Volume 7, ANZCA Special Issue (2016): 35–43.

Cybernetics of digital-engagement: Optimizing the self for social networking

Diane Spencer-Scarr – Curtin University

diane.spencer-scarr@student.curtin.edu.au

The 'Fifth Estate' is a direct result of the digital networked environment and practitioners in the 'Fifth Estate' are now compelled to operate within a duality of environments (digital and physical) whether they understand the duality or not. This paper examines digital-engagement, the complex relationship between humans and digital networked technology, a relationship that can be explained as a second order cybernetic system. I propose that the source of issues rising from digital-engagement is humans' understanding of their relationship to technology and its effect on their internal physiology, which alters behaviours and thus society.

This research found that digital-engagement involves communication-feedback-loops, which is in essence a cybernetic system and that self-awareness is a significant part of digital-engagement making second-order cybernetics more appropriate for developing an understanding of the engagement process because it accommodates both observation and participation of the individual in the human-technology communication system.

Following the background, the discussion proceeds to original research where participants' behaviours (personality and decision-making style) were correlated to their digital engagement. Significant findings were positive correlations to the personality traits Agreeableness and Openness and a negative correlation to Extraversion. The research also found that an intuitive decision-making style correlated to greater digital-engagement. Whether these results are predictive or causative of digital-engagement is as yet undetermined and further research in this area has been proposed.

This paper also discusses how altered perceptions of first principle concepts within the digital environment such as time, memory and space, are affecting human behaviours and considers the proposition of digital networked technology as simply being either a tool or an environment and concludes it is both. The internal environment of the individual is also discussed using Antonio Damasio's theories and emerging research in biochemistry and physiology.

Understanding the Fifth Estate as being part of a second order cybernetic system enables individuals, institutions and organisations to manage technology for better outcomes rather than being managed by it. This paper is relevant to all who engage with technology but it is particularly relevant to participants and facilitators of communication because they are in the front-line of changes due to digital-engagement.

Introduction

This research examines why digital-engagement affects some people in a constructive way resulting in positive outcomes while others struggle to manage it. In this section, I provide a brief background of the components necessary to understand my research into digital-engagement. Although cybernetics and second-order cybernetics is the primary theory used to understand the process of digital-engagement (the why and how), other theories were also influential such as actor-network theory, which helped explain digital-relationships, and tool-ecology, which facilitated the understanding of digital networked technology as a dynamic and evolving environment.

Defining cybernetics is no simple task because many theorists have used the term cybernetics in a variety of disciplines, each with their own variation on the definition (Hayles, 1999). Cybernetics relates to the study of systems, where an action by the system creates a change within the environment of that system. This change is revealed within the system by the initiation of a system change; the cycle is generally referred to as a feedback-loop that can be either a positive or a negative feedback loop. *Second order cybernetics* extends this and is best explained by Heinz von Foerster's brain example.

> A brain is required to write a theory of a brain. From this follows that a theory of the brain, that has any aspirations for completeness, has to account for the writing of this theory. And even more

> fascinating, the writer of this theory has to account for her or himself. Translated into the domain of cybernetics; the cybernetician, by entering his own domain, has to account for his or her own activity. Cybernetics then becomes cybernetics of cybernetics, or second-order cybernetics (von Foerster, 2003, p. 298).

