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Phil Turner

HCI Redux

The Promise of Post-Cognitive Interaction

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The Promise of Post-Cognitive Interaction

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Preface

the initial vision of HCI as an applied science was to bring cognitive-science methods and theories to bear on software development (Carroll 2003, p. 3)

The discipline of human-computer interaction (HCI) was originally concerned with the design and evaluation of interactive systems. Its initial aims were to understand their use and to create technologies which were usable. In these early days, to understand the human aspects of HCI was, of course, an appeal to cognitive psychology (and very quickly, 'cognition' and 'cognitive' were adopted to stand for 'psychology' or 'psychological'). Researchers, practitioners and designers were also able to make use of the many cognitive theories, models and methods which were emerging at that time. As for the design aspect of HCI, it was recognised that the best way to create usable and accessible technology was to involve the intended end users, and thus a whole raft of user-centred and user participatory methods were also created. These approaches, in practice, were realised through incremental prototyping, that is, cycles of design, evaluation and redesign which the noted designer David Kelley describes as 'enlightened trial and error'.

However, in all of this excitement, psychology has rather been left behind. While research is still being conducted into understanding and designing for people with special needs or who are very old (old, of course, has been redefined upwards) and those on the wrong side of the 'digital divide', it is now generally expected people are sufficiently familiar with technology to be able to use it or be able to ask their friends how to use it or, failing that, their children. Excepting these groups, there simply isn't a problem to research.

So, what is this book about? We begin by considering some of the things which will not be discussed. For example, we are not concerned with the *design* of interactive systems. There is, after all, no shortage of books, manuals, recommendations, websites, tutorials, online videos and guidelines which will point the interested developer to a good design. So, if you are looking for advice on how to build a better website, app or bot, please look elsewhere, and then come back to understand how and why these recommendations work! Nor will we not discuss why some people appear to use technology compulsively. We read, in the popular press and on

technology new sites, about young women checking social media accounts when they first wake up and even during the night (The Telegraph 2016) and that some people check their cell phones as frequently as every 6 s (BuzzFeed 2016). If these bewildering observations are so, they may be better accounted for from the perspective of those studying addiction and the fact that they seem to share many of the characteristics of the partial reinforcement effect that is probably not lost on old behaviourists (and some modern game designers).

So returning to the question of what we will discuss, we are primarily concerned with the role of cognition in HCI, and this discussion is effectively framed by two quotes. The first, which appeared at the outset of cognitive psychology, is from Neisser (1967) who wrote that 'it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon'. So, this establishes cognition as being important. While this kind of all-encompassing observation is not always particularly helpful, we can see why this sort of thinking dominated for decades. Then 40 years later, Clark tells us that cognition is 'whatever mix of problem-solving resources [which] will yield an acceptable result with minimum effort' (Clark 2008, p. 13). This is effectively turning the definition on its head. We have gone from 'cognition is what we use to achieve our ends' to 'whatever it is we are doing to achieve our ends is what we mean by cognition'. And we would add, the greatest problem-solving resource we have invented to date is interactive technology. We can also see that a further problem for psychology is that HCI has emerged as being necessarily multidisciplinary (cf. Clark's 'whatever mix of …'). Cognitive psychology, as such, is just too narrow in itself to do the job as it has been traditionally concerned with understanding our mental lives. As HCI is about using technology in the world, to account for this extracranial behaviour, we need a wider set of conceptual tools. These tools, in the main, have been developed in the cognitive sciences and, compared with psychology, are a good deal less constrained or confined to the laboratory. It is for these reasons that this book presents a cognitive scientific account of HCI rather than one which is confined to traditional cognitive psychology.

However, to understand the present, we must consider the past.

