

**Integrating Practice Based and Neuroscientific Perspectives
on the Impact of Digital Technology
on Contemporary Narrative Dramaturgy,
Investigated through Live Simulation Exercises.**

Teresa Crea

A thesis comprised of an experimental creative output and exegesis submitted
to the University of Technology, Sydney, in fulfilment of the requirements
for the Degree of Doctor of Creative Arts.

2013

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate

.....

Acknowledgements

While the questions that led to this thesis date back across many years of practice involving innumerable artistic collaborators, I remain particularly indebted to the individuals who took the time during my candidature as a research student to listen, share insights and support these explorations. I have been very fortunate to share this journey with many open spirits and agile minds.

To begin with I would like to thank Professor Ross Gibson. I walked into his office several years ago with the presentiment that it would be enriching to engage with him as a supervisor – and that intuition never once proved me wrong. I doubt whether I would have had the fortitude to embrace this inter-disciplinary trajectory without his enthusiasm, insight and great capacity to move between intellectual and artistic endeavour. Many thanks also to my Co-Supervisor, Professor Rick Iedema. Our discussions were immensely reassuring in setting up the medical simulation exercises. It was wonderful to find a ‘home’ at the UTS Centre for Health Communication.

I must also acknowledge Professors Ian Gibbins and Marcello Costa whose generous conversations - often at the Art Gallery of South Australia - opened up the world of neuroscience to me. And Dr. Braden McGrath, whose chance encounter highlighted the growing field of simulation and the learning that might come from it.

My gratitude also goes to Dr. Dave Sainsbury for introducing me to the Simulation Unit at the Royal Adelaide Hospital (RAH), and for allowing me to experience the operating theatre first hand. The insights of that day continued to accompany me throughout this research. I remain indebted to Dr Graham Lowry, Director of the Simulation Unit at the RAH. This research would not have been possible without his willingness to embrace my investigations. I owe immense gratitude to Graham and his exceptional team of participating clinicians for their time, their knowledge and their candour. It was a privilege to have access to such experts and their working processes. What transpired across our interviews and conversations has gone far beyond the technical; their care and humanity still resonate within me.

My appreciation also goes to Senior Medical Scientist, Anna Marie Carrera for her support and facilitation of this research project within the hospital. The trials, a first for the unit, were conducted amongst the immense pressures and real life emergencies at the RAH, and required an enormous commitment from everyone involved. For his practical support in the preparation of this manuscript, credit goes to Peter Heydrich for his invaluable editorial, formatting and proof reading assistance. I would also like to acknowledge James Coulter for his advice, Paola Niscioli for additional proof reading and Domenic Minorchio for the video transfer.

A big thanks to Juleigh Slater for helping me through the unexpected vicissitudes of my candidature and to Mark Ward whose fabulous conversations sustained me as a fellow researcher and traveller. But most of all, my deepest gratitude extends to Peter for being a truly generous partner, for maintaining his sense of humour and for frequently putting his own wishes on hold while I pursued this adventure.

TABLE OF CONTENTS

Certificate of Original Authorship	ii
Acknowledgements	iii
Table of Contents	iv
Abstract	v
Notes to the Reader	vi
 Introduction	 1
Introduction To Simulation	13
Why Simulation?	13
Why an Emergency Scenario?	16
Micro Narrative as Research	18
The Personal Experiential Narrative	21
 Emergency In The Sim Ward	 23
Analysis Part One - The Mise En Scene	87
Introduction.	87
Enactment in a Medical Context	88
Plot and Meta Narrative Framework	89
Mise-en-Scene	91
Characters and Role Play	92
The Production of Presence: Technology and the Senses	93
The Technology Paradox	96
Sensory Processing, Presence and Perceptual Realism.	101
 Analysis Part Two - The Micro Narratives	 105
The 'New' Subjectivity	105
Micro Narrative as Sense Making:	109
Medical Sensemaking	109
Enaction – Actionable Perception	112
Narrative Sensemaking as Information Processing	115
Algorithms	116
Unconscious Processing	118
Mind- Body Schisms	119
Time, Presence and 'Presentness'	123
The Gelofusine Trigger	124
Processing in and Across Time	126
 Conclusion	 130
Revisiting the Research Questions and Findings	130
Final Considerations and Future Speculations	133
 Addenda	
Addendum 1: Anaphylaxis to Gelofusine	141
Addendum 2: Considerations on the Processing Brain	144
Addendum 3: DVD, Video excerpt, Simulation Trial [attached rear sleeve]	
 Bibliography	 156

Abstract

The collision of the dramatic and narrative arts with digital technology has seen the emergence of distinct narrative experiences incorporating new attributes such as interactivity and participant's agency within the unfolding of the work. The disruption caused by these innovations and attributes has been hotly debated in many creative industry forums and further reinforced in theoretical discussions focussing on narrative and interactivity, a case in point being the 'story versus game' debates waged between the narratologists and the ludologists.

As a director and deviser of live performance, my own use of digital technology in productions throughout the 1990s generated concomitant dramaturgical dilemmas regarding the changing structure of narrative and the shifting role of the audience. From the outset of my investigations into these challenges it was clear there was a critical problem to be addressed. Temporality, and the ordering of experience and events in time, provides the foundation of storytelling and narrative dramaturgy. While conventional story structure is predicated on a reflective, re-telling of experience, games and many emerging forms appear to be contingent on a form of lived experience and enactment.

This doctorate examines particular aspects of narrative understanding as it is affected by the emergence of these new modes of dramaturgy and performance. Given that the new developments seemed to be challenging western dramatic conventions, in particular the key Aristotelian tenet of representation, I guided my research with this question: 'How is this technological disruption renegotiating our traditional Aristotelian sense of time and presence?'

This thesis investigates the question from a neuroscientific perspective, integrating practice-based understandings and creative experimentation with neurobiological insights from Antonio Damasio, Francisco Varela and Benjamin Libet. It does so under the supposition that the shifts in narrative composition might in fact be reflective of how we process information. Further, it puts forward the proposal that we might enhance our understanding of contemporary narrative experiences by considering a model of dramaturgy that is informed by this understanding of the brain's processing mechanisms.

In order to test this proposal I firstly set up a live simulation as an example of a technologized and interactive performed narrative, and then I distil four creative micro narratives from that simulation. I then analyse and discuss the micro narratives as forms of neurobiological sense making, potentially indicative of a compositional structure based on an alternate, neurobiological temporal dynamic.

The creative experiment and research findings (delivered in the exegesis) suggest the emergence of a new dramaturgical aesthetic and poetic of time; one that is predicated on a neurobiological dramaturgy distinguished by subjectivity, embodiment, enactment and above all, 'presentness'.

Notes To The Reader

One of the challenges in embarking on this multidisciplinary research was that of necessity, I needed to navigate across diverse and frequently opposing processes - subliminal, intuitive, analytical and reflective. Scholarly practice requires that these processes be rendered explicit and understandable to the reader through contextualisation and analysis. The illusion, when faced with a completed thesis, is that these processes have occurred in an orderly fashion; that there is an inherent sequential logic to the knowledge gained during the course of the investigation.

The reality of creative practice is quite different. Often I was pursuing a course of action purely on a hunch, uncertain where it would take me, and the observations to emerge during the elaboration of the work were frequently haphazard and not easily interpretable. The actual process of sense making (as is hopefully demonstrated across this thesis) is far more nuanced and circuitous than linear and direct. The test remained as to how to impart this process to the reader such that they too might glimpse some of the revelations and epiphanies through an analogous inter-weaving of narrative threads and sense making processes.

Naturally, the reader is free to logically (and expediently) embrace this dissertation by reading in a linear fashion from beginning to end. Indeed, sections of *Emergency in the Sim Ward* are deliberately punctuated by time codes to provide a chronological record of how events progressed. However, this chronological framework differs significantly from the experiential narratives and trajectories captured throughout the creative endeavour: chronological and experiential time loop across each other in a disorderly manner.

Apart from the introduction, which by necessity acts as a springboard for the origin of this research, the ensuing creative artefact, analysis and addendum are more indicative of a series of narrative loops; a pattern of weavings moving forwards, across and back on each other in a flow of information, analysis and sensation.

Emergency in the Sim Ward has an overarching framework and structure. The reader is welcome to construct their own path, and interrupt the linear narrative with digressions into the analysis, addendum and video excerpt. Often the very same understandings and insights are highlighted in differing ways as the clinicians strive to consolidate their own subjective experience. The micro narratives and their analysis respectively offer an internal experiential view and external objective view of the same process. The analysis itself takes on different nuances when contextualised against theories of brain functions.

To this end I am particularly compelled to say a few words about the addendum. It contains two important 'narratives' that go to the heart of my undertaking, plus an accompanying video documentation of a 'sample' simulation enactment.

The first narrative is a description of the medical scenario as developed by the Simulation Director, which provides the foundation for *Emergency in the Sim Ward*. It functions as a performance 'canovaccio' and the reasons for its inclusion are explained within the exegesis.

The second narrative is a consideration on the processing brain and is intended as a companion narrative for the neurobiological theories that underwrite my experiment. Whilst the majority of my scientific references are elaborated via footnotes, the overall picture of the brain to emerge across my readings was influenced by a range of experimental theories and considerations from the evolving field of neuroscience. Each discipline's questions about the processing brain would often steer towards more complex readings about consciousness itself as different scientists and philosophers delved into explanations about the elusive mind-body relationship.

As an artist I needed to make sense of, and collate, the ideas that most excited and influenced me in such a way that they formed a cogent thread and springboard for the ensuing creative speculation. My introduction to the brain serves that basic purpose, and is offered to the reader for precisely the same reasons: not as a scientific study, but as a condensation of the readings that shaped my understanding of the working brain. Some readers may prefer to read the Addenda after the Introduction so that they can carry these overarching perspectives across the subsequent chapters. Readers may also include reference to the video excerpt in Addendum 3 in similar fashion.