This approach to understanding digital-engagement places the autobiographical self (Damasio, 2000, p. 17) in the position of observer and participant within the digital-engagement process: a process that is comprised of both an internal environment (in-the-skin) and an external environment (out-of-the-skin). The external environment is considered in two ways. Firstly as the *physical environment*, the one in which humans have evolved over millennia as part of the evolutionary process and is the environment in which humans have developed an intuitive understanding of first principle concepts such as time, space and memory. These concepts have in general aided human survival and prosperity. The second external environment, which is pertinent to this research, is the *digital networked environment*. This is a recently created environment in which humans increasingly have to function due to the ubiquitous embedding of digital technology in society. There has been extensive research into the seamless enmeshing of both physical and digital environments ranging from user interface to improving human functionality (Bavelier et al, 2010; Gallagher et al, 2013) or social behaviours (Modecki et al, 2014; Sormanen and Dutton, 2015; Turkle, 1995) and education (Bavelier et al, 2010). Generally speaking, research has focused on the seamless integration and adoption of the digital environment into the existing framework of the physical environment. However, using a few examples of first principle concepts the following discussion illustrates why the two environments should be viewed as being somewhat different. This is not a definitive argument; it is simply a brief discussion to illustrate how first principle concepts are indeed experienced differently in the digital networked environment. During the interviews that formed part of the empirical research in this paper, participants expressed experiencing the differences in the first principle concept as discussed below.

Altered Perceptions in the Fifth Estate—the External Environment

Time in the physical environment is generally perceived as being a linear concept—although there are some specific cultural concepts of time—across most cultures. Time in the digital environment is described by Manuel Castells as being *timeless time*. He explained that the "elimination of sequencing creates undifferentiated time which is tantamount to eternity" (Castells, 2010, p. 494). In the digital environment users' experience of time is instantaneous, as in global financial markets where geographically dispersed humans interact in "local-time'". However, time is also experienced as being eternal. The concept of *eternal time* is the result of the operational behaviours of the digital network environment where information is identically copied, shared, stored and archived by humans, hardware and software in multiple places without the initiator's knowledge, making information potentially exist for eternity. Geoffrey West proposes *accelerating time* which he says is a result of "the collective that we have constructed by coming together and interacting" through and with networked technologies. "The clock that we [now] actually work by… is getting faster and faster" (West, 2015, no page). West suggests that our unbounded growth requires accelerating cycles of innovation to avoid collapse. Time is no longer bound to biological or celestial entities but rather to the *evolutionary innovation of technology*. From this discussion the concept of time does indeed appear to be different within the digital environment.

The concept of traditional **memory** is also being affected by increased digitisation that negates the natural fading of memory by retaining exact and vivid memories (Mayer-Schönberger, 2009, p. 113). Digital memory also has an unprecedented potential to affect social memory. Guy Pessach argues digitisation of information "tends to result in partial and gradual privatisation of society's memory institutions" (2008, p. 73). This offers the utopian view of decentralised and democratised memory institutions and social remembering practices, where more information is available to more people in more formats. On the other hand, it offers privatisation of institutions that may compromise a democratic vision of social remembering due to memory institution biases, which are driven by the motives of commercial enterprise, be they human, structural framework, or algorithmic biases. In addition to this,

Volume 7, ANZCA Special Issue (2016): 35–43.

the combination of digitised information, ease of authoring, and cognitive surplus (Shirky, 2010) means that the general population can now easily fragment, decontextualise or trivialise social memory. An example is the subtitled parodies of Adolf Hitler's last days in the Berlin bunker, as taken from the 2004 film *Downfall* (Boutin, 2010; Rohrer, 2010). Although these memes are, in general, humorous and harmless they exacerbate the fragmentation and decontextualising of information within the digital environment thus altering social memory. Regardless of whether one takes a positive or negative view of the impact of digitisation on memory there does appear to be a case for digital-memory being different to traditional memory. This is critical because memory plays a key role in the evaluation and validation of all incoming information and will have a significant impact on personal decision-making, which in turn affects individuals' behaviour.

Space in the physical environment can be passively occupied and there is some form of physical resistance in transitioning from one space to another. On the other hand, space in the digital environment is ephemeral, described by Manuel Castells as being a "space of flows", a space that he says provides the "possibility of organizing the simultaneity of social practices without geographical contiguity" (2000, p. 14). Felix Stalder expands on this saying it "is that stage of human action whose dimensions are created by dynamic movement, rather than by static location" (2002, p. 1). This *space of flows* is a series of non-hierarchical connected nodes that can be described as a rhizomic system. Gilles Deleuze explains: "The rhizome connects any point to any other point… It is composed not of units but of dimensions, or rather directions in motion. It has neither beginning nor end, but always a middle (milieu) from which it grows" (Deleuze and Guattari, 1987, p. 21). Over the last twenty years this concept has become intuitive for digital-technology users in social media, but it is not necessarily understood as being a different concept of space.

