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Cognitive probatonics: Towards an ecological psychology of cognitive particulars

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A B S T R A C T

This article takes an ecological approach to the functioning of self-organised cognitive systems. The dynamics of such systems are traced to how they are animated by agents through interactivity, or sense-saturated agent-environment coordination. These dynamics give rise to cognitive events, the nature of which is revealed with detailed micro level qualitative analyses which, in turn, unveil unique cognitive trajectories in a problem landscape. The article presents and exemplifies a method for doing so, the Cognitive Event Analysis. This method is based on a "probatonic principle" that prompts cognitive scientists to pay close attention to fine-grained particulars in human behaviour. Based on the methodological approach and two case studies, the article discusses how affordances and language function in a cognitive ecology.

1. Introduction

In early 2014, 50 participants were given a problem-solving task in the *Systemic Cognition Lab* at Kingston University (Steffensen, Vallée-Tourangeau, & Vallée-Tourangeau, submitted; Vallée-Tourangeau, Steffensen, Vallée-Tourangeau, & Makri, 2015). The participants were given the so-called 17 Animals problem in one of two conditions (using pen and paper, or using a physical model), just as they underwent a series of psychometric measures. The experiment was designed to determine how differences in the physical layout of the problem presentation affects behavioural outcomes and success rates. The statistical results suggested that a physical model does in fact facilitate a successful outcome (Vallée-Tourangeau et al., 2015), which is not surprising if one takes recent work on cueing into account (e.g. Ball & Litchfield, 2013; Kirsh, 2009). By determining whether a participant had reached a solution or not within the time limit, it was shown that participants in the "physical model" condition perform far better than chance performance, while subjects in the "pen and paper" condition perform much worse. So far, so good. But here comes a surprising insight: the 50 participants were all video-recorded during their performance, and even a first glance at the videos revealed that the uniform group of "successful solvers" in fact covered a substantial variability in the way that they used the physical model. This surprising variability was undetected in the initial measurement and would thus never have reached the surface without the additional analysis of the video-recordings. Obviously, one's measurement methods constrain what one can find, but one may wonder, how many experiments would have exhibited similar variability, had the measurement methods allowed for it.

Variability can be utterly trivial. For instance, whether a subject solves the Tower of Hanoi problem using his/her left or right hand (or whether the disks are red, blue, or green) hardly matters; such questions are hardly worth any scientific investigation. But how does one a priori distinguish between cognitively relevant and irrelevant variability? Given the usual methodological assumptions of cognitive science, the obvious way forward is to advance a set of experimentally testable hypotheses. However, while cognitive science has developed robust methods for testing hypotheses, the field is surprisingly silent when it comes to its methods for generating hypotheses.[1] In the absence of explicit procedures for

[1] For instance, a search on PsycINFO gives 1979 hits for "test(ing) or evaluat(ing) hypothesis/-es" within cognitive psychology, but only 149 hits for "generat(ing), creat(ing) or produc(ing) hypothesis/-es" within this field (Steffensen et al., submitted).

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generating hypotheses, the field has to rely on anecdotal hypotheses, or hypotheses derived from theoretical arguments.

In this paper, I argue, that what is missing is an inductive method for observing cognitive performance and behavioural particulars, both in real-life and in the lab. On the one hand, such a method complements the standard inventory of methods in cognitive science, as it generates hypotheses on a principled basis and with a starting point in empirical work. On the other, slightly more radical hand, such a method goes one step further by complementing the nomothetic enterprise with an idiographic framework. In both variants, the argument builds on a methodological principle called the *Probatonic Principle*; this principle is introduced in section 2. In section 3, the method, *Cognitive Event Analysis*, is introduced, and section 4 demonstrates the kind of insights yielded by such a fine-grained qualitative method to human behaviour by showcasing two examples. In section 5 I use the two case studies to discuss how affordances are best conceptualised in an ecological framework. Finally, in the discussion in section 6, I discuss the role of language in human behaviour and the perennial topic of the validity of idiographic approaches.