Suddenly Human

Evolutionary psychology has developed accounts of many of our fundamental characteristics and behaviours (e.g. Barkow et al.1992; Buss 1995; Bereczkei 2000). Cosmides and Tooby (2000) note that evolutionary psychology is not a specific subfield of psychology, but 'It is a way of thinking about psychology that can be applied to any topic within it […]'. Further, as Buss observes 'Because all behaviour depends on complex psychological mechanisms, and all psychological

mechanisms, at some basic level of description, are the result of evolution by selection, then all psychological theories are implicitly evolutionary psychological theories' (ibid, p. 2). For Bereczkei (ibid, p. 185), it involves recognising features of human behaviour that have been selected to be useful for our survival and reproduction. Significantly, he writes 'It claims that cognitive and emotional processes have been selected in our evolutionary environment as devices of solving particular adaptive problems faced by the Pleistocene hunter-gatherers'. In short, the evolutionary psychological perspective is one which supposes that selection pressures on our hunter-gatherer ancestors and the demands of their social lives shaped our contemporary thinking and behaviour. We should note that recognisably modern humans have been around for, perhaps, 250,000 years. It has often been said that if we were to take a man from that time, clean him up and dress him appropriately, he would pass more or less unnoticed amongst us. This similarity is, however, only skin deep as behaviourally and culturally he would be quite different. Yet approximately 50,000 years ago, modern human behaviour appeared almost 'overnight' (e.g. Ambrose 1998; Chase et al. 1990; Klein 2001, amongst many more). We should note that when an anthropologist writes 'overnight', they tend to mean approximately 10,000 years. Despite the uncertainty over the precise dating, a number of prominent authors agree that something remarkable happened to the ways in which we thought and behaved (Klein 2002). Tattersall (2006) agrees and notes that the appearance of the first Cro-Magnons some 40,000 years ago brought with it new behaviours which distinguished them from all that had gone before. These people were able to create sculpture and engraving and were able to paint and add ornamentation to their bodies. They also created musical instruments and buried their dead with care and ceremony (Lewis-Williams 2004, p. 97). They also began to decorate everyday tools. They were recognisably modern humans. Calvin (2006) who attributes these changes to a 'brain specialisation', such as that for language, writes tellingly that these people who looked like us 'finally began acting like us'. Mithen (2002) has argued that '… modern humans had a cognitive advantage which may have resided in a more complex form of language or a quite different type of mentality … Support for the latter is readily evident from dramatic developments that occur in the archaeological record relating to new ways of thinking and behaving by modern humans' (p. 33). He also comments on the sudden change in the archaeological record c.50,000 years ago with the appearance of representational art, religious imagery and rapid adaptations in the design of tools and artefacts. Included in the list of changes in which we can recognise some of the attributes of cognition as we currently understand it are (a) abstract thinking, that is, the ability to act with reference to abstract concepts; (b) planning depth, the ability to formulate strategies […] and to act upon them in a group context; and (c) behavioural, economic and technological innovation and symbolic behaviour, the ability to represent objects, people and abstract concepts with arbitrary symbols. Thus, the full expression of human cognition is to be found in the savannah of the Upper (Late) Pleistocene. We now jump forward to 1983.

More Recent Origins

The first great HCI text *The Psychology of Human Computer Interaction* (Card et al. 1983) addressed the theory, practice and design of interactive technology, and that theory was almost exclusively the application of cognitive psychology – a position which is still largely (but not wholly) true today. Card and his colleagues, for example, proposed a model of human cognition which could be used to guide the design of technology and to make predictions about its use. This was the first of the many attempts to capture, model, represent and employ accounts of human cognition in HCI which Winograd and Flores (1987) have described as modelling people as 'cognitive machines'. It was assumed that most of what we did was essentially cognitive (cf. Neisser's definition). But this was quite a stretch; psychology had to be broader than just cognition as we were also concerned with understanding how people use technology to do their jobs, interact with other people, have fun and, generally, do all manner of everyday things. These dimensions cannot always be reduced to purely psychological phenomena as other disciplines such as sociology had something of value to contribute here too. To understand how people use technology, for example, is to address the context in which the technology is used which, as we shall see, is often described as 'cognition in the wild' with all the untidiness this implies.

Further, while these endeavours may have begun as different strands of inquiry, they have converged, separated and reconverged at regular but unpredictable intervals against a background of rapidly changing technology. For example, the first IBM personal computer appeared in 1981, Apple Lisa perhaps a year later, the first digital mobile phone about 10 years later again and the Web after a further five or so years. We had to wait until 2001 for Apple to create the first of the i-series of technologies, the iPod. This technological exuberance is not confined to these signal technologies alone as it has changed almost every aspect of our everyday lives.