The digital environment, which is aptly explained using the actor-network theory, is a system of nodes or actors that prosper and grow proportional to their contribution to a network that has no central power. Growth and power are proportional to actor performance and inactivity results in redundancy. Connections and relationships are essential because if a node or actor is not connected then from the network perspective it does not exist. These connections and relationships are not limited to humans. As Michel Callon and John Law have said "there is no difference between the person and the network of entities on which it acts. Or between the person and the network of entities which acts through the person. Network and person: they are co-extensive" (1997, p. 169). Unlike space in the physical environment, which can be statically occupied, space in the digital environment is created and retained *only by connection, action and relationships,* be they human or non-human. This concept of space is certainly different.

Based on these few examples of first principle concepts, time, space and memory, there is indeed an argument for the digital environment being in some way different to the physical environment because of the different way in which humans are now experiencing first principle concepts. In a study of how we engage with technology we need to face those elements that challenge our conventions.

Before proceeding, it would be prudent to address the often-raised argument that digital networked technology is simply a "new tool". An ecological approach was used to examine digital tool-use because it considers the fluid relations and interactions between organisms, the environment in which they are found, the organisms' relationship to other organisms, the synthesis of elements and their resulting relationship within the context of time (Fuller, 2005; Gibson, 1979; Michaels, 1981). Based on definitions from cognitive neuroscience (Frey, 2007, p. 368), computer science (St. Amant and Horton, 2008, p. 1203), ergonomics (Baber, 2003, p. 8), and primatology (van Lawick-Goodall, 1970, p. 195) the common properties of tool-use appear to be *the use of manipulable objects to alter the environment in order to achieve a goal*. When considering digital networks as a tool, these properties certainly do hold. Digital networks are manipulable via software code, or in the case of hardware through processors and routers. Digital networked technology has profoundly altered the environment in which humans function; from education to the way humans socialise and work and how they source, consume and share information and resources. A.W. Smitsman (1997) notes that tool use is a means of conveying insights between generations and humans of different skill levels. Digital networked technology is doing this in an unprecedented way. From this discussion it appears that digital networked technology can indeed be

classified as a tool but it also appears to be more than a tool because digital networks *engage* with the human at a practical, emotional and cognitive level and they also behave as an environment in which humans operate. Digital networked technology can therefore be considered as being both a tool and an environment.

The Human that Engages—The Internal Environment

The internal environment of the human body (in-the-skin) has until recently been a mystery that has been partially revealed in incremental steps over millennia. Revelations of in-the-skin systems have been through behavioural observation or examination of the non-living. In the last few decades advancements in medical technology and neurosciences have enabled examination of the "living patients brain at the same time behavioural or cognitive observations are being carried out" (Damasio, 2000, p. 14) as well as the observation of behavioural consequences by disabling specific genes in animal subjects. Medical and technology advances of how and why humans function the way they do now extends to understanding the affects of human biochemistry and the complex role it plays in behavioural outcomes. To give just one example, oxytocin acts as both a hormone and as a neuromodulator that aids the development of social attachments by selectively lowering the natural resistance animals have to the proximity of others. This facilitates trust or "approach behaviour".

From a cybernetic perspective the internal environmental system is as complex as the external environments. Humans are only now beginning to understand the role of the physical structure, mechanics and function of the body components, the biochemistry and more recently neuroplasticity (Doidge, 2007; Merzenich, Kaas, Wall, Nelson, et al, 1983; Merzenich, Kaas, Wall, Sur, et al, 1983; Tan et al, 2007). These insights aid human understanding of observed behaviours, even complex relationships like self-awareness, which is important to this research. This research found that the individuals' awareness of their relationship to their own internal environment as well as their relationship to the external environments plays a key role in digital-engagement. Advances in many disciples such as robotics (Arsenio and Fitzpatrick, 2003), philosophy (Clark, 2011), and decision sciences (Kramer, 2010; Stanovich, 2010) have all contributed in some way to developing an understanding of the complex digital-engagement relationships used in this research but the work of Antonio Damasio has been significantly influential and to do it justice requires far more space than this paper allows.

