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Guest Editor's Introduction

THE END OF COGNITION?

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The papers that make up this special issue of *Human Technology* have been elicited as a response to the growing interest in user experience and second-wave HCI (human–computer interaction), also known as post-cognitivist HCI. User experience, in particular, has shifted the focus of research interest away from cognition per se to, for example, affect (e.g., Norman, 2004); fun (e.g., Blythe, Monk, Overbeeke, & Wright, 2003), pleasure (e.g., Jordan, 2000), and aesthetics (e.g., Tractinsky & Lavie, 2004), thus begging the question, where does this leave cognition? To judge from the submissions to this special issue, cognition in HCI is alive, well, and positively thriving. Indeed cognition is proving to be a remarkably robust theoretical framework that is expanding and adapting to a growing understanding of how people use, interact with, and think about interactive technology.

CLASSICAL COGNITION

At the heart of all classical cognitive accounts is some form of representation. While it is difficult to be precise about the origins of cognitive psychology, Tolman (1948), some 60 years ago, was one of the first to argue for a map-like representation in the brains of rats that enabled them to find their way around a submerged maze. The presence of this representation raised problems for the then-dominant behaviorist account, which argued that we could only be certain about stimulus (input) and response (output), and what lay between was effectively a "black box." However, it was not until Chomsky's (1959) damning review of Skinner's (1957) *Verbal Behavior* that behaviorism was consigned to the history books and cognition became a dominant paradigm in psychology.

Norman and his colleagues went on to create a human information processing account of human cognition that bore an uncanny, but unsurprising, resemblance to the operation of digital computers (Lindsay & Norman, 1967). Other significant landmarks included the appearance of Simon's (1969) *The Sciences of the Artificial* and the journal *Cognitive Psychology* in 1970.

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The influence of all of these developments can be clearly seen in Card, Moran, and Newell's (1983) psychological model of the user: the model human processor (MHP) that comprised perceptual, cognitive, and motor systems, and was used to develop a set of predictive models known as GOMS (goals, operations, methods and selection). GOMS models behavior in terms of a changing "goal stack" and a set of rules for adding and removing goals from this stack—a cognitive model couched in the language of digital computation. Norman's (1988) execution–evaluation cycle similarly envisages the user formulating a plan of action (a cognitive representation) that is then executed by way of the system's user interface. As this plan is executed, the user observes its results, which then form the basis of the user's next plan. This cycle continues until the goal has been achieved.

In addition to these models, the centrality of cognition to the practical design of interactive technology was recognized with the appearance of Gardiner and Christie's (1987) *Applying Cognitive Psychology to User-Interface Design*. However, it is also worth remembering that probably the most defining characteristic of HCI is *usability*. Usability, according to Nielsen (1993), is defined in terms of five dimensions, namely, learnability, memorability, the treatment of errors, efficiency, and satisfaction. Excepting the final dimension of satisfaction, the others are based on cognition, though satisfaction by no means excludes a role for cognition. Although noncognitive forms of evaluation are being developed and applied, it cannot be denied that usability and its foundations in cognition remain the sine qua non of all interactive technology and media.

Since the introduction of these applications of classical cognition to the problems of designing and evaluating interactive technology, a number of practical extensions have been created, taking cognition beyond its original formulation. One strongly theoretic use of cognition can be found in Vicente's *Cognitive Work Analysis* (CWA; Vicente, 1999). CWA has its origins in the work of Rasmussen and draws on the theoretical foundations of cognitive engineering. The method is primarily targeted at those domains with complex, dynamic environmental constraints; typical examples involve nuclear plants and operating theatres. The approach includes five complementary analyses: the *functional structure* of the work domain; *control tasks*, which must be undertaken to achieve work goals; *strategies* to cope with task demands; *social organization and cooperation* (broadly, allocation of responsibilities for tasks and communication between roles); and *worker competencies*. Together the analyses provide a very full description of the work domain under study, having addressed many of the shortcomings of classical cognition.

