Fleur Summers
RMIT University

Infinitely Malleable – Approaching contemporary sculptural practice through the notion of neural plasticity

Keywords**:** Sculpture, Neural Plasticity, Embodiment, Mirror box, Neuroscience

In her 1979 essay *Sculpture in the Expanded Field*, critic Rosalind Krauss used the phrase 'infinitely malleable' to describe the changing conditions of sculpture at the time. She was not only referring to the expansion of the physical conditions of sculptural materials and their potential elasticity but also to the collapse of the historical and seemingly immutable logic of the sculptural monument (Krauss, 1979, p.30). Malleability, plasticity and flexibility are terms that are now also used to describe the neural properties of the brain and how the very fabric of the brain (also once thought to be immutable) is altered through the processes of learning. In this paper, I will discuss these similarities with a particular emphasis on neural plasticity and my own work as a contemporary sculptural practitioner.

Neural plasticity is a widely used term. Scientifically, it can refer to a large range of changes in brain tissue from sub-cellular levels to changes in gross brain anatomy. It involves the 'ability of the nervous system to respond to intrinsic and extrinsic stimuli by reorganizing its structure, function and connections' and it can occur 'during development, in response to the environment, in support of learning, in response to disease, or in relation to therapy' (Cramer et al 2011, p.1592). It has also become of popular interest, with a large number of nonfiction books exploring experiences of brain plasticity, such as the bestselling *The brain that changes itself* by Norman Doidge (2007) and *Brain Rules* by John Medina (2008) and TV series such as ABC TV's *Redesign My Brain* (2013). Whilst plasticity can be adaptive or maladaptive, most of these books focus on positive adaptive changes and on conditions and narratives that capture popular imagination such as locked in syndrome or phantom limbs.

Neurological changes usually occur through experience and involve a combination of environmental inputs, biomechanical actions, bodily feelings and cognition or thought. In *Transformative art: art as a means for long term neurocognitive change*, psychologist Son Preminger confirms the experience of art to be 'transformative' in a neurological sense in that it can 'modify synaptic connections and consequently cognitive processing' (Preminger 2012, p.2). In sculptural and installation-based artworks, this often encompasses a temporal experience involving vision, hearing and vestibular functions and other complex sensations. These experiences undoubtedly involve the body and embodied perception and cognition. Embodied cognition has an important role to play in our understanding of the potential neurobiological effect of sculpture. Recognising the body in neurological processes argues for the reconstitution of the body by stating that our motor system influences our perception and cognition, just as our thoughts influence our bodily actions (Wilson and Golonka 2003, p. 1). The idea of embodied cognition caused a revolution in the way the body was understood and represented in the late 20th century and early 21st century. In order to understand this, it is useful to reflect on how the body has been considered historically in relation to sculpture and neurology.

Historical Associations – Sculpture and Neurology

Whilst contemporary sculpture is multifarious in scope, traditional sculpture has a strong association with the body. This substantial lineage can be seen in prehistoric Venus figurines and symbolic Egyptian relief figures, the full-figure sculptures of the Greeks and Romans, the classical revival of the Renaissance, realist portrait busts and monuments of historical figures. This emphasis changed radically in the twentieth century. Industrialisation and the rise of technology resulted in the use of a wider range of materials and methods and, more importantly, the way artists conceived of and represented the figure changed. Not only did the sculptural pedestal disappear but the figure itself almost completely dissolved into abstraction as art moved its focus from representation to interpretation. Avant-garde art movements such as Cubism, Futurism and Constructivism responded to this conceptual rupture by fracturing bodies and objects and embodying technology and abstracted dialogues on the spatial experiences of modern life. The temporal rupture of modernism ultimately led to a 'self-conscious interest in new experiences, possibilities, technologies, dimensions, ways of sensing the world, and forms of representing it' (Salisbury and Shail 2010, p.6).

