The Ageing Present

Neurophysiological change and the relational affordances of technological objects.

John Vines and Michael Punt

Transtechnology Research, University of Plymouth
Plymouth, United Kingdom, john.vines@plymouth.ac.uk

Abstract: This paper outlines a doctoral thesis investigating claims that difficulties older people encounter in comprehending new technologies may be accountable to a reduced cognitive and neurophysiological capacity that occurs in later life. The thesis questions whether understanding an individual's experience of technology within a reduced and predetermined cognitive model is suitable in design methodologies attempting to alleviate these difficulties. A body of knowledge opposing this view is introduced arguing that neurophysiological change should not be considered through an internal schema but in the way it relates to the wider physiological and ecological context a person is situated within.

1. Original Key Idea

The thesis argues that product and interaction design research should more fully account for neurophysiological capacity in the design of dynamic systems of affordances that emerge between organisms and objects in the development of novel technological experiences for older users.

2. Problem Domain

The thesis is situated within the context of product and interaction design research and the role it plays in the context of an ageing Western European population [6]. The problem attended to by the thesis stems from the difficulty, observed within various disciplines, that in older age it becomes more difficult for a person to participate with and comprehend new technologies [10]. Numerous factors could influence this difficulty in participation; social, financial, cultural, psychological, health etc, many of which have been examined previously within design research. However, this thesis is particularly interested in claims emanating from cognitive science and cognitive psychology that changes in cognitive ability in the later life of most adults results in a reduction in the abilities required to learn a new technology [2,13,15]. This claim is coupled with other neurophysiological claims that older people have differing levels of activity in brain regions that may relate to this loss in ability [1]. The thesis reflects upon these claims and questions whether the application of research from the cognitive disciplines may be appropriate in the design of new technological objects for older people, and whether there might be potential to provide an alternative route for design research in this area.

3. Related Work

Cognitive science and psychology has traditionally argued in favor of a cognitive model of the human mind. It appears that cognitive models are based on the understanding that mental phenomena are fundamentally

computational in their operation and that the brain acts as a form of central information processer managing an individual's perceptual input and respective motor output [9]. Resulting from this, it has been plausible to suggest that the responses to particular phenomena, such as aspects of computer interfaces, can be predetermined through understanding the cognitive schema of a particular group of individuals. Researchers within the cognitive sciences and psychologies have gone to great lengths in attempting to understand how the cognitive model differs in later life and how this affects competencies on certain tasks. Within such studies, it appears to be widely agreed that cognitive systems related to the forming of abstract concepts, the holding of information in short term consciousness, and explicitly recalling certain long term memories reduce in functionality in later life [2,13]. Studies from this area have also established that the cognitive systems that unconsciously recall and draw upon past experience and knowledge (particularly language and procedures) show little alteration in ability [11,13]. Neuroscientific research suggests that these changes observed through cognitive modeling may be mapped onto actual physiological alterations that occur in human neural circuitry in later life [1].

HCI and interaction design research has drawn upon cognitive models of the mind previously in an attempt to form strategies for designers to implement when developing technological interfaces that are inclusive of older people [4]. When the cognitive model of older people is integrated into design research it commonly leads to the development of interfaces that avoid the need to use the less competent cognitive systems and/or exploiting the systems that do not alter. Essentially, this suggests that in order to be less cognitively demanding on an older person, technological objects are designed in a manner that draws upon past knowledge through an emphasis on interface metaphors and analogies [4,5]. Although logically implemented in design research, the application of the cognitive model of mind presents situations where dramatic neurophysiological alterations in a person are modeled in a mechanical and systematic manner; however, the strict predetermined nature of the cognitive model does not meet the requirements of a group of users in a state of rapid neurophysiological change. The application of this model in design research methodologies and practice is also problematic as a result of the reduced level of ability through which the cognitive model claims older people experience the world. In design terms there appears to be a reliance on the construction of past events in human memory as the determining factor through which older people experience a new technology. This presents situations where the older participant is only ever engaging with a new technology based upon metaphors and analogies of past experiences, as identified by the designer, rather than being presented an opportunity to engage their own level of meaning creation.

4. Research Goal and Methodology

A broad review of literature identified the diverse and inter-disciplinary nature of research concerning the relationship between the design of new technologies and internalized changes that occur as people age. From this review it appears that contemporary design research has not addressed discussions of neurophysiological change beyond of the cognitive model of the mind. The thesis speculates that current methodologies and practices within interaction design are limited in their response to this problem due to the rather mechanistic model of cognition and human experience they draw upon and apply. Resulting from this initial discussion, the thesis questions: *Can a broadened understanding of human consciousness in relation to the neurophysiological*

changes that are claimed to occur in later life provide a less restrictive account of technological interaction for older people? The aim of this research is to provide an account of human interactions with new technologies through the strategy of investigating the role of the changing neurophysiological capacities of older people as a technique in design. This aim requires the thesis to discuss ideas, concepts, models and language, which have rarely been cited in the design discourse.