This doctoral research and its conclusions are therefore put forward through a variety of frames: creative, poetic, theoretical, and practical. As already noted these insights are not at all sequential. I regularly found myself revisiting material and experiences in order to make sense of the territory. Across this process I also eventually came to a place where intuition, experience, reflection and analysis no longer felt as opposites. Mirroring in a sense, the broader themes of this inquiry, the different roles of artist and researcher, experience and reflection, are intertwined, overlapping to become part of a larger, more fluid understanding.

The Doctorate of Creative Arts (DCA) bestows particular value to the creative component of the work produced during the research phase of the doctoral candidacy. The dossier in front of you contains this creative work (entitled *Emergency in the Sim Ward*) as well as the 'exegetical' material that is required by DCA guidelines to accompany it. Usually DCA candidates separate these two components, offering two distinct documents. However, given the declared non-linear nature of my creative and analytical processes, I have woven the two elements together in a single dossier, allowing the exegetical work to both surround, and be interlaced by, the creative work.

Introduction

The motivation for this creative enquiry stems directly from emerging trends in the creative industries, and from experiences within my own artistic practice as precipitated by the engagement with digital technologies. I first started incorporating digital technology into live performance during the early 1990's in my capacity as Founder and Director of the Australian Performance Company Parallelo. The use of technology in the arts has of course a much longer trajectory,¹ but advances in the development of new digital tools of production suddenly made digital media more affordable to artists, myself included, giving rise to a new wave of experimentation.

It was an exciting period, but also a disruptive one, as I became increasingly aware of the unsettling influence digital technology was having on my understanding and structuring of narrative. As a writer/director I was working with and exploring new media platforms in a variety of contexts, but it was in live performance that I most became aware of the unsettling new phenomenon. The new digital tools were introducing potentially novel dimensions, such as the integration of digital sound and light triggering, video projection and real-time vision mixing. It made for more a complex structuring of performance works which often challenged narrative coherence. This tension resonated in ensuing performance reviews with critics either ecstatic or puzzled by our productions, a phenomenon illustrated by the following reviews:

*"So many levels of activity are happening in The Last Child – music, video projected graphic design /multimedia, dance, live music and song- yet this production fails to adequately manage the audience's narrative focus on each of these elements [...] all in all you end up wondering where you as a viewer are meant to go narratively"*²

[O'Brien 2000, p. 19]

*"Parallelo positions itself at the forefront of intersections between performance art, visual arts and new technologies, art as community cultural development practice and the constantly evolving (meta) physical body of contemporary theatre. As such its work stands alone in nature [...] Racing performance art into the new millennium, Parallelo's In the Time of Distance tells us that the face of live art is changing and the power of live art is extended, increased and critically informed by new technologies."*³ [Moody 2003, p. 45]

The reactions were perplexing and precipitated a deep questioning within me.

¹ See Dixon [2007]; Bolter & Grusin [1999]; Grau [1995].

² The Last Child was directed by myself and developed in collaboration with a team of interdisciplinary artists. It was performed at the Cargo Club, Adelaide Festival of Arts, 9-11 March 2000

³ In The Time of Distance was written and directed by myself and performed at the Queen's Theatre, Adelaide, SA, Sept. 4 - 13, 2003.

I had in fact inadvertently been grappling with alternate dramaturgical and compositional strategies for several years in my role as a deviser of a distinctive cross-cultural performance style that, by necessity, needed to integrate diverse cultural codes and conventions.⁴ The artistic choices involved in this constant cross-cultural negotiation often placed me in a position of tension with established dramatic convention as I strove to weave diverse cultural aesthetics, rhythms and languages into the performance narrative. Technology, and the fluid, open interactions afforded through the digital medium, appeared to add another unique dimension to that predicament.

The problem was two fold: while the new elements appeared to challenge the continuity of narrative focus, that same focus also appeared to be intrinsically dependant on how the reader/spectator was positioned within the work. The changing structure of narrative and the role of the audience seemed to be intimately connected. My creative struggle was brought to a head in a production entitled, *Tracking Time*. The reviews of this production distilled the issues I had been unable to resolve across various presentations, caught up as I was in the economic 'haggling' of presenting the work in diverse festival contexts and arts markets.

Tracking Time was conceived as a performance installation specifically for spaces of transit – train stations, departure lounges, and border stations. Consequently the work was performed in different sites. While neither the stories nor the dramatic elements of the performance altered across the different venues, the work was received and 'read' very differently in the different localities. Clearly something quite distinct was occurring at the subjective level of narrative processing.

In Perth we had the assistance of a very enthusiastic Festival Director and we were able to negotiate a public intervention that allowed us to 'perform' directly on a railway platform with trains arriving and departing either side of the performer and audience space. The reader/spectator was thus literally positioned in the natural flow of the location; the audience was physically immersed in the real space, as if waiting for a train; they had agency and were able to engage easily with other non-performer commuters.

At the Adelaide and Singapore Festivals, box office and financial pressures required us to set up a formal audience 'bleacher' seating area and perform within that. Thus, although the installation was in a disused area of a train station (Adelaide) or on a Pier (Singapore), and even though the audience could watch passenger flows, embarking and disembarking, the performance and viewing frame operated more like a conventional theatre venue with fixed seating. This then, for the audience, engendered a certain classic Aristotelian immersion and perspective, placing them

⁴ See Mitchell, 'Maintaining Cultural Integrity: Teresa Crea and Critical Multiculturalism' in Kelly [1998, pp. 132 – 151].

psychologically in the position of passive witnesses. The impact of this changing audience configuration on the capacity of the spectator to hold the narrative is clearly illustrated in the following sequence of reviews:

Perth:

"At the Perth railway station, on track six, strange things are taking place. The slab of concrete located between the Armidale and Freemantle lines has ceased to be an area for passengers waiting to board a train; instead it has transmuted into a junction where the stories of four people meet. Tracking Time, the brain child of Teresa Crea, has created a world that has no identifiable sense of place and is set in a time that can only be described as 'now' [...] Visually stunning, this performance creeps up slowly, only to pounce on the audience, taking them completely by surprise when the movement and music take over. In turns surprising, disturbing, confronting, Tracking Time slowly peels the layers away to reveal the human condition within each person. The music is fluid, alternating between driving beats, haunting arias and well known songs that lodge in the brain, creating a space that reflects the constantly changing nature of the performers. Behind the action, images (live and pre-recorded) of the performers are flashed onto a wall to add to the colour and confusion. At times there is so much going on that no matter where the eye is cast, it will fall on some aspect of the story being told".

[Hunter 1999, p. 14]

Adelaide:

"The new work is a rude shock. You feel like you're entering a familiar space, cupboards, baggage, a quiet entry through railway gates after contemplating lockers filled with clocks and bones that eerily transform the modern station into something elderly and surreal, even dead. But once you're up amongst the baggage a grimly modern world briskly and densely and noisily unfolds out of the smoke [...] I'm not sure where I was or what or where I was supposed to be ... And where were the performers? In a room off the main hall as if doing a theatre show regardless of the installation (bags, lockers, boxes, video screen) and the station which merely became a set, a frame not engaged with [...]"

[Gallasch 1998]

Singapore:

"The audience had various points of focus in this relatively busy production, but faced with a picture-frame staging, there was something stilted about turning one's head about like a tennis match. It would have been better if we were moving about the pier – deciding which of the many lockers to open, which performers to listen to or move away from. Protagonists of constructed situations rather than passive consumers we too would have been caught in the transit. Not only would this have opened up the space for reflection, leading audiences to further interact with the pier itself, it would have implicated us – in the subject of journeys.

[Oon 2000, p. 7]

The Singaporean reviewer, Clarissa Oon, had astutely understood the core mechanism that needed to be activated in order for the narrative to 'make sense' to the spectator. The audience needed to be immersed as 'fellow travellers' in the story not just positioned as 'observers'. It was a revelation. The reader/spectator presence and engagement activated by the differences in staging had obviously created confusion, often stranding the audience between a conventional dramatic referencing

(vis-à-vis Adelaide and Singapore) and something else. It was not enough to passively watch the work; the multimodal, non-linear narrative needed to be read through a physical embodiment and navigation of the performance itself.

My real life dilemmas resonated in the writings of Hans Theis Lehmann [2008] whose seminal study of new theatre forms argued that we were moving beyond conventional drama towards a “Post Dramatic Theatre”; Staff [2009, pp. 207 – 218], who asserted that there were new forms of spectatorship emerging across contemporary art practices that attempted to formulate a conception of the artwork through an ‘embodied viewer’ and Oddey and White [2009, p. 8], who believed that the new mode of spectatorship entailed more than “just watching”; it substituted “a sensory, kinetic experience” in which the spectator was “drawn into a liveness” – a liveness that I will argue involves both the here and now (i.e. the present), and a transformed experience of ‘presence’ within the narrative.

It was clear through these shifts that the classic Aristotelian premise underpinning much of western dramatic and literary conventions was no longer adequate and could no longer accommodate the changes taking place.⁵

If we look at the dominant paradigm of western narrative and drama, it is essentially based on literary and dramatic principles first articulated by Aristotle in his Poetics [circa 350BC]. Stories move through time, and Aristotle’s model is predicated on a linear and logical ordering of story events across time. In this model, story has a beginning, middle and end, representing a linear progression and logic based on the classical unities of time, place and action.⁶

Dominated by “logos and linearity”⁷, Aristotle’s notion of mimicry and representation is also characterised by a form of empathy that relies on psychological immersion. In a classic story or dramatic narrative, the reader identifies and empathises with a character - conventionally the protagonist - and this then serves as the emotional hook or ‘buy-in’ to immerse and lose oneself in the story as a passive witness to the unfolding drama. By empathising with a character or a situation, the reader is transported into that fictitious world as a passive (psychological) presence rather than as an active real time bodily presence.