Damasio (2000) draws on case studies and his own research in neurophysiology to develop a theory of how the internal environment of the human body gives rise to consciousness. He suggests, "the organism is defined by the maintenance of internal states [homeostasis] within the boundary… [Leading to the suggestion that the] constancy of the internal milieu is essential to maintain life… it might be a blueprint and anchor for what will eventually become a self in the mind" (Damasio, 2000, pp. 135-136). In terms of second-order cybernetics, an action from the external environmental system creates a change within the internal environment of the individual. The change is reflected within the internal system by triggering a system change that results in a behavioural change. For example in most cultures bonding occurs when a familiar smiling person approaches a child (the external environment action). Oxytocin is released in the child facilitating "approach behaviour" (this reflects internal environment change). "Approach behaviour" is rewarded by a hug and other pleasant familiar sensory rewards such as smell and touch (these are additional external environment actions). The child responds with further positive bio-chemical reinforcements all of which result in the commonly understood personality behaviour of "trust". The specifics of such an interaction may differ between cultures and families but the cascade of chemical signaling is common to most people.

The above example was dealt with at length because it illustrates a series of feedback-loops within and between the environments where the individual is both the observer and the participant. My research has led to the conclusion that digital-engagement operates as a similar type of second-order cybernetic system where the autobiographical self is the observer and participant of both their in-the-skin systems and the interaction with the digital networked environment. The autobiographical self acts as the controller of the iterative feedback loops that operates between these two systems. The next section discusses my empirical research.

Volume 7, ANZCA Special Issue (2016): 35–43.

Empirical Research Discussion

Mixed methods were used in this research: 1) Self-reported surveys for personality and decision-making style data; and 2) Three in-depth interviews with each participant. All participants were Information and Communication Technology (ICT) professionals with education ranging from year 10 to postgraduate. The gender spread was slightly weighted to males and the age spread was 21 to 62. The surveys included the Big-Five Factor personality test, the NOE-PR-I personality tests as well as the Rational Experiential Inventory (REI) test (Goldberg et al, 2006; Pacini and Epstein, 1999).

A grounded theory approach was used to develop successive interview questions in order to gain an understanding of digital-engagement (Bryman, 2008, pp. 538-689). This involved three video-recorded interviews of the 16 participants who were ICT professionals. Following Kathy Charmaz's (2006) guidelines the interviews were coded into themes. The initial coding resulted in 128 areas of interest that were grouped into 10 themes being Behaviour, Core Concepts, Decision Making, Digital Networked Technology, Engagement, Feedback, Personality and Demographics, Physical Environment and Tool Use. It became apparent these themes were not useful in developing an understanding of digital engagement. All the nodes were re-analysed into 108 nodes that were grouped onto 12 themes; Intensity, Embededness, Consciousness, Openness, Adaptability, Willingness, Rational Applications, Experiential Application, Implementation, Existential-Motivation, Fulfillment-Motivation, and Gratification-Motivation. In addition to this there were 12 nodes that required further investigation; seven of these appeared more significant but the reasons were not understood. Of the original 128 nodes the balance were considered not related to the process of digital-engagement (for example they related to demographic data) and they were therefore disregarded. Further investigation resulted in the regrouping of nodes into five major themes or Sectors. Sectors are the term that I used for the identified themes and each Sector has three sub-sectors (sub-themes). From this I developed my Digital Engagement Model (DEM) that when considered as a system can be used to understand digital-engagement. I also used the DEM to develop statements against which I evaluated each participant interview in order to obtain a measure of their digital-engagement that I then correlated to their personality score, which had been obtained from the surveys (correlations are discussed below).