As a method, further review of literature and discourse analysis will be applied to address this problem and examine the manner in which designers draw upon the claims from the fields of cognitive science and psychology in order to identify if they provide a suitable response. By approaching the problem in this manner avenues of dialogue are identified, as proposed below, that have not being considered within discussions of the design of new technological objects in relation to the changing neurophysiology of older people. These bodies of knowledge will be integrated into the argument of this thesis along with an analysis of case studies, which together will provide a revised basis to critically engage with current design interventions. The thesis intends to provide a valuable contribution of knowledge for the product and interaction design community that enables to establish a new perspective on understanding design responses to the aging mind.

5. Preliminary Outcomes

The thesis has identified how the cognitive sciences can provide an alternative modeling of how human mental abilities relate to interactions in the world by acknowledging change. In this area of research, often referred to as the embodied and/or enactive cognitive sciences, it is argued that the neurophysiological and mental capabilities of an individual are shaped by the sensorimotor capabilities of their whole body [14]. The whole body itself is situated within the context of an ecology [7]. Arguably, this mode of thought differs from the dominant cognitive paradigm in its move away from relating human-technological interactions as being pre-determinable on the basis of an internal cognitive schema. Rather, it is intended to understand the transactions between embodied organisms and their ecology. These transactions may be understood as relational affordances that are in a constant state of flux [12]. Approaches based upon this particular understanding of cognition have been studied within areas related to human-machine interactions, often within the context of robotics and artificial intelligence [3,8] but not to such an extent within HCI and interaction design practice. Embodied and enactive research provides a more dynamic account in relation to the neurophysiological changes that occur in later life, which is not offered by applications of the mechanical cognitive model. Rather than determining interaction based upon a predetermined and concrete cognitive schema, the human participator is portrayed as in a constant state of flux in their transactional relationship with the ecology. It is possible to speculate that new technological systems based upon this paradigm would be as open-ended and provisional rather than closed and concrete; this conception may be of particular benefit in the context of aging individuals whom are experiencing neurophysiological change but it may also have implications beyond this group of potential users.

6. Future Research

The preliminary outcomes of this research suggests that the discussion of interaction design in the context of older people with differing neurophysiological capacities requires a similar paradigmatic shift as has been identified within the cognitive sciences over the past two decades. This requires the thesis to reconsider the

terminologies, methods and practices employed in this area of design research, from that of the cognitive to the embodied and enactive. By identifying the terminologies and language of this alternative perspective and the usefulness of the associated approach the intervention must continue to be accessible to the design community. The next stage of research includes the continued re-evaluation and contextualization of this alternative body of knowledge in relation to both the established practices of designing for neurophysiological change in later life and the research goal of establishing new practices and research methods/tools for designers to apply.

7. References

[1] Ballesteros, S., Nilsson, L. G. and Lemaire, P. (2009) Ageing, cognition, and neuroscience: An introduction. *European Journal of Cognitive Psychology*, vol. 21, no. 2/3, pp. 161-175.

[2] Birren, J. E. and Warner Schaie, K. (Eds) (2001) *Handbook of the psychology of aging*. (5th ed) Academic Press, London.

[3] Brooks, R. (1999) *Cambrian intelligence.* The MIT Press, Cambridge, MA.

[4] Docampo Rama, M. (2001) *Technology generations handling complex user interfaces*. Doctor of Philosophy Thesis, Technische Universiteit Eindhoven.

[5] Lewis, T. (2007) Generational effects from users' previous experience. In *Proceeding of Include 2007: Designing with people.*

[6] Statistics. (2008) *Ageing: More pensioners than under-16's for first time ever.* Available at: http://www.statistics.gov.uk/cci/nugget.asp?ID=949 [Accessed: 19th May 2009]

[7] Noë, A. (2009) *Out of our heads: Why you are not your brain, and other lessons from the biology of consciousness.* Hill & Wang, New York.

[8] Pfeifer, R. and Bongard, J. C. (2006) *How the body shapes the way we think.* The MIT Press, Cambridge, MA.

[9] Rosch Rosch, E. (1992) Cognitive psychology. In: Hayward, J.W. and Varela, F.J. (Eds). *Gentle bridges: Conversations with the dalai lama on the sciences of mind.* Shambala Publications, Boston.

[10] Schieber, F. (2003) Human factors and aging: Identifying and compensating for age-related deficits in sensory and cognitive function. In: Charness, N. and Warner Schaie, K. (Eds). *Impact of technology on successful aging.* Springer, New York. pp 42-84.

[11] Smith, A. D. and Earles, J. L. (1996) Memory changes in normal aging. In: Blanchard-Fields, F. and Hess, T.M. (Eds). *Perspectives on cognitive change in adulthood and old age.* McGraw-Hill, New York. pp 192-220.

[12] Stoffregen, T. A. (2003) Affordances as properties of the animal-environment system. *Ecological Psychology*, vol. 15, no. 2, pp. 115-134.

[13] Stuart-Hamilton, I. (2006) *The psychology of ageing: An introduction.* 4th ed., Jessica Kingsley Publishers, London.

[14] Varela, F. J., Thompson, E. and Rosch, E. (1991) *The embodied mind: Cognitive science and human experience.* The MIT Press, Cambridge, MA.

[15] Zajicek, M. (2001) Special interface requirements for older adults. In *WUAUC'01, 2001 EC/NSF*, pp 60-65.