in real time. It seems as strange to me, as it apparently did to Skinner, to refer to behavior of such supreme importance as fine-grain detail, molecular, or as being part of a reductionistic research program.

Real-Time Behaving and Dynamical Systems Theory

Many years have passed since voices were raised for the replacement of contiguous causation in the form of linear chaining by alternatives involving hierarchical organization of memory and behavior (Anderson & Bower, 1974; Shimp, 1976). One way Field and Hineline seek to show that moment-to-moment behaviors and behaviors extended in time are fundamentally different, are on different levels, and have different explanatory principles, is that real-time behaviors are explained in terms of contiguous causation and behaviors extended in time are not. Contemporary theories of moment-to-moment behaviors, however, do not involve what I understand to be contiguous causation. Instead, they involve dynamic interactive processes in the context of hierarchical structures. "Plans," moment-to-moment feedback, and moment-to-moment interaction are now routine features of dynamic theories for real-time behaving. Robots, drones, and unmanned vehicles of all sorts, assembly lines for the manufacturing of complex items, and countless other objects behaving in real time are controlled by dynamic interacting processes. Skinner appears to have been very aware of all this: His *Pigeons in a Pelican* project nicely exemplified a dynamic, interactive systems approach, and his lament about the demise of cumulative records similarly revealed a mind alive to the dynamic nature of real-time behaving. I feel, at times, that the Field and Hineline paper's advocacy of behavior extended in time is like throwing out the baby (i.e., behaving) with the bath water (i.e., linear chaining).

Behaviors Extended in Time and the Idea of Independent Levels

Field and Hineline advocate the conceptual integration of moment-to-moment behaviors and behaviors extended in time by arguing for different and independent levels. As I noted above, they would achieve integration by separation. They advocate this multi-level analysis in terms of analogies involving gravity, resonances, microscopy, and molecular biology. While these are interesting analogies well worth promoting, we should remember that they are *analogies* and involve different kinds of processes than those of behavior analysis. There is no gravitational theory of behavior, and we do not see moment-to-moment behaviors and behaviors extended in time through a microscope set at different powers of magnification. Why do we resort to such analogies? Because there is no theoretical

understanding of behavior corresponding to that for gravitational forces, how microscopes work, or molecular biology. Physicists do not explain their phenomena by appealing to analogies to psychological theories because they have their own actual theories to explain their phenomena. We do not, so we resort to analogies. Psychology has had its share of analogies and sometimes they have—for a while—proven useful, such as the utility of telephone switchboard analogies for associative learning theory in the early 20th century, fluid hydraulics in the form of the reflex reserve for various behavioral phenomena, and various computer architectures for the human mind. One could make a much stronger argument for independent levels of behaviors by developing methods and theories to explain and legitimize the argument. The argument would then rest on science rather than on speculative analogy and would show that the processes that explain moment-to-moment behaviors and those that explain behaviors extended in time are actually *different*, and would explain what it means for them to be different. Absent such an argument, we should not forget for a moment that the proposed analogies to these other sciences are highly speculative. Instead of advocating for independent levels in advance of even knowing what that would mean, why not conduct more relevant experiments and develop a better theory to inform our understanding of how to discriminate between independent and interdependent levels, if they exist? In short, I advocate for determining empirically and conceptually whether there *are* independent levels.

Behaving Versus Static Pictures of Behaving

I especially like Field and Hineline's harping on language as the source of many unnecessary conceptual problems in psychology. A feature of much language about psychological processes is, in my judgment, a failure to discriminate between real-time behavior, on the one hand, and various static "pictures" of behavior, on the other hand. Oddly, we quickly forget how a static printed page of writing about behaving differs from real-time behaving. Similarly, a printed algebraic equation about behavior is a static picture of behavior, but it is not behaving. I think advocates of both moment-to-moment behaving and of behaviors extended in time could benefit from a more careful consideration of this issue (which is a special case of the relation between models and reality). On the one hand, let us suppose there is a woman dancing, and on the other hand, we have a Degas painting of that woman dancing, or a page of written English describing that dancing, or an equation describing some feature of her dancing. In order to promote discussion, I suggest that the actual dancing is real-time behaving and analyses of behavior extended in time are like the pictures and verbal descriptions, because one can seldom, if ever, reconstruct from such analyses what the original real behaviors were. In sharp contrast, the point of dynamic interactive systems theories of behaving is that they can, or at least try to, reconstruct actual behavior streams. I have called such theories "behaving theories." It is enlightening, I think, that Catania (e.g., 2005) developed his dynamic theory of behaving in the context of developing software to simulate the behavior of organisms under different

schedules of reinforcement as a means of teaching students how to implement those schedules in real time. His theory simulated real-time behaving, and if parameters for an organism were estimated, it could reconstruct that organism's behavior stream. Theories I have developed have had the same goal (Shimp, Childers, & Hightower, 1990; Shimp, 1992). From this perspective, if such a theory does not enable a reconstruction of the behavior stream, then one may fairly ask whether a theory of behaviors extended in time is about *real* behaving at all.

