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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

<https://escholarship.org/uc/item/44p2368p>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 30(30)

ISSN

1069-7977

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Publication Date

2008

Peer reviewed

The Interactive Routine as Key Construct in Theories of Interactive Behavior

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Somewhere between 1/3 and 3 seconds, the cognitive, perceptual, and motor elements of embodied cognition come together in dependency networks of constraints to form *interactive routines* (Gray, Sims, Fu, & Schoelles, 2006). Interactive behavior proceeds by selecting one interactive routine after another or by selecting a stable sequence of interactive routines (i.e., a method) to accomplish a unit task. We see interactive routines as the basic elements of embodied cognition (Ballard, Hayhoe, Pook, & Rao, 1997).

The selection, assembly, and execution of interactive routines is typically non-deliberate and non-conscious. The contrast is between deliberative actions performed for some purpose of their own versus routine actions performed as a means rather than as an end.

I will argue that interactive routines should be viewed as the key construct in theories of interactive behavior. To this end, I review data in the following five categories.

The Natural Unit of Interactive Behavior. Newell (1990) defined immediate behavior as, “responses that must be made to some stimulus within very approximately one second (that is, roughly from ~300 ms to ~ 3 sec).” Regularities at this level of analysis across four cultures led Schledit (1988) to refer to this interval as a “universal time constant”. The prevalence of simple object-related acts that take about 3 s to complete led Land (1999) to suggest that this interval has “something to do with the intrinsic time scale over which the brain prefers to operate” (p. 1325).

Unconscious Attention in the Control of Interactive Routines. Acts of routine interactive behavior are often considered to represent “automatic” not “controlled” processing. To the contrary, considerable evidence suggests that it is controlled (Schwartz, 1995), though not as much as less routine behaviors. Labeling this phenomena as *unconscious attention* (Land et al., 1999) Land concludes that, “even if the subjects themselves are not attending to the task, their oculo-motor systems are” (p 1326).

Role of Memory in Guiding Eye Movements during Interactive Behavior. If the eyes dart around 4 or 5 times per sec, perhaps internal memory is not needed. Perhaps the world itself forms an *outside memory*. I will argue that during routine interactive behavior the level of encoding required for getting about in the world is both selective and shallow. It does not encompass the entire world (no Blu-Ray™ Discs in-the-head) and what is encoded is not encoded for the ages, but for the instant. It is *information for use, not reflection*.

Interleaving of Interactive Routines. With experience, the operations of successfully executed interactive routines become interleaved thereby increasing the speed and efficiency with which interactive behavior is executed. This

interleaving of components of different interactive routines is also observed by Land (1999) who in his study of tea making notes that movements lead action by about 1/2 s and action continues after the eye has moved on.

Innate Timing of Interactive Behavior. Recent work (Joiner & Shelhamer, 2006) suggests the existence of two timing systems in the brain. A predictive timing system that operates on events under 3 s and a reactive timing system that operates above that level.

The Dark Side of Interactive Routines

The soft constraints hypothesis (Gray et al., 2006) claims that the selection mechanism for interactive routines optimizes locally, not globally. This local optimization may result in the human-computer interaction phenomena called the Paradox of the Active User (Fu & Gray, 2004) in which experienced, daily users of software consistently fail to optimize their use. In more basic research settings, this phenomenon is referred to as stable, suboptimal performance.

Acknowledgments. The writing of this paper was supported by grants from AFOSR #FA9550-06-1-0074 and ONR N000140710033.

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