Neurology, as a discipline, also emerged out of these changes as the body was subjected to increasingly complex sensations. Through physical displacement and sometimes trauma, the body itself became fragmented. Amputees became more numerous and visible, due to industrial accidents and the trauma of war, providing valuable research material for neurologists who relied heavily on pathological subjects to create new knowledge. Psychiatry and psychology focused on the brain and computer science was developing ways to represent brain function using abstract systems and rules that did not involve the body.

Initially it seemed the body was almost completely lost through the early ideas of artificial intelligence and non-figuration. However, with the rise of art movements such as Minimalism in the 1960s, the figure began to be recuperated. This work was not concerned with the representation of the body but instead reinstated the body as the subject of the work by privileging the experience of the viewer. Minimalist artists introduced notions of time and space into their work in response to Maurice Merleau-Ponty's 1945 work *The Phenomenology of Perception.* Merleau-Ponty argued that it is through our bodies that we come to know ourselves and the world around us, and that the complex sense we have of our environment cannot be understood purely through the activity of a 'disembodied eye' (Marsh 2006, p. 3). Merleau-Ponty considered it essential that this encounter was fully integrated within the kinaesthetic (or muscle sense) and tactile dimensions of experience:

> Our own body is in the world as the heart is in the organism; it keeps the visible spectacle constantly alive, it breathes life into it...and with it forms a system (Merleau-Ponty 1945, p. 235).

Similarly, Minimalist artists believed in the need to experience the physicality of artworks in the everyday world and stressed the psychological, spatial and temporal circumstances in which the work was viewed. They produced works that demanded an active and participatory, even 'theatrical', mode of viewing and that actively questioned the spatial conventions of the gallery. This meeting or encounter with the work interrogated the very conditions of sculpture and created new experiences and ways of seeing and thinking about art.

At the same time as Minimalist artists were beginning to explore perception and embodied cognition, computer science was developing and applying the concepts of artificial intelligence (AI). This primarily involved using abstract symbols and rules – an inherently disembodied approach. After some initial success in AI, it became obvious in the 1980s, as Hans Moravec wrote in his 1988 book *Mind Children,* that humans are 'prodigious olympians in perceptual and motor areas' and while computers could easily undertake higher level reasoning they lacked the resources necessary for even low level sensorimotor activities (Moravec 1988, p.15-16). Rodney Brooks in his 1990 paper "Elephants Don't Play Chess" goes on to point out that traditional AI's 'grounding in reality has rarely been achieved' and suggested that an 'ongoing physical interaction with the environment as the primary source of constraint on the design of intelligent systems' was necessary to build more complex systems (Brooks 1990, p.1). This has led to the further investigation of ideas surrounding the ways in which perception and thought are both influenced by and determined by bodily sensations and is currently being explored in robotics research.

Phantom Limbs and Mirror Boxes

It is only comparatively recently, in the latter part of the twentieth century, that the concept of embodiment has been seen as valuable within the scientific community and systematic studies have taken place (Ramachandran1998, p.1852). While much of this research now involves sophisticated technological imaging, basic neurological testing can still be done with minimal equipment in a doctor's office and with simple analog objects. This simplicity is evident in the mirror box devised by neurologist V.S. Ramachandran, which is used clinically to treat the pain and discomfort often experienced by people with phantom limb pain. Phantom limbs are a well-known phenomenon in which a part of the body that has been amputated continues to feel present and is often painful or uncomfortable. It is more commonly seen in upper limb amputees than lower limb amputees (Subedi and Grossberg 2011, p.1) but phantom sensations and pain have also been reported upon the removal of other body parts, such as the eyes, teeth, tongue, breast, penis, bowel and bladder (Weeks, Anderson-Barnes and Tsao 2010. P.270). The exact mechanism of phantom limb pain is still not agreed upon and it is widely thought that multiple mechanisms are most likely to be responsible. My interest lies with central neural mechanisms involving neural plasticity resulting in changes to the 'body schema' and the presence of mirror neurons and how they relate to the function of the mirror box.