⁵ According to Turner & Behrndt [2008, p. 187] these shifts in performance, and the evolving compositional strategies, culminated in a crisis of dramatic form at the end of the millennium wherein synthesis had largely disappeared and mimesis been abandoned in a search for a new relationship with representation.

⁶ In reality many of the so-called Aristotelian concepts - including linear sequential ordering, unity of time, place, action, mimesis, catharsis - are complex terms. While these concepts have amounted to an embedded form of ‘pattern recognition’ upon which the official (western) canon has been predicated, in reality they have continued to be re-interpreted by thinkers across the ages, as well as being debated by Aristotle’s own contemporaries (such as Plato). For an historical perspective on the evolution of the dramaturgical model originated by Aristotle, see Turner & Behrndt [2008], Chapter 1.

⁷ Flusser & Strohl [2004, p. 21].

For me, the disruption of linear and sequential narrative action was underpinned by a rejection of psychological immersion (mimesis); it seemed to me as if the new physicality and incorporation of real time/real space was striking at the core of classic dramaturgy, was demanding a new configuration and relationship of the spectator/reader's 'self' to those unities of time, place and action.

In actual fact, my practice was probably more comfortably situated in what came to be called the Live Art Movement.⁸ This movement followed a lineage of avant-garde artists, dramatists and performers already contesting Aristotle's premise of re-presentation, the illusion of narrative coherence and psychological identification.⁹

Bertold Brecht, for example, strove to rupture all form of identification and empathy. His 'dialectical theatre' operated as a deliberate artistic and political strategy to force the spectator into a more critical engagement with the work. He rejected the idea of art as mimicry, and his technique of 'alienation' involved interrupting the unity and linear progression of the dramatic action with direct address to the audience. Hence he fundamentally suspended the process of absorption, forcing the spectator/ readers to confront themselves in real time with the ideas being portrayed and, in so doing, distanced them from any emotional identification with the character. [Brecht & Willet, 1964; Styan, 1981]

Brazilian dramatist Augusto Boal, founder of Theatre of the Oppressed, went further in his disruption of representation and narrative by allowing the audience/reader to interject and become a protagonist of the action. Boal's model of Forum Theatre (or Legislative Theatre as it was known in his later years) advocated for a radical exchange between spectator and performer. It invited the audience to intercede in the action by literally stepping into the scene being re-presented and to enact alternate outcomes or solutions to the conflicts presented. In this way the reader/spectator was not only transformed into an active agent of the unfolding drama, but also had the agency to change the outcome. [Boal 2000]

⁸ Live Art is a term coined in Britain in the 1980's to encapsulate live and ephemeral art works ensuing from visual art, experimental theatre, dance, performance art, installation, digital art and hybrids thereof. It is described as follows: "Live Art is a framing device for a catalogue of approaches to the possibilities of liveness by artists who chose to work across, in between, and at the edges of more traditional artistic forms. [...] For many artists Live Art is a generative force: to destroy pretence, to create sensory immersion, to shock, to break apart traditions of representation, to open different kinds of engagement with meaning." Viewed 19 March 2012, <http://www.thisisliveart.co.uk/about_us/what_is_live_art.html> Examples of artists experimenting at this coalface include Blast Theory (UK), The Builder's Association (USA), Sydney Front (AUS) and the PVI Collective (AUS).

⁹ Goldberg [1988] traces the origins of live interventions back to ancient forms of ritual and spectacle. The main thrust of the contemporary LIVE and PERFORMANCE ART movements however, gained impetus from the artistic manifestos of movements such as the Dadaists, Surrealists and Futurists; early examples of radical dramatists include Antoine Artaud and Vsevolod Meyerhold.

The type of audience engagement and agency heralded by Boal really came to the fore in the new practices of digital media narratives and video games.¹⁰ Not surprisingly therefore, the search for a solution to my dramaturgical dilemmas led inevitably to the 'narrative and interactivity', or 'story versus game' debate that had begun to rage in that arena. This dispute between traditional narrative scholars - the narratologists - and the new theoreticians of the digital game worlds - the ludologists - came to represent an epicentre for the polemic about narrative's changing form.¹¹ It was a forum where Aristotle was being fiercely debated.¹²

The zealous dispute hinged on arguments over linear storytelling versus nonlinear storytelling, and was fuelled by the new interactive nature of the digital game space. At a fundamental level this was a discussion about the difference between doing (playing a game) and telling (conventional storytelling). The former required direct participation, and had to be 'experienced' whereas the latter relied on a recounting of events and retrospection. Ludologist Jesper Juul asserted that game and story were incompatible:

*"[...] there is an inherent conflict between the now of the interaction and the past or priori of the narrative [...] you can't have narration and interactivity at the same time"*¹³

Colleagues working and training with digital industry games professionals, such as Dr John Buchanan, Director of the Carnegie Mellon Entertainment Technology Centre Australia, also underscored this distinction regularly to me: "story is what happens after you have played the game."¹⁴ Underpinning these arguments was of course the shifting relationship with the spectator brought about through interactivity. All of this continued to confirm for me that the crisis around dramatic narrative was also a crisis that implicated the spectator/reader's role and their sense of presence within the changing narrative structure.

In the seminal *Narrative as Virtual Reality* [2001], Marie-Laurie Ryan, scholar of narrative theory and electronic text, began her analysis of electronically mediated narratives by examining hypertext. This rather humble innovation, brought about by a

¹⁰ Both Brecht and Boal's dramaturgical strategies appear to have pre-empted the new type of presence found across new digital narratives, and games theorists frequently cite them. Gonzalo Frasca for example, has even proposed a modified version of the infamous video game, *The Sims*, based on Boal's dramaturgy, which he has called, "The Sims of the Oppressed". [Frasca 2004, pp. 85 - 93]

¹¹ Frasca [2003, p. 222], defines Ludology as 'a discipline that studies games in general and video games in particular'. Frasca subsequently argued that ludology provided a new paradigm and that narrative theory was no longer appropriate to cope with the forms and formats of new media. www.ludology.org, video game theory, viewed 23 March 2008.

¹² The key issues and perspectives of this extensive debate are documented in the formidable anthology by Wardrip-Fruin, N & Harrigan, P. (eds) [2004], in *First Person: New Media as Story, Performance and Game*, MIT Press, Cambridge, MA. USA. See also Kallay [2010] and Matteas [2004].

¹³ Juul [2001], viewed 17 April 2011, <[http:// www.gamestudies.org/0101/](http://www.gamestudies.org/0101/)>.

¹⁴ Between 2008 & 2009, I acted as lecturer working with cross disciplinary teams being trained in building virtual worlds at the Carnegie Mellon University Entertainment Technology Centre, Adelaide Campus, South Australia. This is one of many personal conversations.

word processing program was, in essence, the beginning of interactivity in text. Suddenly there was choice - you didn't have to proceed in a linear and sequential order through a text, instead you could mechanically navigate multiple pathways and branching networks of story line through hypertext. The net result of what is today a simple computer program, was that the circumvention of linear story time no longer relied solely on devices such as plot or metaphor: it could unexpectedly be disrupted by the direct physical intervention and discretion of the reader in ways that had not previously been considered.¹⁵

Agency, or the inclusion of choice and interactivity¹⁶, as it became commonly referred to, had a profound impact. Choice was at once a subjective phenomenon allowing the reader to follow individual preferences, and at the same time a property of deep political ramifications that invited the reader to become a co-producer and participant in the mode of production. As early as 2001, Celia Pearce recognised this as a new development. She coined the term 'emergent authorship'. As a result of this new partnership, she described new hybrid narrative/game forms as nothing less than revolutionary:¹⁷

"They are revolutionary because they not only represent the emergence of new forms that are unique to the computer medium (although, as we will see, they both have their roots in non-computer forms), they also reframe the producer/consumer relationship. Both genres challenge fundamental notions of authorship and create a new consumer-producer hybrid, inviting the player to become a co-author in the narrative [...] I believe that these forms will challenge the narrative hegemony, and fundamentally change the way we both experience and create narrative content."

[Pearce 2001, p. 1]

For me then, this inclusion of the reader as part author - co-creator so to speak - of a unique narrative pathway shaped by his/her choices represented a profound shift and signals the beginning of a new relationship between the reflective experience of story and the primary experience of interaction.¹⁸ The two modes of game and story encapsulated two ways of processing information and lived experience: a primary, automatic unconscious route – associated for example with real time narrative game

¹⁵ 'Choice' of course is the 'illusion of choice' from the reader perspective. It goes without saying that with any creative narrative, one needs to distinguish between the conscious structuring, framework or 'code' set up by the author, and the reader's navigation and experience of that structure or code.

¹⁶ Some scholars argue that choice has always been present. Even when reading a book, one has the choice to casually skim in a non-linear fashion across the pages of the text. I concur with Aarseth [1997], that current usage of the term interactive requires that there is a deliberate and active mechanism – in other words, an intentional, embodied action operating in the execution of such a choice. Candy & Edmonds [2002], outline the history of interaction in art and technology from the 1960's and identify diverse forms of participation from the static to dynamic.

¹⁷ In 2009 at the Digital Media International Think Tank - XMEDIA LAB, Susan Bonds, CEO of 42 Entertainment, described the same phenomenon in the following terms: "the boundaries of entertainment have exploded- or been erased, because the audience is no longer content to simply stay on the side lines [...] by blending story telling with gameplay, we can create immersive entertainment." Viewed 2 December 2009, <<http://www.screenhub.com.au/news/shownewsarticle.php?newsID=30478>>

¹⁸ The etymological origin of the term story has its roots in the Latin *historia* indicating that it reflects back on experience. It suggests that story is human experience re-told.

play – and a secondary, reflective conscious processing route activated through storytelling.

