Stepping outside the traditional "science" box

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Ethologists and other students of behavior are faced with a difficult challenge. Their goal is to see how individual components of behavior fit together into higher order patterns. Clearly this provides enormous statistical problems. In this presentation I wish to move beyond these issues of statistics, although they are obviously critical [1].

The more detailed our observations, the more components we can record and the greater number of relationships we need to consider. Clarity in observation is the first challenge. What do we look for, and what do we ignore? Often standardized measures leave out potentially important features. For example, I talked with a professional dancer who asked me how I recorded breathing patterns in the wolves I was observing. I had not thought about doing that. But changes in breathing can signal actions that are not only being performed at the moment, but also actions that are likely to occur next. As illustration, we as other creatures often take a deep breath prior to actions that involve high exertion.

Such comments from my non science friends got me thinking about what we tend to see and record as scientists. As one example, the timing and sequencing of behavior, as they occur together, is for the most part imperfectly analyzed. Our friends in music and dance have much to offer. If we think about music, for example, we deal with notes, rhythms, melodies and so forth. It is often useful to play our behavioral records as if they are natural compositions. We have done that with rodents as well as wolves, and the results are often enlightening. As a single example, think of chords where two or more action properties occur together or in overlapping combinations.

Here I introduce what I think is the most difficult challenge to our measures of behavior. I call it the "pieces – relations" problem. The standard way to think about behavior is to divide an observed stream of events into components, and then ask how these components fit together in time. An obvious example is human speech. Combinations of phonemes produce words which in turn allow speakers to articulate sentences and make points. But the phonemes we articulate are not truly independent of one another. Individual phonemes can be adjusted as a function of other sounds that precede or follow. The "pieces" of our speech are affected by the rules through which they are connected in time.

Similar things happen in animal actions. Individual properties of behavior are adjusted by their neighbors. Thus "pieces" of behavior which we isolate may not be truly "fixed". They can vary in terms of their broader contexts of expression. I will show how this applies both to rodent grooming and wolf vocalizations. My colleague, Simon Gadbois, has applied issues of prosody in human speech, super-segmental modulations in tone and other features, and shown how they may apply to animal actions. How do we measure these modulations that are superimposed across action components we normally record? [2]

There is a deep issue here. While it is tempting to isolate "pieces" of behavior and then to see how these pieces are strung together, it is easy to forget that these "pieces: can be modulated by their contexts of expression. One image is that of a series of rubber bands that are pulling upon one another, thus changing shape by actions in their neighbors. From a statistical point of view this is a potential nightmare.

The sequencing and timing of behavior are often looked at independently, but these features of behavior are not truly independent. As a simple illustration the duration of face licking movements in rodents is a predictor of which other actions are most likely to follow next. To my knowledge we do not have adequate methods to look at both the timing and sequencing of action properties within a coherent framework.

Those involved in the brain sciences face a similar problem. Our brains are "modular" in important ways. Different areas are primarily involved with different functions. However, these "modules" are not truly independent from one another, and only by examining them in the broader contexts of their operations can one truly achieve an understanding of their operations. Even in invertebrate studies of ethologically derived concepts, such as "central motor programs", studying systems in their isolation provides a distorted picture of how they operate when connected at the level of the intact organism. Mechanistic and systems views of both brain and behavior provide a conceptual dilemma that we have not successfully come to grips with.

I have found students of music and dance to be especially helpful. In each case they look at the flow of action properties in terms of their relations to one another. As in speech, a dancer or musician blends individual events in terms of the neighborhoods within which they occur. Computer speech and music can sound choppy simply because this blending is not applied.

What does this mean for how we record and interpret behavior? I offer a few thoughts and invite others to share their views.

The question becomes: What is a piece of behavior? We label actions in terms of nouns, but even that linguistic necessity can place a freeze frame on patterns of expression that in reality are much more fluid. .

This presentation seeks to supplement new technologies in scientific study of behavior. There are the most important analytical tools that we have established.. Noldus has been a leader, and in my judgment its contributions are of major significance. What I suggest is that at a conceptual level we have a long way to go, whether looking at the behavior of intact individuals, social groups, or neural mechanisms. Our friends in the arts often have sensitivity to issues that we would do well to hear.

References

1. Martin, P. Bateson, P. (2007). *Measuring Behaviour: An Introductory Guide.* Cambridge University Press, Cambridge.
2. Fentress, J.C., Gadbois, S.(2001). The development of action sequences. *Handbook of Behavioral Neurobiology,* E. Blass, editor. Kluver Academic / Plenum Publishers, New York. 393-431.