The body schema is the 'internal, dynamic representation of the spatial and biochemical properties of one's body, and is derived from multiple sensory and motor inputs that interact with motor systems in the generation of actions' (Giummarraa et al 2007, p.223). These interactions occur without awareness or the need for perceptual monitoring. It was originally thought that the brain, and therefore the body schema, was relatively fixed by adulthood. However, while the brain may not be as 'infinitely malleable' as contemporary sculpture, it is now understood that changes in neural pathways occur throughout healthy adult life via learning and memory and in response to injury and illness. Most importantly, specific functions may not be limited to particular areas of the brain and environmental factors can markedly affect neural plasticity in both positive and negative ways. Although phantom limb pain caused by injury is viewed as negative or maladaptive, successful treatment for phantom limb pain shows that the brain can compensate for loss and that it continues to alter and reprogram neural pathways throughout life (Ramachandran 1998, p. 1852).

The mirror box itself is very similar to a sculptural object and illustrates the creativity and inventiveness involved in developing and transforming physical objects to test perception. Although it can be constructed in various ways, it generally appears as a box, open from the top, divided in two sections — one closed (for the absent limb) and one open with a vertical mirror in the centre. The mirror is used to provide artificial visual feedback to the brain by causing it to view the reflection of the healthy limb in the visual plane of the missing limb and in effect 'tricking' the brain into believing the missing limb is moving. If the pain is induced by a conflict between visual feedback and proprioceptive representations of the amputated limb then illusions or imagery of movement of the amputated limb have the potential to reduce the pain (Chan et al 2007, p.2206). This releases the phantom from its disembodiment by reinstating the motor-sensory feedback loop. By providing visual feedback of a limb that isn't actually sending back any sensory information this actual neuronal activity may disrupt the negative pain cycle (Lamont, Chin and Kogan 2011, p.370). Mirror box therapy may also demonstrate the function of mirror neurons. These neurons become activated both when individuals carry out motor tasks and when they see similar activities undertaken by others. The pain relief associated with therapy for phantom limbs may be due to the activation of these neurons that occur while watching the healthy limb move (Chan et al 2007, p.2206).

Table Tennis, Libraries And Reflection

Embodied cognition and its inherent temporality are central to my own sculptural practice. My work attempts to critically re-examine how our encounters and negotiations in time and space in contemporary sculpture occur with reference to the neurocognitive experience. As mirror boxes are known to alter clinical and neural responses and share formal relationships with sculptural objects, these physical structures were used to begin a sculptural investigation.

Initially this process involved creating a series of scale models employing mirrors in conjunction with objects or forms that separate, divide and reflect the body and potentially enhance or extend cognition. Institutional furniture and architectural

Figure 1: Studio models 2013. Photo: Fleur Summers

structures, and objects used in physiotherapy and occupational therapy were considered in order to understand familiar forms known to encourage neurocognitive and physical engagement. For example, the library desk or carrel is partly designed in this way to give the user the space for focus and contemplation, in the same way the mirror box or polling booth does, but it also acts as a device to reduce dialogue and exchange. The work *Transpositions – A Proposition for the 21st Century Library,* which is a set of models and full-scale works that combine the structure of the library carrel with the spatial expansion of the mirror and include the potential to improve cognitive abilities through play and biomechanical activities. It is now well recognised that play is important in learning and that movement can aid in this process (Pound 2014, p.103). As libraries potentially move from places of quiet contemplation to include more active modes of thinking, a modified version of table tennis was included in the work as a kinaesthetic approach to learning and to boost creativity. Table tennis is often found in schools, offices and aged care facilities due to the way it is known to activate multiple regions of the brain and increase cerebral blood flow improving physical co-ordination, alertness and mood (Heller 2011, p.1).