Marie-Laurie Ryan [2001,p.13], believed that the new forms of media were searching for “a new synthesis of immersion and interactivity in the participation of the whole of the individual in the artistic experience”. Ryan proposed a break down of different types of immersion – spatial, temporal and emotional – by distinguishing them from notions of interactivity. She argued that what we are dealing with now is in fact a new combination of presence, immersion and interactivity. Janet Murray [1997] suggested that games and digital worlds were evolving a new poetic. In describing the digital environment as procedural, participatory, and spatial, Murray added the properties of immersion, agency and transformation to the classic Aristotelian poetics. Immersion and interactivity were in fact two notions that often blurred in the narrative/ludology polemic. Thus, both from my practical experience and a theoretical perspective, it appeared as if the reader/spectator was moving from being a passive witness, to having choice and agency as an active co-creator and, in the process, a different type of immersive presence appeared to be being forged.

But while these readings of the story versus game debate added insight to the challenges I was facing with dramatic narrative, it somehow felt as if they were ignoring deeper realities about human perception and the ways we make meaning. It was then that I came across an article published by Murray almost a decade after her seminal *Hamlet on the Holodeck*, entitled, ‘Toward a Cultural Theory of Gaming, Digital Culture and the co-evolution of Media, Mind and Culture’¹⁹. The article drew on cultural anthropologist Michael Tomasello’s theories of the cultural origins of human cognition to argue that the shifts being witnessed in the new digital genres were in fact indicators of a cultural evolution in human consciousness.²⁰ If narrative were our core mechanism for cognition, comprehension and meaning making, [Simmons 2007] then it would follow that any shifts in narrative construction might also be connected to how we cognized and make meaning.

Murray’s article was seminal because it triggered a whole new perspective for me. What if the fundamental issue we were facing were not so much about ‘story versus game’ but about how we processed information to construct meaning in time? In what ways might a deeper understanding of meaning making, information processing, and the workings of the brain’s neural processes, enhance our comprehension of contemporary narrative experiences? If the game and story were based on two different ways of processing information, how then did they relate to each other? And even more importantly for my practice, if I were able to understand these processes better, would it then be possible to find an alternate way of framing the debate to

¹⁹ Murray [2006].

²⁰ Tomasello [2000].

consider a different dramaturgical model?

These questions led me to a broad interdisciplinary interrogation. In considering how to set up my ensuing creative experiment, I drew on readings in neuroscience (Damasio, Libet, Varela), philosophy and cognitive science (Clark, Dennet, Gallagher, Chalmers, Massumi), psychology (Klein, Bruner), presence research (IJsselsteijn), sense making (Wieck), ludology (Frasca, Juul), narratology (Ryan, Simmons), media, narrative and literary theorists (Jenkins, Bolter, Manovich, Ricouer, Chatmore) as well as creative industry forums such as the international think-tank, XMedia LAB.

By concentrating specifically on the neuroscientific aspect, I found the work of three neurobiologists, Antonio Damasio, Francisco Varela and Benjamin Libet, particularly influential. The ideas and propositions put forward by these neurobiologists, whilst still regarded as experimental, have continued to gain traction since first introduced. They have opened up new perspectives on how the brain processes meaning and have provided the foundation for my analysis.

In essence, my doctorate examines how the new narratives and emerging cultural forms (such as digital games), resonate with many of the processing mechanisms identified by these neuroscientists. Given the importance of their theories, I have included a background paper on these neuroscientific understandings as part of the addendum to this thesis. For the purposes of this introduction however, the key thrust of their arguments can be summarized as follows:

For Damasio meaning starts as a biological process - not with the mind. Damasio's research dissects what happens in the body at the biological and cellular level, to trace how our biochemical responses translate through the body to a state of mind. He deconstructs our emotions to hypothesize how mental responses emerge from sensations which all start as automatic biochemical reactions.

Francisco Varela, as co-creator together with Humberto Maturana, addresses the concept of autopoiesis. His autopoietic theory encapsulates a kind of 'biology of cognition', which he articulates in *The Embodied Mind* [1991]. Varela describes a total enactive approach, arguing that the human organism and the brain is a self-organizing system, where meaning is derived through enactment and embodiment.

Benjamin Libet introduces the dimension of time onto these cellular processes. He identifies a 0.5 second delay between the instantaneous, automatic physical timing of a neural response and the secondary mental timing of 'conscious' response and thus challenges our notions of the present.

The neurobiological positions put forward by these scientists provide firstly, the basis for what I would describe as my neuro-biological approach to narrative cognition (Damasio/ Varela); and secondly, they call into question our conventional understanding of time as a linear ordering of past, present and future (Libet).

From a neuroscientific perspective, cognition and meaning making start as a bottom up process: with our biology and our senses. But the question of when and how the brain processes information - across its matrix of chemical and electrical impulses and firing synapses – is, at its most basic level, a question of time. The difference between our instantaneous and reflective mechanisms is therefore one of timing. Narrative too is ultimately a way of ordering and structuring our human experiences in time; it is essentially a form of time-based cognition. It constructs meaning by describing experience and also by ordering this experience across time:

"[...] narrative is the principal way in which our species organises its understanding of time - we see the world not just in space but in time – narrative gives a shape to time."

[Abbott 2002, p. 11]

Philosopher Paul Ricoeur describes that narrative is a way of encapsulating eternal time and making it human. It is through narrative that we understand ourselves as subjects in time:

"...time becomes human to the extent that it is articulated through a narrative mode, and narrative attains its full meaning when it becomes a condition of temporal existence."

[Ricoeur 1985, p. 52]

And it does so in a sequential fashion:

"Regardless of the medium in which it appears, it is clear that the fundamental dimension of narrative is time, or, more precisely, successivity, that is, time seen as the compass in which successive events occur."

[Chatman 1975, p. 313]

Chatman additionally explains how narrative breaks down into content (story), and modes of expression (discourse). The discourse, or the how, may manifest in many forms or modes - cinematic, verbal, visual - but the content, or the what, requires the specific organisation of the elements, according to the 'unities' of time, place and action:

"This kind of distinction has of course been recognized since the Poetics. For Aristotle, the imitation of actions in the real world, praxis, was seen as forming an argument, logos, from which were selected (and possibly rearranged) the units that formed the plot."

[ibid, p. 295]

Temporality, and the ordering of experience and events in time, therefore provides the foundation of narrative. It is also the key building block integral to any dramaturgy. Given the temporal shifts observed to date – in terms of implicating the reader's embodied and real time enacted presence – it would follow that such changes might percuss across that classic Aristotelian configuration of time. A different mind-body experience of time was apparently being encountered in these new forms. Might this new sense of presence and time be reflecting our processing systems in ways previously not considered in dramaturgy?

As I began to refine my research trajectory and the questions that would guide it, I started to speculate on how this integration of the reader's neurophysiological presence into the narrative loop and DNA of story telling might be resulting in a fundamental shift in the experience of presence and representation of time. Digital technology was engaging both our perceptual system and our body in new ways, imposing a direct physical intervention in the real time of 'now'.

Could this provide the basis of an alternate dramaturgy and narrative aesthetic?²¹
Could I conduct an experiment to investigate this assumption?

My creative practice had brought me to a place where I felt the need to reach inside narrative. Through my explorations I found that while our creative narratives are conventionally constructed according to (Aristotelian) linear, top-down hierarchical ways of ordering information in time, this does not at all correlate with how we make sense of and process information from a scientific and neurobiological perspective.²²

Rather than a linear, hierarchical, top down processing machine, the picture of the processing brain painted by current neuroscience is one of a complex, dynamic emergent system: networks of synapses and feedback loops firing at different intervals.

The ensuing creative interrogation is underpinned therefore by two key questions:

- i. How are emerging narratives renegotiating our traditional Aristotelian senses of time and presence?
- ii. Can we enhance our understanding of contemporary narrative experiences by considering a model that is informed by neural processes?

Implicit in these questions is the speculation that the new digital tools of production are allowing us to align and model narrative more and more according to the brain's processing systems.

To investigate these questions I set up a creative experiment using live simulation as a

²¹ Whilst the term dramaturgy originates in the Greek, '*dramaturgia*', referring to the composition of a play, I will also use it more generically to refer to the underlying ordering and compositional principles of creative narratives in general.

²² When discussing the literary construction of time and supposed linearity of story with neuroscientist, Prof. Marcello Costa, he commented: "The linearity of this is the result of a simple model of the real world in which events appear to occur in given sequences. The modelling of the past and future (which is mental activity) needs not to be constrained by this model. Indeed very few people think (mentalize) in such temporarily linear fashion. This model has become important simply because it enabled humans to construct a shared model of events in time. This model does not bind imagination. Thus different mental experiences can be shared outside serial sequential events. The new digital media enable this process to occur much more easily than ever before." [Personal email correspondence with Prof Marcelo Costa, 10/03/09]

representation of the new forms, and analyse the micro-narratives²³ to emerge from that experiment from a neuroscientific perspective.

My belief and my speculation is that, aided by advances in digital technology, contemporary narrative forms are starting to encapsulate a new type of 'performed narrative' that requires the co-author/reader to navigate time differently.

I hypothesize that there is a new dramaturgical aesthetic unfolding across contemporary and emerging narratives that is more aligned with our neurobiological temporal dynamics and sense making processes.²⁴

²³ The use of the term 'micro-narrative' will be further elaborated during the course of this enquiry.