Consider a few other common static examples. A musical score, this very manuscript you are reading, as well as a Degas painting of dancers are all static. In some as-yet unexplained way, they capture features of the dynamic world; but they are to singing, talking, and dancing as is an equation about the matching law is to actual behaving. The problem is the same in all these cases: we do not understand the relation between the musical score and the orchestral performance of that score, dancing and a Degas painting of that dancing, or behaving and a printed equation. The problem of the relation between different kinds of representations of ostensibly the same thing, say the same piece of music on the printed page or as performed in real time, is so basic that such a relation plays an important role in several philosophies of science. Most regrettably, this problem is as inscrutable as it is pervasive. I believe much of the paper by Field and Hineline focuses on the static picture kind of behavior and, thus relatively speaking, neglects behavior in continuous real time. A most welcome exception to this neglect occurs when the authors note that the idea of "need" in the social psychology literature is an informal construct that is not shown to be translatable into action. I would encourage the extension of this concern to the construct of behavior extended in time.

A good theory of behaving should pass what might be called a dynamic, real-time version of the Turing test. An observer looking at the behavior stream produced by a behaving theory would not simply look at a (usually static) printed page produced by the theory responding to questions put to it by an examiner, but would look at how the theory actually behaves in time. Catania's (2005) students were, in this sense, performing as examiners in a real-time Turing test. So, yes, real-time models *are* privileged because if a model generates a behavior stream with the correct temporal patterning, it automatically generates any summary descriptive statistic one cares to compute, including the kinds that apply to the notion of behavior extended in time.

I have challenged the paper's concept of "behavior extended in time" and it is now time to acknowledge some limitations of my own work. I and my colleagues began by looking at temporal patterning in situations where animals successively chose between two alternatives. In some cases, the alternatives were different spatial locations and in others they were pauses of different durations between successive responses to the same location. We found it remarkably easy to establish new behavioral units that were precise quantitative functions of their temporal properties and of how reinforcers were assigned to them. We examined how we might use these new units to segment the behavior stream into successive behavioral categories. More recently, we have looked at how animals learn the

statistical structure of the stream of information provided by a task, and how that learning translates into real-time behavior (Shimp, Froehlich, & Herbranson, 2007). However, it is a far cry from these kinds of moment-to-moment behaviors to hitting home runs, playing Rachmaninoff, or typing something intelligible on a computer keyboard. Some disciplines are eagerly trying to close the gap between the laboratory science of simplified real-time behaving on the one hand and complex naturalistic behaviors on the other hand. Countless examples could be given, among which are the "man–machine interface" in engineering psychology and robotics, studies of speech recognition and production, analyses of the dynamics of locomotion and of athletic performances, studies of music performance, real-time medical decision making in operating rooms, and so on. I think behavior analysts could contribute greatly to these research programs because of their uniquely powerful experimental methods and because of their sophisticated conceptual perspectives as evidenced by the Field and Hineline paper. I feel uncomfortable, however, (as Skinner apparently did) with putting real-time behaving on a different, independent level of analysis. I hope that much more empirical research is conducted, and a more comprehensive behavioral theory is developed, before we accept the idea that there are different and independent levels of behavioral analyses, one involving moment-to-moment behaving and a second one involving "behavior extended in time." Kudos should go to the paper by Field and Hineline if it motivates such research.

References

Anderson, J. R., & Bower, G. H. (1974). *Human associative memory*. Washington, DC: Hemisphere.

Catania, A. C. (2005). The operant reserve: A computer simulation in (accelerated) real time. *Behavioural Processes, 69*, 257-278.

Field, D. P., & Hineline, P. N. (2008). Dispositioning and the obscured roles of time in psychological explanations. *Behavior and Philosophy, 36*, 5-69.

Shimp, C. P. (1976). Organization in memory and behavior. *Journal of the Experimental Analysis of Behavior, 26*, 113-130.

Shimp, C. P. (1984). Timing, learning and forgetting. In J. Gibbon & L. Allan (Eds.), *Timing and time perception*, Vol. 423, (pp. 346-360). New York: New York Academy of Sciences.

Shimp, C. P. (1992). Computational behavior dynamics: An interpretation of Nevin (1969). *Journal of the Experimental Analysis of Behavior, 57*, 289-299.

Shimp, C. P., Childers, L. J,, & Hightower, F. A. (1990). Local patterns in human operant behavior and a behaving model to interrelate animal and human performances. *Journal of Experimental Psychology: Animal Behavior Processes, 16*, 200-212.

Shimp, C. P., Froehlich, A. L., & Herbranson, W. T. (2007). Information processing in pigeons: Incentive as information. *Journal of Comparative Psychology, 121*, 73-81.

Skinner, B. F. (1960). Pigeons in a pelican. *American Psychologist, 15*, 28-37.

Skinner, B. F. (1976). Farewell, My LOVELY! *Journal of the Experimental Analysis of Behavior, 25*, 218.