2. The probatonic principle

The approach presented in this paper builds on a methodological principle that I call the *probatonic principle*, borrowing a term from Luke 15,4–6:

> Which one of you, having a hundred sheep and losing one of them, does not leave the ninety-nine in the wilderness and go after the one that is lost until he finds it? […] And when he comes home, he calls together his friends and neighbors, saying to them, 'Rejoice with me, for I have found *my sheep* [*πρόβατόν μóυ* (*próbatón mou*)] that was lost'. (Luke 15:4–6; New Revised Standard Version; my italics and insertion of the Greek original)

The probatonic principle is named after the single sheep (*próbatón* in Greek) that has our full attention and which is not reducible to being just a member of the herd – or of the dataset, as it were. It acknowledges each participant as following his or her own "microecological orbit" (Goffman, 1964), and thus takes a starting point in a specific cognitive ecosystem (Vallée-Tourangeau et al., 2015). As a research principle it states that much can be gained from scrutinising single, particular instances in detail. The probatonic principle urges us to study *instances*, either in their own right or as part of a hypothesis-generating procedure. The principle's importance lies in the fact that it forces us to attend to small, nonlinear (and at times one-off) phenomena that (also) impact on behaviour.

The argument for this line of though is as follows. If we accept the view that cognition is embodied, we must reject the assumption that there is an inner bodily core that does the cognition: the body is a systemic whole, and not a layered non-cognitive. This view parallels Thelen and Smith's (1994:337) comment that "we, like the symbolic computational theorist, view cognition as all one kind; but in our view, it is all embodied, all distributed, all activity, all a complex event in time." At the very least, we must acknowledge that *if* there is a cognitive core somewhere in a cognitive system, it is sensitive to input from all other parts of the system. Following this argument, there is no principled way of determining what is, or can become, part of the cognitive system. Cognition regulates the agent-environment relation, and all ingredients in the agent-environment system potentially partake in this regulation. Therefore, we have no a priori ways of determining what parts of the system we should attend to. In contrast, experimental methods rely on isolating and measuring variables. By necessity, a measurement requires that the parameter to be measured is determined a priori. Likewise, experimental methods require that the variables are predetermined.

Given the probatonic principle, how do we study cognitive particulars? The ecosystemic emphasis entails that, while the uniqueness of particulars may appear as differences in peripheral details, it is not reducible to such details. Thus, it makes little sense to study specific details in isolation, without considering how they contribute to a specific cognitive system. How this system is defined depends on the specific research question being asked. Obviously, any investigation depends on some sort of delineation, but the probatonic principle urges us to rely on inductive delineation where a given cognitive system is documented in as much detail as possible, so that the delineation can be an a posteriori procedure based on data, rather than an a priori procedure.

On a naturalised viewpoint, a cognitive system is ecological, and as such it has an irreducible and irreproducible historical trajectory. Studying cognitive particulars, thus, amounts to studying the unique trajectory of a dynamical cognitive system. Evoking Dynamical Systems Theory in this context is not incidental. Thus, the emphasis on cognitive trajectories parallels Esther Thelen's *mountain stream metaphor* for describing cognitive development:

> I suggest another metaphor for human behavior: a mountain stream. This is an apt comparison to keep in mind, because a stream is moving all the time in continuous flow and continuous change. Development is continuous—whatever has happened in the past influences what happens in the future. But the stream also has patterns. We can see whirlpools, eddies, and waterfalls, places where the water is moving rapidly and places where it is still. […] The patterns reflect not just the immediate conditions of the stream, however; they also reflect the history of the whole system, including the snowfall on the mountain last winter, the conditions on the mountain last summer, and indeed the entire geological history of the region, which determined the incline of the stream and its path through the mountain. (Thelen, 2005:259)

Thelen focuses on the temporal scale of child development, but the metaphor also supports the probatonic principle because it urges us to study particulars in real-time behaviour. Just like development is non-linear, so are real-life, on-line, cognitive action–perception cycles non-linear.

In the current context, the principal explanans for how the ecological agent-environment relation is upheld and modified is *interactivity*, here defined as *sense-saturated coordination that yields functional results*.[2] Coordination takes place whenever a living agent interacts with (conspecific, living, or non-living) entities in its environment. In the words of Kirsh (2006:250), "coordination is the glue of distributed cognition": embodied agents are physical-material structures, and their actions are directed towards physical-material structures in their ecology. However, it is a peculiar fact about the human ecology that it is permeated by (historically generated) symbolic and organisational structures that extend our perceptual and actional domain. The human ecology is an *extended ecology* (Steffensen, 2011), because sociocultural resources (above all language) extend our range of action and perception, not unlike how a spider's web functions as "a huge extension of the effective catchment area of her predatory organs" (Dawkins, 1982:192; quoted in Waters, 2012:509). The human ecology extends by exploiting sense-making capacities: when we

[2] This definition differs slightly from the one given in Steffensen (2013:196): "sense-saturated coordination that contributes to human action."