The Digital Engagement Model

The model consists of five sectors. *Tool Use* examines the relationship between the individual and technology. This involved examining how intensely the individual used technology and how they embedded it in their life as well as how aware they were of the process. *Feedback* explores the individual's relationship to, and use of, incoming information. This involves the individual's openness to explore information and willingness to process it against their autobiographical self and their capacity to adapt to their learned experience. *Action* investigates the individual's potential to act on the information they have processed by examining both internal and external influencers as well as how the individual uses processed information for behaviour modification. *Motivation* looks at what drives the individual to engage with the technology. This considers three types of motivation. Firstly, where the motivation provides temporary benefits or pleasures and its consequences are transient. Secondly, where there is a tangible or acquisitive element to the individual's motivation that exists beyond the immediate engagement and relates to more practical issues of survival and prospering. The third type of motivation is where the individual is driven by abstract meaning, purpose and attitudes that shape how they see the world and it may have significant physical environment consequences for themselves and others close to them.

The final sector, which was the most elusive, was *Value Exchange*. All of the fully engaged participants seemed to exhibit deeper understanding and more nuanced attitudes in their dealings with other parties. This was exhibited in obscure ways such as how they took notice of other people's motivations, how they ensured there was some equity in their exchanges and if they were quick to reciprocate in dealings with others. After much consideration, I decided all of these factors could be summarised as one sector called Value Exchange since they were the visible expression of an internal processing. Value Exchange seems to be particularly significant but how it works in the digital environment is not fully understood. Value

Exchange describes the mechanism that the individual has developed to translate what they have to offer into what they want in order to develop relationships, be it with other humans or with the technology.

In this sector of my model, I examine the individual's internal understanding and self-awareness of values that they have and how they feel about the risks and rewards in potential interactions. These are the in-skin systems that are modified by the autobiographical self and internal milieu. The second aspect is the individual's expectations of external exchanges within the digital networked environment that tends to be modified by their external environmental-experiences and conditions such as technology constraints (e.g. profiles, option choices) or human behaviour like troll-aggression. The final aspect of Value Exchange in my Digital Engagement Model is the individual's overarching philosophy and expectation of how social interactions or behaviours will be experienced.

Correlating Digital-Engagement to Personality

The overall results of personality (Big-Five Factor and NOE-PR-I) correlations to my digital-engagement model scores resulted in some interesting insights. There was a *positive* correlation to the personality trait Agreeableness: highly engaged individuals also had high Agreeableness scores. There was also a moderate positive correlation to Extraversion in the least engaged people but strong negative correlation amongst the most engaged people: Extraversion appears to play a positive part in some early engagement but at some point as the individual becomes more engaged Extraversion becomes counterproductive. High Openness scores supported digital-engagement particularly where the intellect subscale was one of the participant's highest subscale scores. In these cases digital-engagement behaviours appeared to be amplified. Some digital-engagement sectors such as 'motivation' and personality subscales like 'dutifulness' could moderate, mask or possibly change personality traits. High Conscientiousness scores tended to enhance *skill-levels* rather than digital-engagement. Neuroticism was not particularly significant in relation to digital-engagement and appeared equally influential in both the digital and physical environment.

Investigation of personality traits at the subscale level revealed that a limited selection of subscales had strong positive or negative correlations to the more fully engaged individuals. These subscales were found in all of the Big-Five Factor traits. This suggests that the Big-Five Factor, as an indicator of digital-engagement, is too broad to provide sufficient relevant information.

The REI survey examined the individuals' decision-making style. Correlations revealed that: 1) Rational decision-making did not seem to support digital-engagement whereas Intuitive decision-making was significant; 2) Decision-making appeared to be less important to Motivation and Value Exchange than to the other sectors (Tool use, Feedback and Action); 3) In the fully digitally engaged individuals, the sectors of Action, Feedback and Tool Use appeared to operate as a system that could possibly enhance or at the very least would support digital-engagement; and 4) Surprisingly, the Action correlation results appeared to be the most indicative of digital engagement level, showing a progression of scores from weak Rational Iterations at -0.44 and Rational Ability at 0.60 to strong correlations of Intuitive scores being Intuitive Iterations at 0.79 and Intuitive Ability at the very high 0.88.