²⁴ For clarity, I will continue to use the terms 'new' and 'emerging' across this thesis to distinguish contemporary forms that sit outside of the Aristotelian paradigm.

Introduction to Simulation

Why Simulation?

In order to test this proposal of a new dramaturgical aesthetic unfolding across contemporary narrative experiences, I have chosen to set up an experiment consisting of the live simulation of a medical emergency and the extraction of four micro-narratives from that experience. These micro-narratives are then analysed and discussed as neurobiological sense making and information processing, revealing the underpinnings of an alternate – neurobiological – temporal dynamic.

Possibly no one is more surprised than I to have found myself developing an emergency medical simulation scenario as part of this creative enquiry. This choice of live simulation however emerged as a logical extension of my creative practice, developing industry trends, and the broader theoretical considerations posed across my investigation.

The disquiet that I had experienced in the domain of live art was challenged further during my time at Carnegie Mellon Entertainment Technology Centre (ETC) where I lectured in improvisation and visual story telling. It was while working with interdisciplinary teams in the building of virtual worlds that the dilemma and polemic around story telling became a practical reality for me. It was where I first sensed the emergence of a new type of immersion and presence.²⁵ That realisation, coupled with the ETC's innovative exploration of virtual and interactive worlds in contexts that reached beyond mere computer gaming, heightened my awareness of the growing spread of these new forms across a wide variety of domains from arts and entertainment, to education.

It was increasingly apparent that as the new technologies evolved to become platforms and 'worlds' in and of themselves, the challenges to dramatic composition and audience engagement were growing - at times even questioning reality itself. [Christiane 2003, p. 36; Dixon 2007]. Live and virtual simulation²⁶, transmedia, locative narrative, alternate reality and augmented reality games were emerging narrative experiences where real and artificial/fictitious worlds met.²⁷ Through the ETC I became particularly interested in this body of extended and augmented narrative experiences

²⁵ The explicit mission of the ETC was to "foster leadership in education and research that combines technology and fine arts to create new processes, tools and vision for storytelling and entertainment." Carnegie Mellon University WEBSITE, viewed 3 May 2012, <<http://www.etc.cmu.edu/site/>> Building Virtual worlds was ETC's flagship course wherein students worked in interdisciplinary teams to develop interactive worlds every two weeks.

²⁶ Live simulation places participants in a real environment but adds a virtual or synthetic layer to that reality.

²⁷ The rise of this phenomenon was forecast in the conclusion to Michael Rush's exposé of New Media in late 20th Century Art: "Perhaps the merging of 'the real' and 'the virtual' in art, as well as in life, will be in the future what the merging of 'art' and the 'everyday' has been in the twentieth century." [Rush 1999, p. 217]

loosely defined by Montola [2009], under the genre of pervasive games.²⁸

In these forms the narrative experience often spills over into 'real' physical spaces, and 'real' time, forcing us, as the reader and spectator, to walk an increasingly fine line between fiction and reality, mediating and negotiating between an indirect imagined artificial (virtual) world and a direct and tangible presence in the physical world.²⁹ By seeking to integrate real life and artificial or virtual activities, they expand the linear boundaries of the conventional storytelling and narrative space - potentially reconfiguring the experience of narrative itself:

"Pervasive games extend narrative gaming experiences into the real world – be it onto city streets, remote wildernesses or living rooms. In pervasive games, players with mobile computing devices move through the world. Sensors capture information about the players' current context – including their location – and are thereby able to deliver experiences that change according to where the players are, what they are doing and even how they are feeling. The players become unchained from their consoles and experience a game that is interwoven with the everyday world [...]"

[Benford et al, 2007, pp. 248 – 250]

For me, a live medical simulation offered an extreme example of these new enacted "half real" genres extending across real, artificial and virtual worlds - a compelling example of mixed reality, involving real time interventions and interactions. Live simulation required a direct involvement that went beyond the intimation and representation of reality.

In this respect the ensuing narrative experiment resonates with Augusto Boal and with recent trends such as performed documentary and verbatim theatre:³⁰ it offers a moment-by-moment account of a 'real' (live simulated) event and cuts across interview, documentary reconstruction, re-enactment and diarist (journal) entries. But more importantly even for my purposes, for this simulation narrative to exist at all, it had to be first enacted or performed, it could not be just recounted. The reader/narrator needed to inhabit the story world and navigate the scenario with their body in real time/space.

This was my attraction to live simulation and the inherent paradox of emerging narrative experiences.

²⁸ According to Montola et al [2009, p. 11] the genre loosely incorporates a broad range of games and transmedia narrative including locative narrative, role-playing games, urban adventures, treasure hunts, mobile games, geo-caching, and location-based games. Two large-scale examples of this genre include *Majestic* and *Animal Crossing*. As an online conspiracy thriller, *Majestic* [EA ARTS 2001], incorporated real time webcasts, faxes, emails and phone calls as part of the embedded narrative. Publicity for *Majestic* included the tag line, 'you don't just play this game, you live it'. [PCWORLD, 2001], whereas *Animal Crossing*, a multiplayer 'life simulation video game', released by Nintendo [2001-2013], synched the narrative and game play to real transitions of day and night, as well as events synched in real time to actual calendar holidays and real time community interactions.

²⁹ This blending of "two realities" is described by Ludologist Jesper Juul's *Half Real* [2005], wherein he reframes the games versus story debate by arguing that we are now dealing with a new genre that is in fact half fiction (story) and half real (the real time interaction).

³⁰ See Boal [2000], Anderson & Wilkinson [2007] and Hammond & Steward [2008].

While operating ostensibly within a broad narrative construct, the actual story sits within the individual, who experiences and ultimately recounts it in his or her own way. In selecting simulation, I have been particularly influenced by Morie's description of narrative in immersive environments as a living text,³¹ and by Rovner's [2009, pp. 97 – 115] thesis that new dramatic game narrative must be 'enacted.' Morie describes the experience of an immersive environment as a primary, pre-reflective sensori experience, and proposes that narrative in such an environment operates as a form of living text, simultaneously written and read.

Rovner continues to affirm the contemporary shifts towards more dramatic (action) narrative, which he describes as a 'call to action or performative presence'. My view is that his thesis starts to pry open the nexus between classic representation and the self. Rovner argues that the raw material of story (fabula) - the chronological events that formed the basis of a story – does not exist prior to plot (sjuzet),³² that instead they have to be accessed and assembled by the individual reader/player for the story to be told.

"Video games narratives must be first assembled before they can be interpreted – or they must be assembled in parallel to their interpretation. Games narratives in other words must be rendered present before they can represent, and thereby engender interpretation. Narrative video games thus starkly expose a fundamental paradox that haunts narrative theory."

[Rovner 2009, pp. 98 & 111]

For Plato, art imitated nature (mimesis) and was dangerous because of this, whereas for Aristotle, art was mimesis re- presented: that is, deliberately structured and re-organised along unifying principles to arouse emotion and provoke catharsis. Rovner challenges the very premise of Aristotle's mimesis:

"Video games have as their primary aesthetic mode not imitation or representation – mimesis – but participation and configuration – methexis. The term methexis is found in Plato (Parmenides 132d) where he distinguishes it as participation, and the idea is later taken up by play theorist, John Huizinga (1955;15) and performance theory. Methectic arts include oral storytelling and ritual performance in which both epic and drama respectively originate."

[ibid, p. 109]

The suggestion that emergent narrative must be rendered present before it can be re-presented, and that this presence can only be accessed through direct participation provides the foundation of my experiment. Live simulation is methexis par excellence: despite all the elements of the medical scenario being pre-determined, the story cannot be told without the active participation of the clinician-narrators. It is no longer a representational form of narrative and because of this, it also affords a different

³¹ "I assert that the experience of the immersive virtual environment, being a primary experience, is that direct and primitive contact [...] the immersive experience can be thought of as a form of living text that is both written and read at the same time." [Morie 2007, p. 154]

³² Rather than adopting the Chatman [1978] distinction between story and plot, Rovner references the original Russian Formalist terms of *fabula* and *sjuzet*.

experience and construction of time. This view aligns with the ludologists, particularly Frasca, who rejected all notions of games as an imitation of reality. Instead, for Frasca, the new narratives were simulations, an incorporation of a set of events and behavioural rules to be enacted through a different sense of time [Frasca 2003, p. 227]. The structuring of time was pivotal; the impact on the conventional representation of time also highlighted by another games theorist, Eskelin:

"In games, the dominant temporal relation is one between user time and event time, and not the conventional narrative one between story time and discourse time." [Eskelin 2004, p. 37]

Like the emerging games genres described by the ludologists, live simulation, engages our perceptual system and body in new ways and requires a direct physical intervention in the real time of 'now'. This allows us to explore my earlier suggestion that the new presence and 'way of being' in narrative sits between the reflexive time of representational story and the alternate space of embodied and enacted real-time interaction: a space where, possibly, story time and discourse time, human mind time and biological time, collide.

Why an emergency scenario?

The specific choice of an emergency scenario also relates to my questions about how contemporary narrative experiences and constructions might in fact resonate with aspects of our brain's information processing function. When used to replicate extreme conditions and crisis situations that require critical performance and decision making in real time, live simulation can bring into focus the challenges and issues in human cognition and information processing.

This was a realisation that continually came back to me during my investigation of industry uses of simulation technology. Many presentations at the 2009 National Simulation Conference, for example, concerned themselves with human factors and how simulation technologies might map "bottom-up" instantaneous, sensori-motor responses with higher-level "top-down" reflective functions.³³ The search for information fusion – as the ability to fuse or aggregate conscious and unconscious processing - remained at the forefront of discussion during many forums and hence the interest in the role of narrative as a fundamental cognitive tool in the sense making process.