When the Web was invented in the early 1990s, it was quickly colonised and appropriated by emergent brands such as Google, Amazon and Facebook which have facilitated new ways of working, thinking, socialising and spending money. The Web has changed the ways in which we do business, teach young people and consume entertainment, and products and services have emerged which we could not have anticipated. By the Millennium, mobile technology was becoming ubiquitous with the meteoric rise (and subsequent fall) of Scandinavia chic. These technologies became smaller, more powerful and indispensible and then larger again. Somewhere in there, Apple rewrote how we interact with technology. As I write, apps are the media of choice by which we access, encounter, enjoy and embrace technology. We can be confident that this too will change, for example, Microsoft has just announced that 'bots' are the future (Microsoft 2016), 2 months later Facebook (Facebook 2016) announced something similar, and it is against this background that we seek to outline the promise of a post-cognitive future for HCI, but first let us consider how psychology has fared since 1983.

Guidelines

In *A Guide to Usability* (1990) written for a professional audience by the Open University on behalf of UK's Department of Trade and Industry, we find advice on 'how to apply psychology' to systems design. Its advice includes, for example, help with designing usable screens of information. As a first step, we are encouraged to understand the workings of the visual system. Using this knowledge, we will then be able to ensure that our computer screens are uncluttered and that the content displayed there is meaningfully structured (p. 24). Although linking the workings of the visual (or any other cognitive) system to systems design does seem a little optimistic, we also learn that the overall aim of this is to ensure that the information processing involved completing a task within the capabilities of the users' mental processes (p. 23). This presents the use of psychology as something rather like the application of a coat or two of paint to a garden shed. One coat will help structure information (allow to dry), and a second coat will ensure that the information processing capacity of a user is not exceeded. This, to say the least, is rather naïve, but it is a fine example of the instrumental use of psychology. As we have already observed, psychology was never developed for this use, but this has not stopped people from trying.

Hansen (1971) published arguably the first list of four still perfectly reasonable design guidelines, which were (a) know the user, (b) minimise memorisation, (c) optimise operations and (d) engineer for errors. Shneiderman (1980) amongst his many contributions to HCI doubled the number of guidelines to eight. Both sets of guidelines are a mixture of heuristics, good practice and cognitive psychological principles. So we are not surprised when Shneiderman tells us that we should strive for consistency, offer shortcuts, provide feedback and reduce the load on short-term memory, writing, for example, 'The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions' (Shneiderman 1997).

This was followed by the longest set of guidelines (running to more than 300 pages) which were compiled and published by Smith and Mosier (1986). The guidelines are well referenced, and the psychological bases of the advice have become a matter of good practice. In 1987, Gardiner and Christie published their *Applying Cognitive Psychology To User-Interface Design* in which they systematically derived design principles from cognition. For example, memory was again a popular choice; the limited capacity of short-term memory (which they describe as working memory) prompts them to suggest that we should design our dialogues in chunks so as not to overburden our limited information processing and storage capabilities. It is fair to say that many of these recommendations are still with us today, while others seem very dated. This was not the first instrumental use of cognitive psychology, but it was undoubtedly one of the most grounded and systematic.

In each instance, and there are many others, these principles have not been derived from a psychology of interaction but from off-the-shelf undergraduate-level

psychology. Further, there is rarely any evidence presented that the guidelines work. While it is entirely reasonable that an academic discipline should have different emphases, what is surprising about HCI is the dominance of design. This has been noted by Dourish (2006) who writes, 'A common lament to be found in reviews of ethnographic work is, 'yes, it's all very interesting, but I don't understand its implications for design' or the somewhat more subtle (and intriguing), 'this paper does not seem to be addressed towards the CHI [computer-human interaction] audience'. Dourish goes on to consider how theory in its own right has been relegated to a second place behind design. Admittedly he is bemoaning the fate of sociological/anthropological insights; the same observations also hold true for psychology. Psychology has, in recent years, become an unwilling maidservant to design.