It must be stressed that these results are based on a small sample group of ICT professionals. The small sample size was necessary for the development of an understanding of the digital-engagement phenomenon. My results are however being incidentally substantiated by new third party research that involved large sample groups exploring other areas of technology use (De Bolle et al, 2015; Mitzner et al, 2014).

Discussion

The objective of this research was to develop an understanding of what digital-engagement is and why some individuals were engaging more beneficially than others. My understanding of digital-engagement came from the rich interview data and led to the development of my Digital Engagement Model. The model provided a framework for analysing and understanding the process of digital-engagement and for deriving a less subjective measure of each individual's engagement.

As briefly discussed above, I had come to the understanding that while digital networked technology may at times behave or be used as a tool, digital technology was not simply a tool. I therefore had to

Volume 7, ANZCA Special Issue (2016): 35–43.

investigate not only the frequency and way in which individuals used technology as a tool but also how they incorporated it into their lives and most importantly their awareness of the relationship that they had with the technology. Further investigation led me to conclude that the individuals' unique perception and understanding of some subtle differences when operating within the digital network as an environment were rooted in first principle concepts as discussed above. A further significant difference relating to digital-engagement was *Value Exchange* because of its role in the development, maintenance and enhancement of relationships. This is particularly evident in the Fifth Estate where communities that could not previously have existed are now forging strong and enduring relationships.

The data also showed that the fully engaged who demonstrated beneficial outcomes were not only open and willing to take feedback but they were also highly adaptable. *Feedback* was consistently important to digital-engagement. Feedback requires a capacity for identifying something against which incoming information can be evaluated and the potential for adaptability as indicated by a capacity for decision-making and action. Because of this I incorporated *Motivation* and *Action* into my Digital Engagement Model. A number of other possible sectors were considered but rejected from the model as being either not strongly indicated in the interviews or impossible to measure such as an inclination to experience solitude.

When taken together *Tool Use*, *Feedback*, *Motivation* and *Action* can be considered as a cybernetic system. This however did not take into account the high level of self-awareness that I had encountered in fully engaged participants, particularly in relation to *Value Exchange*. When considering all these components the process is indeed a second order cybernetic system because the individual has to be considered not only as a participant within the system but also as an observer and governor of their own digital-engagement as a system. I therefore had to consider the individual and digital networked technology as both separate systems (made up of subsystems) and as one single digital-engagement system. I was looking at nested cybernetic systems that functioned in a second order cybernetic way.

Consideration of insights resulting from this research leads to the underlying issue of causality. Did my fully engaged participant become fully engaged because of their personality or did the process of being fully engaged modify their personality? If it is the former, and is predicative, then this research can be used to identify those likely to succeed in the digital age and targeted methods can be developed to aid or assist those likely to struggle. If it is the latter, and is causative, then the global uptake of technology may be leading to fundamental changes in society and those who are key communicators using technology should be aware of this in order to plan appropriately for themselves and those that they influence.

Conclusion

This paper began with a background discussion, which covered diverse areas of research that resulted in bringing together the elements necessary to view digital-engagement as a cybernetic system. The paper then discussed the development of the Digital Engagement Model and how it behaves as a second order cybernetic system. Correlation results revealed that certain personality traits and decision-making styles were closely related to successful digital-engagement. Whether these results are predictive or causative is as yet unproven. These results are however significant considering the global growth of the digital network phenomenon and the widespread uptake.