Figure 2: *Transpositions – A Proposition for the 21st Century Library* in the Reading Room of West Space gallery, Melbourne, 2014. Photo: Christo Crocker

As sculptural objects, these works create stimulating and unusual spatial relationships. The mirrored surfaces enhance perception and create expanded fields of vision as well as providing visual feedback concerning participants' bodies and actions. The mirrors reflect and disperse responses as participants can be observed from many positions, allowing individual and group reflection of the feelings and reactions elicited in open and positive ways. Presented as a full-scale artwork in Melbourne Gallery *West Space*, the work occupied three large tables (normally used for committee and board meetings) located in the Reading Room. This room has multiple uses and opens on to gallery and foyer space. The work invited viewers to either sit at one of the three mirrored cubicles on one side, play table tennis down the narrow mirrored centre with a partner or sit at the large open cubicle designed for small group discussion.

Participants of the work were surprised with the possibilities for perception the work presented. Primarily they found the work playful and interesting, offering new ways to experience play and to interact in familiar but unusual spatial arrangements. Many participants explored the potential for spatial expansion by experimenting with multiple reflections of the table tennis ball and the upper body in the mirrors. Whilst the works are largely participatory, there is also the opportunity for more quiet individual observation. The mirrors accentuate the subjectivity of the activity of spectatorship and force the viewer to reconsider their role. The viewer cannot remain a passive observer due to being implicated in the work and consequently embedded within it. If the contradictory feedback from the clinical mirror box causes a crisis in representation and forces active changes in neuronal activity in the brain, we can also surmise that neural changes occur in the perception and consequent cognition of this work.

Figure 3: *Transpositions – A Proposition for the 21st Century Library* in the Reading Room of West Space gallery, Melbourne, 2014. Photo: Stephen Dixon

Despite the seriousness of this project, the work is designed to encourage playful interaction. It draws upon the absurdity of Dada, the spontaneity of Happenings, the collaborative inventiveness of Fluxus and the playfulness of the work of artists like Erwin Wurm or the video work of John Wood and Paul Harrison. This work is very low tech and economical in its use of materials and forms: the nature of the work is largely determined by the encounter and response of participants and once activated will create lively and interesting physical and conceptual interactions. Neuroscientists have created similarly playful experiments with mirrors, rubber hands and phantom noses as well as with inanimate objects such as tables and shoes. Not only are these experiments creative and imaginative but they also illustrate that it is possible to project tactile sensations on to inanimate objects that do not represent the body. Ultimately, these experiments suggest that body schema is flexible and adaptable even without prior injury or alteration to neural pathways (Rhamachandran 1998, p. 1855).

Figure 4: Playing table tennis in *Transpositions – A Proposition for the 21st Century Library* in the Reading Room of West Space gallery, Melbourne, 2014. Photo: Stephen Dixon

Conclusion

It is clear from both scientific studies and concepts in contemporary art that multiple disciplines share an interest in experimenting with proprioception and vision and the way in which these senses interact. Clearly, these embodied ways of knowing are not new and are embedded in our culture. As such, it does appear that the interests of artists and scientists overlap and that this is particularly evident in the area of embodied cognition, as contemporary sculpture continues to experiment with the perception and response of the viewer and subsequent neural responses. Ultimately, it appears that if the study of phantom limbs provides valuable insight into neural plasticity, how new connections develop in the brain through multiple sensory modalities, and how our sense of reality is continuously updated through this sensory input (Ramachandran and Hirstein 1998, p.1626), it may also be possible to study sculptural and installation practices that experiment with the body in a similar manner. Not only do these creative practices actively interrogate and experiment with knowledge from neuroscience, they may also have the capacity to extend knowledge concerning the conceptualisation of space and the body and to present potential applications within a broader cultural context.

Figure 5: Reading in *Transpositions – A Proposition for the 21st Century Library* in the Reading Room of West Space gallery, Melbourne, 2014. Photo: Stephen Dixon

References

CHAN, BA, WITT, R, CHARROW, AP, MAGEE, A, HOWARD, R, PASQUINA, PF &.