In parallel to these developments, the whole bases of cognition in HCI have been challenged, firstly and most significantly, by Suchman's (1987) *Plans and Situated Actions*, and then by other researchers, such as Bannon (1991) with his "From Human Factors to Human Actors." These works, for many people, marked the end of the dominance of cognition in HCI and the beginning of the "turn of the social." Suchman highlighted the importance of contextual or situated factors in using technology, concluding that a plan is better thought of as a resource that could be drawn upon rather than a program to be executed, while Bannon criticized the laboratory-based study of technology use and the accepted practice of treating people as mere "users."

RESURGENT COGNITION

In many respects, the frequent citations of Suchman and Bannon's criticisms of cognition may be a little unfair, since they only really address classical cognition, that is, the cognition of symbol manipulation and rules; a cognition unconcerned by context, culture, or the social world; and a cognition that is rarely, if ever, found in human–computer interaction today.

Cognition has successfully extended and reformulated itself in the last 20 years. For example, Hutchins (1995) is one of the originators of the concept of distributed cognition. Distributed cognition incorporates social and organizational perspectives, the premise being that cognitive processes and the representation of knowledge may be distributed among both multiple human actors and artifacts. It is also distinguished by its emphasis on the role of external representations (cf. Rogers & Ellis, 1994). The elements of the cognitive system include human beings and artifacts, representations of information that may be both internal and external to the human actors, and the relationships between these elements as they work to achieve the system's goal. In the real world, tasks involve the coordination of representational states, both internal and external, whereby multiple representations are combined, compared, derived from each other, or made to correspond (e.g., Hutchins & Klausen, 1996). A distributed cognition approach thus offers a means of understanding how socially shared activity achieves its goals. In addition to distributed cognition, Clark (2005, p. 1) has proposed an "extended mind hypothesis," which is the view that ''the material vehicles of cognition can be spread out across brain, body and certain aspects of the physical environment itself.'' Meanwhile, Edmondson and Beale (2007) have written of projected cognition, which adds intentionality to these accounts.

Predating these innovations is, of course, activity theory. Activity theory is not a cognitive account of the use of interactive technology but has, nonetheless, strong social cognitive and distributed cognitive dimensions. Central to activity theory is the argument that all purposive human activity can be characterized by a triadic interaction between a subject (one or more people) and the group's object (usually loosely translated as its purpose) mediated by artifacts or tools (e.g., Blackler, 1993, 1995; Bødker, 1991; Engeström, 1987, 1990, 1995; Holt & Morris, 1993; Kuutti, 1991, 1996; Nardi, 1996). In activity theory terms, the subject is the individual or individuals carrying out the activity, the artifact is any tool or representation (the internalization of external action, as discussed by Zinchenko, 1996) used in that activity, whether external or cognitive; and the object encompasses both the purpose of the activity and its product or output. Developments of activity theory by Engeström and others have added more elements to the original formulation and these are: community (all other groups with a stake in the activity), the division of labor (the horizontal and vertical divisions of responsibilities and power within the activity), and praxis (the formal and informal rules and norms governing the relations between the subjects and the wider community for the activity). These relationships are popularly represented by an activity triangle. Given this description, it is perhaps unsurprising that Cole and Engeström (1993) have argued that activity theory in itself is an account of distributed cognition.

Cognition is also recognized as being embodied, that is, cognitive processes are not confined to the brain but are deeply rooted in the body's interactions with the world (e.g., Lakoff & Johnson, 1999). These ideas echo the words of philosophers such as Whitehead and Merleau-Ponty. Whitehead (1997), for example, observed that, "We have to admit that the

body is the organism whose states regulate our cognition of the world. The unity of the perceptual field therefore must be a unity of bodily experience" (p. 91). However it is Merleau-Ponty's work that has witnessed a renaissance in recent years (e.g., Dourish, 2001). Merleau-Ponty (1945/1962) has argued that it is only through our lived bodies that we have access to what he describes as the "primary world." The world and the lived body together form an intentional arc that binds the body to the world. The intentional arc is the knowledge of how to act in a way that coheres with one's environment, bringing body and world together. "The life of consciousness—cognitive life, the life of desire or perceptual life—is subtended by an 'intentional arc' which projects round about us our past, our future, our human setting, our physical, ideological and moral situation" (Merleau-Ponty, 1945/1962, p. 136). For Merleau-Ponty, the intentional arc embodies the interconnection of skillful action and perception. More recently, Wilson (2002), in a critique of the embodied cognition hypothesis, noted that she has been able to distinguish a number of different claims for it. These include that it is situated; that it functions in real-time; that we off-load cognitive work onto the environment; and that off-line cognition is bodily based. While distributed, situated, and embodied cognition are yet to be fully, practically realized, we can be confident that cognition itself is alive and well and continuing to underpin most of the current research in HCI.