References

Arsenio, A., and Fitzpatrick, P. (2003). Exploiting cross-modal rhythm for robot perception of objects. Paper presented at the Second International Conference on Computational Intelligence, Robotics, and Autonomous Systems - Special Session in Humanoid Robotics, Singapore. Retrieved 7 July 2008 and 29 Sept 2016 from https://www.researchgate.net/publication/228571487_Exploiting_cross-modal_rhythm_for_robot_perception_of_objects

Baber, C. (2003). Cognition and tool use: forms of engagement in human and animal use of tools (eBook ed.). London: Taylor and Francis CRC Press.

Bavelier, D., Green, C. S., and Dye, M. W. G. (2010). Children Wired For Better and for Worse. Neuron, 67(September), 682-701.

Boutin, P. (2010, February 24). Video Mad Libs With the Right Software. Personal Tech. Retrieved from http://www.nytimes.com/2010/02/25/technology/personaltech/25basics.html

Bryman, A. (2008). Social Research Methods (3rd ed.). New York: Oxford University Press.

Castells, M. (2000). Materials for an exploratory theory of the network society. British Journal of Sociology, 51(1), 5–24.

Castells, M. (2010). Rise of the Network Society: The Information Age: Economy, Society and Culture (2nd ed. Vol. 1). Chichester, West Sussex ; Malden, MA: Blackwell Publishers, Inc.

Charmaz, K. (2006). Constructing grounded theory: a practical guide through qualitative analysis. London: Sage Publications.

Clark, A. (2011). Supersizing the Mind: Embodiment, Action, and Cognitive Extension. New York: Oxford University Press.

Damasio, A. (2000). The Feeling of What Happens: body, emotion and the making of consciousness. London: Vintage.

De Bolle, M., De Fruyt, F., McCrae, R. R., Löckenhoff, C. E., Costa, P. T. Jr., Aguilar-Vafaie, M. E., . . . Terracciano, A. (2015). The Emergence of Sex Differences in Personality Traits in Early Adolescence: A Cross-Sectional, Cross-Cultural Study. Journal of Personality and Social Psychology, 108(1), 171–185.

Deleuze, G., and Guattari, F. (1987). A Thousand Plateaus (B. Massumi, Trans.). Minneapolis: University of Minnesota Press.

Doidge, N. (2007). The Brain That Changes Itself. Carlton North: Scribe Publications Pty Ltd.

Frey, S.H. (2007). What Puts the How in Where? Tool Use and the Divided Visual Streams Hypothesis. Cortex, 43(3), 368-375.

Fuller, M. (2005). Media Ecologies: Materialist Energies in Art and Technoculture. Cambridge: MIT Press.

Gallagher, A. G., Seymour, N. E., Jordan-Black, J. , Bunting, B. P., McGlade, K. , and Satava, R. M. (2013). Prospective, Randomized Assessment of Transfer of Training (ToT) and Transfer Effectiveness Ratio (TER) of Virtual Reality Simulation Training for Laparoscopic Skill Acquisition. Annals of Surgery, 257(6), 1025-1031.

Gibson, J. J. (1979). The Ecological Approach To Visual Perception. Hillsdale, New Jersey: Lawrence Erlbaum Associates Inc.

Goldberg, L.R., Johnson, J.A., Eber, H.W., Hogan, R., Ashton, M.C., Cloninger, C.R., and Gough, H.C. (2006). The International Personality Item Pool and the future of public-domain personality measures. Journal of Research in Personality, 40, 84-96.

Hayles, N.K. (1999). How We Became Posthuman: Virtual bodies in cybernetics, literature and infmatics. Chicago: University of Chicago Press.

Kramer, R.M. (2010). Dilemmas and Doubts: How Decision Makers Cope With Interdependence and Uncertainty. In R. M. Kramer, A. E. Tenbrunsel and M. H. Bazerman (Eds.), Social Decision Making: Social Dilemas, Social Values, and Ethical Judgements (pp. 1-9). New York: Psychology Press, Taylor and Francis Group.

Mayer-Schönberger, V. (2009). delete: The Virtue of Forgetting in the Digital Age. Princeton: Princeton University Press.