HEILMAN, KM 2007, 'Mirror Therapy for Phantom Limb Pain', *New England Journal of Medicine* 357 (November 22, 2007): 2206-2207, DOI: 10.1056/NEJMc071927

CRAMER et al 2011, 'Harnessing neuroplasticity for clinical applications', *Brain*, 2011: 134; 1591–1609, DOI:10.1093/brain/awr039

DOIDGE, N 2010, *The brain that changes itself*, Melbourne, Scribe Publications.

GIUMMARRAA, MJ, GIBSON, SJ, GEORGIOU-KARISTIANISA, N & BRADSHAW, BL 2007, 'Central mechanisms in phantom limb perception: The past, present and future', *Brain Research Reviews* 54, Issue 1 (April 2007): 219–232, DOI:10.1016/j.brainresrev.2007.01.009

HELLER, R 2011 'Ping pong therapy brings net gains to Alzheimer patients', *Jewish Journal*, January 25, 2011, viewed 15 August 2014, http://www.jewishjournal.com/50_Plus/article/pingpong_therapy_brings_net_gains_to_alzheimers_patients_20110125/

KRAUSS, R 1979, 'Sculpture in the Expanded Field', *October*, Vol. 8 (Spring 1979), p.30-42.

LAMONT, K, CHIN, M & KOGAN, M 2011 'Mirror Box Therapy - Seeing is Believing', *Explore* 7 (2011): 370, 7:369-372,p.370, DOI:1016/j.explore.2011.08.002

MARSH, J 2006, 'Looking Beyond Vision : On Phenomenology, Minimalism and the Sculptures of Robert Lazzarini', *Robert Lazzarini: Seen/Unseen.* Charlotte NC: Mint Museum of Art, 2006. Catalogue of an exhibition at the Mint Museum of Art, 25 February through 16 July 2006, http://www.deitch.com/files/artists/lazzarini_lookingbeyondvision05.pdf

MEDINA, J 2008, *Brain Rules*, Seattle WA, Pear Press.

MERLEAU-PONTY, M 1962 *The Phenomenolgy of Perception*, Translated by C Smith, London, Routledge.

PENNY, S 2011, "What is Artful Cognition?" conference paper from *Art as a Way of Knowing* organised by Exploratorium, San Francisco, March 3 & 4, 2011, viewed 30 July 2013, http://www.exploratorium.edu/knowing/pdfs/Penny.pdf

POUND, L 2014, 'How Children Learn', *Foundations of Early Childhood: Principles and Practice*, edited by Penny Mukherji & Louise Dryden, London, Sage.

RAMACHANDRAN, VS 1998, 'Consciousness and body image: Lessons from phantom limbs, Capgras syndrome and pain asymbolia', *Philosophical Transactions of the Royal Society B: Biological Science,s* 353 (1998): 1851–1859, DOI:10.1098/rstb.1998.0337.

RAMACHANDRAN,VS & HIRSTEIN, W 1998, ‘The perception of phantom limbs – The D.O. Hebb lecture’, *Brain* 121 (1998): 1603-1630.

SUBEDI, B & GROSSBERG, GT 2011, ‘Phantom Limb Pain: Mechanisms and Treatment Approaches’, *Pain Research and Treatment* (July 2011): 1 – 8, DOI:10.1155/2011/864605

SALISBURY, L & SHAIL, A(eds) 2010, *Neurology and Modernity - A Cultural History of Nervous Systems, 1800-1950,* Hampshire, UK, Palgrave McMillan.

WEEKS, SR, ANDERSON-BARNES, VC & TSAO, JW 2010, “Phantom limb pain: theories and therapies”, *Neurologist,* 16, no. 5 (Sep 2010): 277-86.

WILSON, A & GOLONKA, S 2013, ‘Embodied Cognition is not what you think it is’, *Frontiers in Psychology*, Volume 4 | Article 58, DOI:10.3389/fpsyg.2013.00058.