Insights gained through conversations with the membership of Simulation Australia were further accentuated in an ensuing workshop with Dr. Braden McGrath, (then) Simulation and Business Analyst with QinetiQ.³⁴ Dr. McGrath was a Board member of

³³ SIMTECT 2009: Simulation, Concepts, Capability and Technology Conference, 15 - 19 June Adelaide. SIMTECT is auspiced by Simulation Australia, a national body whose aim is to further advance the research, development and use of simulation technologies and practices in Australian Society.

³⁴ QinetiQ is a global British Defence and Security Company affiliated with the British Ministry of Defence. It opened its first Australian offices in Adelaide in 2008.

Simulation Australia when I first contacted the organisation. This introduction led to workshops on narrative and cognition at the QinetiQ offices in 2009, with Dr McGrath, neuroscientist Professor Ian Gibbins, and writer, media artist and Professor of Contemporary Art, Ross Gibson. Those conversations cemented for me firstly, the correlation between narrative and how we process information to construct meaning in time, and secondly, how this was being highlighted in simulation training environments through the use of digital technologies and mixed reality environments. The experience was instrumental in my choices for the ensuing creative experiment.

The said workshops were supplemented by my readings of Gary Klein, most noted for pioneering the field of naturalistic decision-making (NDM) and the recognition primed decision model (RDM). Klein's techniques were being used extensively in defence and emergency simulation training to deconstruct human thought processes and intuitive responses in critical decision-making. Klein's objective was to focus on what people do and feel, rather than what they think and remember, as a means of tracing more subliminal 'sense making'. The emergency context brought this to a head. Klein's work reinforced the link between emergency and emergent narrative.

I therefore came to believe that by tracking information processing and meaning making through a simulated real time emergency narrative, I would be able to further illuminate my proposal about narrative cognition, the workings of the brain and prospective new dramaturgies.

Emergency contexts require individuals to make decisions in a complex, ambiguous environment. By processing multiple layers of technology-mediated information in a time-pressured context, participants must also remain alert to the shifting dynamics of a constantly evolving situation and be 'present' at all times. An emergency medical scenario encapsulates a situation where time is of the utmost importance, and the real time choices and transitions in information processing between conscious and un/subconscious attention are critical to narrative sense making. It offers a context to consider how our primary automatic processing system - aligned with game interactivity and emergent narrative - and our secondary reflective process system - aligned with traditional story making - interrelate.

All of these then were the considerations that led me to the set-up and real-time enactment of a medical emergency scenario in collaboration with experienced clinicians from the Department of Anaesthesia at the Simulation Laboratory of the Royal Adelaide Hospital, South Australia. The live simulation is offered as an exploration potentially of a new paradigm - of how the elements of time, embodiment and enactment, complexity and subjectivity work together in a form of emergent sense making and narrative.

As Frasca says, simulation potentially represents an entirely new narrative literacy:

"[...] It will probably take several generations for us to fully understand the cultural potential of simulation, but it is currently encouraged from different fields, such as the constructionist school of education and Boalian drama. One of the most interesting cognitive consequences of simulation is its encouragement for decentralized thinking, which may in the long-term contest Mark Turner's claim of a 'literary mind' by introducing the possibility of an alternative 'simulational' way of thinking." [Frasca 2003, pp. 223 – 224]

Micro-Narrative as Research

For the purposes of this practice-led research, the micro-narrative transcripts to emerge from the enacted simulation represent the fulcrum of my enquiry - where the creative and theoretical intersect. As previously noted, by drawing on the traditions of verbatim theatre, the micro narratives are (creative) reconstructions of actual interviews conducted immediately after the simulation event.

Janet Gibson [2011], points out that the narrative of verbatim theatre places interviews with people and the reporting of facts, rather than the writer's imagination, at the heart of its process. However, the objective with my interviews was not so much to gather the facts but to trace the individual's subjective sense making process and emergent narrative across the crisis scenario. The search for a method to capture the immediacy of the lived experience presented a challenge. Some background on my methodology is therefore warranted.

Although new generation technology and scientific visualisation tools may be enabling scientists to look inside the brain in real time and 'see' brain neural processes as they happen,³⁵ the quest to track the transformation of preverbal sensations and unconscious processes (or wordless forms of cognition) into conscious information (verbalised through narrative), presented me with many difficulties. One of the contradictions embedded in my experiment was that while attempting to capture experience as it was felt, in as pristine a form as possible, the experience itself was inevitably and constantly being re-constructed by the very language and narrative used to describe it.

I must acknowledge therefore that there were unavoidable constraints in attempting to access and extract pre-reflective experience through narrative, and that, of necessity, the information extracted was inevitably accessed by some form of 'remembered' or reflective self. Thus in developing a methodology for the interviews I followed distinct protocols to minimise this reflective, top-down process as much as possible. As a consequence, I utilised a hybrid of techniques developed by Klein during his work with emergency workers, and neurophenomenological protocols utilized by neuroscientist, Francisco Varela. What had become clear from my readings in

³⁵ Consider the advances in the visualisation of medical data described by Prof. Anders Ynnerman of the Centre for Medical Image Science and Visualisation in Sweden - particularly the ability to generate and integrate data in real time. Ynnerman, [2011], viewed 30 July 2012, <<http://www.youtube.com/watch?v=pqTkuaAyKBw>>

neuroscience was that human information-processing mechanisms were rarely linear and prescriptive; sensation, perception, attention, emotion and instinct are just as significant as the secondary elaborative processing mechanisms of memory, thought, learning and language.

The fieldwork of Gary Klein had also attempted to redress some of this complexity and inherent non-linearity.³⁶ The naturalistic decision making framework (NDM)³⁷ and the rapid decision -making or recognition primed decision model (RDM) evolved essentially as mechanisms to capture the more fluid and intuitive processing patterns of emergency field workers in situations where the stakes were high and the environment constantly changing. To deal with these circumstances, Klein needed to adopt a less linear methodology based on the actual lived experience of the workers. As a result, RDM frameworks make room for the role of intuition and rapid cognition as they track subliminal patterns and cues leading to critical responses.

I have made extensive use of Klein's "multi-pass retrospection" approach. In this method, data is collected via a process of repeated interviews and subjective recall; there are up to four passes over the same event – hence the term multi-pass retrospection.

In the first instance the interviewer asks for a brief version of the event, noting the significant points. Then gradually over the subsequent passes the interviewer obtains more detail and focuses attention on the critical anchor points through the incident, probing the thought processes, judgments and actions around those choice points. As noted, this approach asks what people do (action) and feel (intuition) rather than what they think or remember, as a means of tracing more subliminal and intuitive responses. Significantly, information is elicited through narrative, which according to Klein offers the researcher a better pathway into the interviewee's perspective rather than a formulaic questionnaire. [Klein 1998, pp. 189 – 190]

In addition, I have drawn on phenomenological research methodologies. This broad philosophical movement has spawned a variety of methods to record first person, subjective experience - and it is one that neuroscientists are now looking at with a great deal of interest.³⁸

One such scientist was Francisco Varela. Varela sought to combine biology and cognitive science with phenomenology in a new, more disciplined approach to the exploration of human experience. Varela coined this method 'neurophenomenology':

³⁶ For a comparison between Klein's method and traditional task analysis, see Naikar [2010].

³⁷ Naturalistic Decision Making (NDM) is a framework for the study of how people make decisions in real world settings; it emerged in Ohio in 1989 and was formalised in the publication by Klein, Orasanu & Calderwood [1993], *Decision Making in Action: Models and Methods*, Ablex Publishing, USA.

³⁸ See Moustakas [1994].

On its methodological side, neuro-phenomenology is an experiential neuroscience...it is the name I use here to designate a quest to marry modern cognitive science and a disciplined approach to human experience." [Varela 1996, pp. 330 - 349]

In addition to utilizing emerging medical imaging technologies to map the dynamics and oscillations of neurons within the body-brain processes, Varela, quite un-orthodoxly, turned to phenomenological and mindful practice accounts of experience as a way of tracing and illuminating subjective perception. His experiments attempted to build a bridge between biological reality and mental awareness.

Neuro-phenomenology is grounded on a pragmatic will to progressively and systematically "reduce the distance between subjective and objective [...] a way of narrowing the gap between the mental and the physical." [Rudrauf et al 2003, p. 35] Varela described becoming aware as a process of 'coming to know in the first person'. He had a particular interest – as did the phenomenologist, Husserl - in how phenomena emerged or 'appeared' on the horizon of consciousness only to fold into the potentiality of the next moment. In order to 'bring forth' such moments with the attentional shifts in conscious awareness across time, Varela proposed that cognitive scientists develop the skill of phenomenological description by utilizing the known techniques of the suspension of one's judgment to the world (epoche) and reduction, and combine this with mindful practice.³⁹

The meditation techniques were introduced as complementary tools to facilitate the phenomenological requirement of suspension and letting go; to allow experience and phenomena to present and unfold in the subject's consciousness instead of grappling with analytical processes.⁴⁰ The guided introspective interview method described by Varela and Depraz in *On becoming Aware* [2003], requires the interviewer to foster a meditative 'stance' in order to stabilise and empty the mind of the interviewee, thereby focussing their awareness on the emerging experience and promoting involuntary, spontaneous recall without leading questions. In this way, a particular experience or phenomenon is rendered 'present' through a mental act of spontaneous evocation as opposed to being reimagined.

My process for eliciting the lived narrative and direct experience aggregates the Klein and Depraz/Varela methods. The consultants were taken through a guided interview process utilising the multi- pass retrospection. This entailed them describing their experience of the simulation over three separate passes, each time focussing more deeply on their perceptions, sensations and sense making process. Representing a total break from conventional medical debriefing protocol, the interviews were

³⁹ Sadly, Francisco Varela passed away before he could expand on this experimental research method but his legacy continues in many institutions and laboratories.