Merzenich, M. M., Kaas, J. H., Wall, J., Nelson, R. J., Sur, M., and Felleman, D. (1983). Topographic reorganization of somatosensory cortical areas 3b and 1 in adult monkeys following restricted deafferentation. Neuroscience, 8(1), 33-55.

Merzenich, M. M., Kaas, J. H., Wall, J. T., Sur, M., Nelson, R. J., and Felleman, D. J. (1983). Progression of change following median nerve section in the cortical representation of the hand in areas 3b and 1 in adult owl and squirrel monkeys. Neuroscience, 10(3), 639-641.

Michaels, C. F. (1981). Direct Perception. United States of America: Prentice-Hall Inc.

Mitzner, T. L., Rogers, W. A., Fisk, A. D., Boot, W. R., Charness, N., Czaja, S. J., and Sharit, J. (2014). Predicting older adults' perceptions about a computer system designed for seniors. Universal Access in the Information Society, 15(2), 271-280.

Volume 7, ANZCA Special Issue (2016): 35–43.

Modecki, K. L., Minchin, J., Harbaugh, A. G., Guerra, N. G., and Runions, K. C. (2014). Bullying Prevalence Across Contexts: A Meta-analysis Measuring Cyber and Traditional Bullying. Journal of Adolescent Health, 55(5), 602-611.

Pacini, R., and Epstein, S. (1999). The Relation of Rational and Experiential Information Processing Styles to Personality, Basic Beliefs, and the Ratio Bias Phenomenon. Journal of Personality and Social Psychology, 76(6), 972-987.

Pessach, G. (2008). Networked Memory Institutions: Social Remembering, Privatization and its Discontents. Cardozo Arts and Ent, 26, 71-149.

Rohrer, F. (2010, last updated at 10:59 GMT Tuesday, 13 April). The rise, rise and rise of the Downfall Hitler parody. BBC News Magazine. Retrieved from http://news.bbc.co.uk/2/hi/8617454.stm.

Shirky, C. (2010). Cognitive Surplus: Creativity and Generosity in a Connected Age. London: Penguin Books.

Smitsman, A. W. (1997). The development of tool use: Changing boundaries between organism and environment. In C. Dent-Read and P. Zukow-Goldring (Eds.), Evolving explanations of development: Ecological approaches to organism–environment systems (pp. 301-329). Washington, DC,: American Psychological Association.

Sormanen, N, and Dutton, W. H. (2015). The Role of Social Media in Societal Change: Cases in Finland of Fifth Estate Activity on Facebook. Social Media and Society, 1(2), 1-16.

St. Amant, R., and Horton, T. E. (2008). Revisiting the definition of animal tool use. Animal Behaviour, 75(4), 1199–1208.

Stalder, F. (2002). Space of Flows: Characteristics and Strategies. Paper presented at the Doors of Perception conference, Amsterdam. Retrieved 20 September 2015 from http://felix.openflows.com/html/objects_flows.pdf

Stanovich, K. E. (2010). Decision Making and Rationality in the Modern World. New York: Oxford University Press.

Tan, A. Y. Y., Atencio, C. A., Polley, D. B., Merzenich, M. M., and Schreiner, C. E. (2007). Unbalanced synaptic inhibition can create intensity-tuned auditory cortex neurons. Neuroscience, 146(1), 449-462.

Turkle, S. (1995). Life on the Screen. New York: Simon and Schuster.

van Lawick-Goodall, J. (1970). Tool-using in primates and other vertebrates. In D. Lehrman, R. Hinde and E. Shaw (Eds.), Advances in the study of behavior (pp. 195–249). New York, NY: Academic Press.

Von Foerster, H. (2003). Understanding Understanding: Essays on Cybernetics and Cognition. New York: Springer-Verlag.

West, G. B. (2015, January 8, 2015 16:35). On a Technological Highway. uTube Video. Retrieved 15 June 2015 from http://www.tallbergfoundation.org/video/on-a-technological-highway/