The Promise of a Post-Cognitive Future

The use of the expression 'post-cognitive' should be read as both accurate and descriptive rather than speculative or 'futuristic'. Post-cognitive, like 'post-industrial' or 'post-modern', simply refers to research which has sufficiently diverged from the initial formulations of cognition to merit this label. The foundations of cognition, which include ideas such as mental representation as symbols and the adoption of the computer metaphor (as found in 'human information processing'), have been challenged and, in some cases, rejected by a number of the contemporary accounts of cognition. New ideas have appeared to fill these conceptual gaps, for example, a number of authors have made compelling cases for a role for the body in cognition which, in its classical form, would have been unheard of. Similarly, the use of external representation to supplement or scaffold our thinking has become quite widespread and now appears in a variety of different forms, for example, Donald's suggestion of the exogram (external representations and symbols) to parallel the established idea of the memory engrams is particularly appealing (Donald 1991). New ideas emerging from the work of cognitive scientists and philosophers are not the only source of change, as we have seen in the brief sketch of current interactive technology which itself is the epitome of change. As these technologies are a major defining factor of our society, it is clear that they demand a contemporary, post-cognitive account reflecting their importance, perhaps one which reflects what we developed on the savannah 50,000 years ago rather than in the labs of the 1950s.

The Structure of This Book

Each chapter is independent and can be read in isolation, but the book as a whole has adopted a broadly chronological account of the development of (our understanding of) cognition as applied to the use of digital technology. A consequence of

this is that it also begins with a discussion-review of the uncontroversial and slowly becomes more speculative and radical as we approach the modern day.

Chapter 1 starts with a discussion of the *cognitive revolution*. Behaviourism, which had preceded it, had ruled out the possibility of understanding our internal, mental lives, but the advocates of cognition argued that we could indeed access the processes and representations which make up our mental lives. They also adopted the nearly invented digital computer as a model for its operation. With this certainty, they set about not only explaining how we use interactive technology but how we could design it too.

Chapter 2 introduces *activity theory* which we treat from the perspective of mediated cognition. Superficially, activity theory is an alternative to the classical cognition of Chap. 1. It can largely match classical cognition, concept for concept, and then develop the argument further. While classical cognition has a collage-like quality to it, activity theory is coherent, structured and, dare we say, much more complete, but it is also quite foreign to the Anglo-Saxon traditions of the West. We also note that activity theory is not a purely psychological theory particularly in its later revisions or editions (it is currently in its third generation). However, when, in the early 1990s, it was proposed – but not widely adopted – as a theory for HCI, we missed an opportunity. While it is not perfect, it would have met most of our needs at the time and would have continued to do so. While activity theory may not deal with emerging issues in the kind of detail we might like, it does offer a coherent and consistent treatment of tool mediation, context, cognitive distribution, scaffolding, and make-believe – all of which are considered in subsequent chapters.

Chapter 3 addresses the appearance of *situated action*. This arose in the 1980s as one of the most serious challenges to classical cognition. Suchman proposed situated action arguing that the kinds of cognitive models which were being suggested at that time relied on the execution of a plan. The plan might be true to a GOMS-like set of steps or the less structured output from 'running' a mental model: either way for Suchman was not enough because it ignored the nuances and dynamics of the situation. A plan may be appropriate as a kind of starting point for using interactive technology, but it could not account for the social, cultural and historical realities of the everyday world. We are avoiding the word 'context' here, but it is difficult to distinguish between it and 'situation'. So, in short, planning models do not allow for context and as such cannot offer anything like a complete account of HCI.

Chapter 4 finds a place for *the body*. This was one of the first of the post-cognitive initiatives, but it relied on a number of quite different factors coming together. The importance of our corporeality had been identified by Merleau-Ponty in the 1940s. Predating this, the German phenomenologists Husserl and Heidegger in their own, very different, ways had said important things about it, but little of this came to the attention of HCI. When the Media Lab at MIT launched their *tangible bits* initiative, this all changed. However, it was Dourish who was responsible for pulling together these strands of tangible computing and phenomenology to give us a place for the body in HCI. This is still very much a matter of work in progress as if asked 'what is the role of the body in HCI?', we would struggle to give a succinct answer.

However, we would suggest that it is the most likely place to begin (in preference to the brain) if we are to consider technologically augmented and enhanced humans.

Chapter 5 argues that in essence, HCI is about *thinking with technology* or, more fully, thinking and acting with technology. Technology is almost inevitably distributed unless we restrict ourselves to that which is in our reach (which is one reading of Heidegger's famous dictum that technology is often experienced *ready-to-hand*). Technology is also external; it is something which we use to achieve our ends. Vygotski identified this as a defining aspect of purposive behaviour. Technology mediates and technology scaffolds (thinking and) behaviour. This was a start to the argument which persists today and can be found in the work of Scaife and Rogers and of Kirsh. Taking this further, we have Chalmers and Clark suggesting that technology, like the brain, and the body are more or less equal partners in cognition in their extended cognition proposal. Perhaps one day a neural implant will replace the need to master quadratic equations.