⁴⁰ Both modern psychology and cognitive science have been embracing the idea of mindful practice in recent times; Varela and Depraz draw specifically on the mental disciplines of Buddhist and Vedic traditions to induce different states of conscious awareness.

conducted utilising a stance in line with mindful practice. The consultants were taken directly from the simulation exercise into a more relaxed interview room without engaging in any commentary or peer exchanges along the way. They were then given time to settle through mindful practice breathing techniques, and once settled, invited to relive and verbalise what they had just experienced by allowing sensations and perceptions to emerge spontaneously, regardless of chronological order, without forcing any details or analysing what had just happened.

The micro-narratives therefore document actions and events, together with descriptions of sensations, emotions and reflections about those events. The accounts shift across different subjective states from analytical and reflective, to intuitive sensations, feelings and action. My creative reconstruction of those interviews represents a weaving of these threads via a condensation of the three descriptions or passes of the simulation event as told by each consultant. It utilises each participant's words (hence the recall to verbatim theatre), and in the order or sequence as revealed by them. In condensing and distilling the experience into a more poetic form, my aim has been to capture the essence, a snapshot of that moment, in that place, with all of the ensuing sensations and information processing that it entailed for the individual. From this perspective the micro-narratives could be better described as a creative reduction of the thought and decision making process across time.

The dynamic flow of emerging phenomena described above, and the biomechanics of our internal information processing systems, by necessity implicate both chronological and subjective sense time. How each clinician/consultant experienced these time dimensions and loops of awareness during the simulation offers an exposition of the condition of 'presentness' - a quality that I will come to suggest is informing contemporary narrative. It is in the structure of the micro-narrative that the attribute of 'presentness' is revealed.

The Personal Experiential Narrative

The final component of the ensuing creative experiment includes my own experiential micro-narrative and reflection as part of the sense-making process. This was necessary for two reasons.

Firstly, my premise that the new immersive narratives are in fact populated by many individual subjective micro-narratives meant that, I too, was both a narrator and performer (participant) in this story. Secondly, the phenomenological stance underpinning my declared methodology, the subjective experiential perspective of the field study, required that I expose my own process. Moreover, the privilege of an intimate and unique exposition of the subjective decision making processes of highly qualified clinicians, working under extreme conditions, and the candour of our exchanges, compelled me to expose my own subjective frame.

If I were to be transparent and consistent in this collaboration, I needed to acknowledge my own position. To that end I map my own experience and narrative journey across that period and include it as another subjective frame of reference, another knowing, and form of sense making, inextricably woven across this narrative experiment.

The fact that there is no ready-made description or process to capture what is occurring in emergent immersive experiences of multimodal, collaborative, performed narratives, was thus key motivator in the shaping of the following text. While the simulation exercises are offered as an example of a technologized, live interactive performance, the ensuing text is its own rendition and creative condensation of that lived event. As such it cuts across genres: it is at once a creative non-fiction, a documentary, and a documentation text. Consequently I invite the reader to change lenses for a chapter and consider *Emergency in the Sim Ward* as a creative work indicative of the mixed reality or 'half real' experiences muted by Juul [2005]

emergency

in the sim ward

Prelude

Personal Journal Entry

Thursday January 13, 2011

Royal Adelaide Hospital Reception

08.00 hrs.

I push through the revolving door and catch my reflection in the glass: it's been a long time since I have entered a hospital. There is tightness in my chest. I draw a deep breath in anticipation of the day ahead. Today we conduct preparatory tests with a discreet team of clinicians and there is much at stake. It is early morning and the reception area is deserted.

The clock tells me it's too early to head upstairs to the simulation unit.

At least I made good time through the morning traffic.

A nurse's aide wheels a food trolley of patients' breakfasts down the corridor. It provokes a sensation of bitterness. I look beyond the entrance to the street outside and focus on the sunshine. An ambulance worker in front of the emergency signs draws on his cigarette, oblivious to any irony.

At 8.15 I proceed up the escalator towards the simulation laboratory. When I turn the corner I find the door ajar. I think momentarily that maybe I have taken a wrong turn and worry that I might be intruding on a patient. Hearing noises, I approach cautiously, taking care not to disturb anyone.

I walk into the room. The simulation ward looks like any other hospital ward. The 'patient' is positioned in the middle of the room. The simulator mannequin - Mr Sim as I have come to call 'him' - is on an operating table, prepped, as any patient would be for operating procedures. He is covered by green bed linen with only the area on which he is to be operated exposed.

Gone is the football beanie used to add humour in earlier training sessions with novices. Instead, Mr Sim wears a protective scalp cap – standard apparel for any operation - to prevent any heat loss through the scalp. An array of leads and tubes attach him to breathing and other medical apparatus so as to continually monitor his vital signs.

A sheet suspended in front of Mr Sim's face forms a barrier preventing the patient - and any clinicians situated near the head area - from seeing what is being undertaken below, in the torso. This has been described to me as the blood-brain barrier separating the two operating and clinical domains.

Any anaesthetist working behind this barrier needs either to stand and peer over the barrier, or walk around it in order to observe any surgical procedures being undertaken in the torso.

My gaze remains on Mr Sim's exposed abdomen as it rises and falls to the rhythm of the external respiratory machine. Inhale, exhale, inhale and exhale.

I feel myself standing in the middle of the room immobile. I am at once here and in another ward, in another time, listening to the breathing of a friend who has been admitted into the emergency ward. I am paralysed, transfixed by the sound of breath and the strangely synthetic, uncannily human, and equally non-human entity before me on the operating table.



Personal Journal Entry

Thursday February 24, 2011

Royal Adelaide Hospital - Simulation Training Laboratory

14.00 hrs.

The simulation laboratory has undergone yet another level of transformation: there is more supplementary medical equipment, surgical instruments - more of everything. An increasingly circuitous tangle of tubes and pumps, oxygen and plasma envelop Mr Sim. Two security cameras record the scene and feed images back to the control room.

The clinicians gather for today's test, a second session designed to assess the robustness of the clinical scenario. Introductions are made. The mood is strangely calm and casual. It throws me. I look for signs of the impending 'emergency drama' that is about to be staged and cannot find my bearings. The convention of this space is unfamiliar. There is a lack of agitation and anxiety, which contrasts markedly with the performance conventions of the Hollywood and television medical dramas with which I am inculcated.

I am embarrassed and amused by this realisation. Panic is not an option for 'real' clinicians.

The team of experts that has volunteered for this test trial is a skeletal one, 'acting' in the roles of consulting anaesthetist, a registrar, an aesthetic nurse and a surgeon. Those in the role of registrar, aesthetic nurse and surgeon have already been briefed on how to play out their roles. During the intervention the Simulation Director will feed additional instructions to them as he follows the action from a covert control room.

We start. A real life anaesthetist now assumes the role of the consultant clinician and enters the simulated 'operating theatre'. The handover begins. He takes in the environment and information without betraying any visible physical cues to his thinking; just a subtle, yet palpable, suggestion that his mood is withdrawn.

This anaesthetist is very experienced.

I watch his face very closely. There is something about the focus of his eyes - fixed and scanning at the same time. I remember that often during performance rehearsals I would tell actors about the need to remain

focussed on their objective and stay 'open' at the same time. Dancers too use a combination of sharp and soft focus to gauge their bearings on stage.

The anaesthetist scans the equipment. The machines talk - squishing, heaving, pulsing and beeping at different rates, at different pitches. I am struck by the nature of the verbal exchanges in the theatre. Information is revealed it seems anecdotally - communication oblique. It takes a while to understand that under this veneer of apparent casualness there is a tense focus.

Mr Sim's vital signs rapidly deteriorate. The clinicians chase their target as time runs out. The room holds its breath. The line between simulation and reality blurs. A resuscitation protocol is activated. The nurse wheels in the defibrillation machine and when she activates it, the machine talks back. There is a pause as everyone tries to decipher the technology. A beat of frustration, then the connection is solved, life support and vital signs return to normal.

The emergency is averted for the time being.



Personal Journal Entry

Thursday February 24, 2011

Royal Adelaide Hospital – Unit Debriefing Room

15.30 hrs.

The expert clinicians laugh. The failure and the age of the machines is a major talking point during the debriefing. The trial went well. Everyone is satisfied. The narrative and scenario were believable. The 'acting' anaesthetist comments on how he was thrown initially by not being able to hear the breath properly: a more realistic 'wheezing' would have provided a familiar anchor as well as temporal reference points. He did not have the usual anchors. This slight disorientation adds a pressure which everyone then concludes, is good, as it should be.

They discuss the breath, the bronchial tubes, the pulse rates, heart rate monitor pitches and frequency, the smell of cement dust, the sound of blood, the feel of the patient, sweat, cold/hot, pulse rate; a dense mix of technical, procedural yet strangely visceral responses. The expert clinicians talk about how training has changed, how there is little touch or feel today - the machines analyse but the machines can fail. There is a loss of the tactile wisdom.

They describe touch, how you hold the breath bag, how you 'feel and squeeze' it to let air into the lungs: how the action of that touch links you straight into the lungs, the physiology of another. The expert looks for signs, the chest rising, the sweat on the brow. The expert talks about picking up minimal cues - how sometimes you can tell already from the minute you see a patient in the ward whether they will be an easy case or difficult one to deal with - you can feel the physiology, the body, the environment.

I ask how they have accumulated this knowledge and understanding. They shrug their shoulders and then confide, "You spend half your time training about when to do something and the rest of the time learning about what not to do ..."

Personal Journal Entry

Thursday March 24, 2011

Royal Adelaide Hospital - Simulation Laboratory

09.00 hrs.

