Scales of Cognition Evident in Action

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Abstract

When cognitive processes occur alongside observable actions, it is possible for characteristics of these processes to influence the ongoing performance of those actions. This satisfies everyday intuitions. For example, negotiators and poker players claim to be attuned to 'tells,' these early behavioral indicators of eventual decisions. Going beyond intuitions, however, several researchers have exploited this fine-grained source of behavior to highlight online cognitive processing. Using even a simple measure such as computer-mouse tracking can reveal a wide range of cognitive processing. Four participants in this symposium report on applications of the analysis of the action dynamics of cognition across multiple scales: (i) basic decisions, (ii) language processing, (iii) false responding, and (iv) social processes. The similarities and differences in expression of these processes in action highlight important continuities and discontinuities across cognitive and neural processes.

Keywords: action dynamics; social cognition; learning; decision making; language

Cognition and Action

A perhaps still prevailing notion of the relationship between cognition and action is that motor movement takes place mostly near the end of a cognitive process or decision. Implicit in this notion is that the systems are relatively independent, potentially modular and encapsulated. An outcome of this attitude is that action has, to some extent, been neglected in many quarters of the cognitive sciences (for review on this issue, see Rosenbaum, 2005). In contrast, recent work suggests that action and cognition facilitate one another to such a degree that one can understand action as "part and parcel" of cognition (Freeman, Dale, & Farmer, 2011). In this work, researchers extract the computer-mouse cursor movements of participants who carry out a cognitive task. By analyzing dynamic properties of the cursor, such as motion latencies, velocities, complexity of movement, and so on, new insights into cognitive processing are possible.

A tighter relationship between cognition and action has inspired explorations of cognition using densely-sampled behavioural data. Put simply, it may now be possible to investigate ongoing action for evidence of purported cognitive processes. The dynamic characteristics of ongoing behaviour provide a testbed for the comparison of models in various areas of cognitive science. The papers in this symposium will report on applications of the analysis of the action dynamics of cognition at four very different scales. The first talk will address the dynamics of basic choice processes by studying the dynamics of movement while those choices are made. The second talk addresses sentence process and pragmatic inferences. The third showcases the dynamics of false responding as a model of cognitive processes involved in deception. Finally, the fourth talk discusses the application of these dynamic techniques to social cognition. The symposium will end with 20-minute interactive discussion of the relationship between action and cognition, the impact of these measures on theoretical issues across scales, and the inevitable differences in how measures behave at these levels and their different tasks.

(i) Mechanics of Choice and Decision-Making

Our everyday language about choice and decision making is, in English at least, replete with dynamic physical metaphors. We are 'pulled' or 'drawn' towards choices that we sometimes 'cannot resist'. When we make a decision, we might be asked, 'How did you come to this conclusion?' and we might feel were 'pushed' towards it or that we 'fell into it'. These metaphors highlight certain characteristics of decision-making. First, decision making takes time; our preferences gradually develop from less stable to more stable as we choose. Second, how we make our decisions tells us much about the quality of the decision, whether it was easy or difficult, fearful or hopeful, and so on. Indeed, the dominant models of preferential decision-making within cognitive science include the dynamic evolution of choice in that repeatedly sampling information biases the unfolding decision.

Within a short discrimination learning task, Denis O'Hora and colleagues manipulated the strength of attraction to available choices by changing the points available for making these choices. He will describe how they used this method to investigate choice trajectories under a range of conditions of choice conflict.

(ii) Interplay between Pragmatic and non-Pragmatic Inference

Unlike most linguistic phenomena, the derivation of pragmatic inferences is optional. For example if a speaker is asked, "Are Todd and Sam coming to the party," and she responds, "Todds coming," the listener could interpret the utterance as 1) the speaker only knows that Todd is coming but doesnt know about Sam or 2) derive the inference that only Todd is coming and Sam is definitely not. In both cases, listeners at least know that Todds coming. Because pragmatic inferences are highly context dependent, research on the comprehension of inferences needs to tease part the likelihood of making an inference from the process of deriving on one (Bott, Bailey, & Grodner, 2012).

John Tomlinson will present work on how action dynamics cannot only capture this important distinction, but also how action dynamics provide clearer insight into how pragmatic inferences are derived. In several of studies, listeners motor movements show strong initial preference for non-pragmatically enriched interpretations for scalar implicatures before correcting towards pragmatic interpretations. Studies will be presented on how intonation, context, and speaker information can streamline these inferences. Critical for this symposium is how action dynamics, specifically time normalized mouse movements, can provide new insights into how such factors above and beyond that of real time data analyses such as reaction times and eye-movements.

(iii) Action Dynamics Reveal False Responses

Human beings are surprisingly adept at responding to questions with information that is in opposition to what is known to be true. There remain, however, many open questions about how deception is possible. Do we hold in mind what is known to be true, and actively inhibit it to respond falsely? Does it matter whether that information is biographically relevant, or is simply a statement that can be readily falsified in our own semantic memory? Does answering falsely get easier if our cognitive system can prepare for it?

Questions such as these pertain to the underlying cognitive processes that contribute to deception. Yet it is extremely difficult to create experimental situations that permit direct access into such mechanisms. In this presentation Dale and Duran survey a variety of experiments that utilize the mouse-tracking methodology to explore the dynamics of false responses. For example, in one experiment, participants were prompted to respond falsely about their personal experiences and biography (Duran, Dale, & McNamara, 2010). In another, participants were prompted to lie to an imagined part-

ner in a game of 20-questions, thus confusing them about a target objects of the game (Duran & Dale, 2012).

(iv) Cognitive Processes in Social Categorization

Mere exposure to a social target has long been known to trigger spontaneous categorization along multiple dimensions (e.g., sex, race, age). Such categorizations are extremely rapid and efficient, yet also reflect the complex integration of a variety of bottom-up (e.g., facial and vocal cues) and top-down (e.g., stereotypic expectations, motivation) information sources. Jonathan Freeman will discuss recent work exploiting the tight link between cognitive and action dynamics to understand the underlying social categorization process.

In one series of studies, for example, participants were presented with sex-typical and sex-atypical faces and asked to categorize the targets sex by clicking on a male or female response on the screen (Freeman, Ambady, Rule, & Johnson, 2008). During categorization of sex-atypical faces, hand trajectories were continuously attracted to the opposite sex-category before settling into the correct response. These findings and others support an account of social categorization in which dynamic competition is central; perceived facial, vocal, and bodily cues (among other constraints) simultaneously weigh in on multiple partially-active category representations that dynamically evolve over time into stable categorical perceptions (Freeman & Ambady, 2011).

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