Chapter 6 offers an introduction to *enactive cognition*. Enaction is not the product of psychology or of computing but of biology. Its creators see it as self-organising, world creating and embodied. On the face of it, this may seem to be a long way from the everyday use of interactive technology, but it is not. For me, it potentially provides a theoretical rich and highly useful set of concepts which might offer a post-cognitive theory for HCI. Cognition, they tell us, does not exist simply to make copies (internal representations of the world or of technology) and to think with these (poor) copies. Instead, cognition is about enacting a world, and so appealing are these ideas that the European Union funded a research programme to create a new generation of human-computer interfaces or what they described as *enactive interfaces*. Unlike embodied or external cognition, the enactive perspective offers some fascinating insights on the operation of our memories, perception and niche building activities.

Chapter 7 segues to an old debate that cognition may exist in more than one form. In short, cognition may exist as 'fast' or 'slow' thinking. We argue that this is a useful distinction but that fast, intuitive and automatic thinking relies on scaffolding and is better thought of as epistemic coping. In essence, epistemic coping manifests as the smooth, easy, everyday use of technology with scarcely a conscious thought or moment of reflection. If thought-free (or thought-lite) interaction seems unlikely, simply spend 30 min on a rush hour commuter train and observe how people use their cell phones, tablets and e-readers.

Chapter 8 introduces *make-believe* as an unrecognised but complementary cognitive mechanism within HCI. Treating HCI as a set of practices and theoretical positions, we show how make-believe contributes to a better understanding of these. Make-believe involves creating fictional worlds which are not the case and then acting as though they were. We do this every time we create a scenario or prototype or engage in just about any aspect of the design and evaluation of interactive technology – and no one notices that this is make-believe.

Chapter 9 notes that as Gottschall puts it, we are *storytelling animals*. So having presented the current thinking in the cognitive sciences about how we think and behave with interactive technology, we wonder what the story of HCI is. To tell a story about HCI, we must appeal to technology itself. So, what has using interactive technology revealed about us? And you will have to read Chap. 9 to find out what it is. However, we can say that it finds a home for Neisser's definition of cognition and Clark's claim that cognition is a contingent mix of problem-solving resources.

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Web Resources

Buzzfeed http://www.buzzfeed.com/charliewarzel/heres-the-cold-hard-proof-that-we-cant-stop-checking-our-pho#.ddKwzN8aK
Facebook (2016) Available from http://www.bbc.co.uk/news/technology-36021889
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Chapter 1
Classical Cognition

1.1 The Cognitive Revolution

This book presents a rebooting or (radical) updating of the psychology of human-computer interaction (HCI) but we should begin by admitting that when we say "psychology" we really mean cognition. This is not to suggest that the discussion is limited to *just* cognition, but it is more a recognition that cognition has acquired an extraordinary reach. In part, this is because it is constantly redefining itself, often as a consequence of its encounters with the technology.

This chapter sets the scene. We will define cognition and its origins and describe how it was used by researchers in HCI to understand how people use interactive technology. Not for the last time, we stress that this is cognition in the service of understanding human-computer interaction, rather than cognition in the service of the *design* of the interactive technology. This use-design dichotomy will recur throughout this text.

So, just what do we mean by cognition? To answer this question we need to consider a little history. In everyday usage, of course, cognition is associated with ideas such as mental activity, mind, reasoning, consciousness, intelligence or learning but these are either a little too broad or too specific to be immediately useful here. More detailed definitions present their own difficulties, for example, Enactivism (Chap. 7) defines cognition is "self-organising, self-generating, and self-maintaining" and tells us that "life and cognition" are fundamentally the same phenomena. However, we cannot adopt this rather radical definition in isolation, as it only makes sense in the context of Enactivism. Cognition is also ascribed to a number of animals such as the great apes, elephants and cetaceans and, of course, to those disturbingly intelligent New Caledonian crows (e.g. Jelbert et al. 2014). We also speak of cognition as an expected, hoped for or feared property of all manner of artificial intelligences or of autonomous robots or as an emergent property of a complex network such as the Web.

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