This issue addresses a number of current and overlapping research themes identified above while adding particular new perspectives and interpretations. The first two papers consider embodied cognition.

Hurtienne begins by discussing image schemata. Image schemata are described as "abstract representations of recurring sensorimotor patterns of experience." They are formed by and directly structure our experience with the world and, as such, present an important means of exploring the embodied nature of cognition. Hurtienne shows how these image schemata can be used directly drawn in the design of interactive technology.

Preferring the term embodied embedded cognition (EEC), van Dijk writes that EEC is characterized by both its phenomenological roots and action-centeredness. The phenomenological character of EEC is an explicit link to user experience research by relating the ultimate goal of good design in HCI to the quality of the (user) experience of using it and the recognizing that usability is still best understood within a cognitive framework. Moreover, van Dijk argues for a renewed focus on improving usability based on this EEC perspective. He concludes with a tentative sketch for an embodied embedded usability, while retaining the original goal of making interactive technology easy to use.

Next, van den Hoven and Eggen consider the role of external cognition in everyday lives and environments. They introduce the concept of *autotopography*, which refers to the study of personal collections of physical artifacts that serve as a memory landscape to the owner. These artifacts, such as photos, souvenirs, furniture, or jewelry, physically shape an autobiography because they link to memories that are important to the owner. Since those memories are important, the artifacts that link to them are also important, although this link is often invisible and unknown to other people. The collection of artifacts, and their disposition and location, represents a part of the owner's memory, history, and thus identity (cf. Turner, 2008). These artifacts also might represent desire, identification, and social relations, establishing a form of self-representation. In their paper, van den Hoven and Eggen consider the range of memory cues in the environment by comparing the effect of cue modality (odor,

physical artifact, photo, sound, and video) on the number of memory details people related from a unique one-day real-life event. They argue that the HCI specialist or interaction designer cannot just focus on the interaction at hand but must adopt a wider remit and address an individual's broader environment.

Hall, Woods, and Hall introduce and use theory of mind (ToM) methods to investigate children's interpretations of the social and emotional states of synthetic pedagogical characters. Their work focuses on children's cognitive and affective empathic responses to virtual characters in bullying scenarios and their social awareness and understanding of the characters' situations. Although cognitive approaches typically do not consider user social awareness and emotional understanding and their roles in interaction, these are critical for our research, with a focus on empathic engagement. In their paper, Hall et al. present an approach focusing on story and character comprehension using concepts from ToM methods. This approach seeks to understand children's interpretations of the characters within virtual role play scenarios, which were then compared with an adult perspective. Their results imply that ToM methods offer the potential for determining user social awareness and emotional understanding, with the key results suggesting that adults and children have different perspectives on how victims and bullies are feeling. Despite the differences in how the adults and children responded to the characters in the bullying situations, Hall et al.'s study demonstrates that children can exhibit ToM and are able to respond to synthetic characters in virtual learning scenarios.

The concluding paper by Turner and Sobolewska revisits a classic study of mental models but from the perspective of individual differences. They argue that people are able to exhibit different cognitive styles, either a tendency to systematize or to empathize with interactive technology. Systemizing is associated with the creation of mental models, while empathizers tend to treat technology as though it were a friend. Following Payne's (1991) study of how people thought automatic teller machines worked and using Baron-Cohen's work on cognitive styles, they examined the relationship between the cognitive styles and how people think about their mobile phones. Turner and Sobolewska report evidence that lends support for this relationship of cognitive styles, but concluded that the situational factors are important too.

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