The Simulation Director and I go into the unit to check the audio-visual equipment in the lab's control room. We find a twisted web of wires, connections, and things left behind because there is never enough time. The video camera is not recording to DVD. We need to fix it before the next run.

In between we chat, relaxed, circuitously checking whether our mutual expectations align. What do we want to get out of this exercise? The researcher/artist and the anaesthetist - we mask our uncertainties well. This collaboration is unknown territory for both of us.

I ask about the training and the role of simulation. I am careful to keep the questions practical, to not reveal the more ephemeral nature of the creative endeavour, in the hope that this provides reassurance. "We struggle with the technology.... the machines..." he acknowledges, "the machines are never infallible, they do get it wrong ... they do fail."

The Simulation Director asks how I want to do the recordings. I ask him to momentarily 'play act' anaesthetist in order to set the camera angles and views. It is starting to feel like a partnership. "I think the good thing is that you are not coming from the clinical side; we don't do much on the human factors," he comments.

This time I think it is he who reaches out to me. We talk again about the role of simulation training. I ask about how he acquired his own knowledge: "You can go through your medical training without ever facing certain scenarios – so how do you train for that?"

And then he confides, "I have only experienced an acute emergency once."



First Enactment

Personal Journal Entry

Monday April 11, 2011

Royal Adelaide Hospital - Simulation Laboratory

08.30 hrs.

The real simulation starts at ten. It is eight thirty and the laboratory ward is already open, possibly the Director checking things. The door is ajar, the lab is empty but for the hum of the fluorescent lights and Mr Sim's breathing. It hangs in the air suspended by the cold light of the ward.

There is now a precise order to the wires and connections that sprout from the monitors and medical trolleys. I discreetly set up a tripod and camera for the close-up – a single static shot so as not to disrupt the semblance of a real ward. I check for the camera angle and the height. My rubber soles squish against the recently disinfected linoleum, causing me to tread lightly so as not to disturb the disposition of things.

I put the microphone for the interviews on the table in the debriefing room next to the lab and make sure that everything is working. The menu on the sound recorder is circuitous and unfamiliar. It adds anxiety. I run through it again ... have I missed anything?

I reach for my notes and questions, put them next to the recorder and then stand back. Everything feels too precise, too deliberate. How can I create a more intimate feel? I move the notes to make things look less intentional but there is no hiding the formality. The hard surfaces and controlled lines of the ward clearly defy my challenge to capture the unpredictability and pristine intimacy of raw experience.



Emergency Procedure Performed by Consultant A

Monday April 11, 2011

Royal Adelaide Hospital - Simulation Training Laboratory

10.00 hrs.

I walk in,
see the registrar, whom I know,
speak to him: "How's it goin' ?"
An abdominal procedure is in progress.
A young trauma patient is on the operating table – bleeding.

Gosh ...the patient is a young chap.

Get a hand over:
car crash.
Twenty seven year old passenger,
right wrist injury, peripheral,
Abdominal injuries.
No allergies.
No head injury.

In my gut I feel something bad is going to happen.

Nurse puts up a bag of gelofusine.
Check the drugs with the registrar,
how much fluid has been given?
He leaves to help the other patient.
I take over the anaesthetic,
greet the surgeon.
"Hi, how are you?"
Review the monitors,
things going okay?

Nothing...

Feeling comfortable.
Look at monitor,
look at the drugs,
antibiotics given.
Everything's 'cruisy'.
CO2 trace pattern indicates a level of obstruction,
blood pressure is still not too bad.
Sort of happy with that.
Saturations have gone a bit off.
Not doing anything with the chest?

Happens regularly with trauma.

Can't complete my scan.
Now the stats have gone off,
don't really have a chance to complete my scan.
Have a quick listen.

Bronchospasm?

Take patient off ventilator,
take the patient off the ventilator and hand ventilate.
Listen to chest,
listen to the breath,
listen to ensure equal air entry.
Ask the surgeon "Did you see his chest X-ray?
Any pneumothorax?"

At this stage, the most common thing for saturations to go off in a trauma patient is probably pneumothorax.

Look at the screen, look at the monitor.
I am thinking the stats are going off so it's a respiratory thing.
I am thinking just saturations going off, I can handle that.
Feeling let's have a listen,
see if I can exclude pneumothorax,
no big deal, I know how to manage that.
Need to exclude pneumothorax.
That's all.
Thinking and not thinking,
assess and manage whether there is something I can fix.

Assess and manage is what I do.

Listen.
Pop a pressure bag up.
Do recruitment manoeuvres,
bigger breaths on the bag,
feels alright to bag.
Open up the lungs and get the saturations up.
A bit...
A bit of adrenalin...
Saturations don't do what I would expect.

Is he mucking about with diaphragm and stuff?

Not sure what is going on with the blood pressure.
Is anything going on downstairs?
Nothing surgical we can think of?
Ask the surgeon,
"Can you access the diaphragm?
Did you put him on 100% oxygen as well?
Just asking what you can see."

*Is the surgeon doing something he hasn't told me,
... has he made a hole in the chest?
or pushed the stomach up?*

Trouble shooting.
Back in cruising mode,
sort of happy at the moment.
Note that the blood pressure has sagged a little.
The stats are about 94%.
Ask to put another bag of gel up.
Go round to the other side make sure there isn't any blood loss.
Ask what the surgeon has in terms of blood loss.

*Have to check visually for containers of blood...
People don't often tell you.*

He says everything is fine ... so...
he says everything is fine.... So...
Blood pressure starts to drop,
I am looking at the screen
and the stats start to drop again.
Now the blood pressure is starting to drop off.
Is the CO2 trace really sloping like this or is it because of the machine?
Nurse says it's the machine.
Listen again.
Bronchial spasm?

Lots of different causes for bronchospasm...

Get the suction. Get the ventolin.
Treat with broncho dilator.
Treat and assess.
Do we have blood coming?

*Can't wait to get all the information to start treatment.
Might miss the boat.*

Treat and assess as I go.
Not so worried about the saturations now as I am about the blood pressure,
want to get rid of the bronchial spasm.
Pulse is there,
blood pressure falls further.
This might well be a tension pneumothorax ...

Do I go the path of some adrenalin?
Do I go bio-lateral thorocostomy?
Need to exclude both.

In my experience in a trauma patient,
in my experience,
the most common thing is tension pneumothorax.
I am working on experience,

I am thinking this is where the money is.
The other things are secondary.
Treat all the immediate things I can.

*The pneumothorax I can do something about.
At the back of my mind – anaphylaxis.*

Before I think about other things,
bio-lateral thorocostomy or adrenalin?
I really need to exclude those things.
I need to work it out.
Ask for a few incisions through the diaphragm
...just to make sure.

*Need to prioritize.
Where is the bang for the buck?*

Nothing changes.

Pneumothorax... 'bang for the buck' in trauma patients ...

Talk to the surgeon...
"What can you feel... anything else going on...?"

Nothing changes

Decision time!
Things really get compressed.
Grab some adrenaline,
give little bowls of adrenaline
see what happens.
Buy me a bit of time.

*Difficult to sequence events ...
The gut feeling is ...
the pucker factor is up.*

Buy me a bit of time in terms of getting the blood pressure up.
So I can introduce some other things.
Think about draining the chest,
my thinking extends only to the next step.
Start giving adrenaline,
blood pressure not responding.
Is there bleeding that I am just not picking up?
Treat all the immediate things,
adrenaline will treat anaphylaxis anyway,
go down that path...

I'm a bit puckered...

Blood pressure dropping more,
starting to worry - I am on my own,

that I can't cope with what I am doing on my own.
Thought processes not coping with the speed,
we need some more hands here.
Any more staff in yet?

Need to pull myself out of the situation...
Need to look it.

Look over,
the stats are still crap.
The blood pressure is 60.
Not very comfortable...

I need more hands.
Any bleeding?
Is it respiratory? Or is it cardio vascular?
Are they bleeding out?
Trying two things at the same time.
In most people you would expect an effect within 20 - 30 seconds,
we'll have to shock him.

Now, right now I am in the shit,
so um, get help.
Get blood along the way.
Check with surgeon,
have to take a decision,
the gut thing is going,
this is something more than the usual hypertension.

In the back of my mind...
anaphylaxis...

No gas, no blood,
nothing changes.
Nothing there,
give more adrenalin.
We should shock.
Is blood on the way?

Get some more gel up,
what is going on doesn't click.
I'm not pulling the trigger yet.
Anaphylaxis is starting to get a little more prominent,
have another listen.

Support blood pressure with adrenaline.

Everything is all compressed,
can't think of the immediate next step,
can't think about 2-3 steps ahead.
Get help from somewhere,
doesn't really matter.

Feeling that things are starting to come down to a tunnel,
need to free up what I am doing so I can stand back ... and think
...this is almost a tunnel.

I'm uncomfortable.
Is this some sort of threshold for action?

Do a code blue call,
declare emergency.
Nurse checks what to do,
ask for massive transfusion protocol.
Have we got more blood on the way?
Check with Surgeon,
the registrar rocks up.
Blood pressure's down to 44,
the guy's arrested...

Ask for chest compressions.
Feel comfortable again
can understand this,
I can do something about this,
I've got something I can treat.
It's obvious treatment,
the resuscitation protocol.

I can stand back.
I've off-loaded some of the process,
I don't have to think about it any more,
I've got a direct protocol that I can use,
the script for that is already in my head.

Start doing the CPR,
get the defibrillator; give more adrenalin,
we need to stand clear.
The registrar sorts the VT,
nurse does the adrenalin.

Get the 'defribs'!

Are there troubles with the 'defrib'?
Is there another machine?

Two minutes CPR.
Keep going!
This patient needs some more adrenalin,
not strictly AOS protocol - give another 500 mgs.
There may be subtle triggers,
but they are still triggers.

Feelings in the gut ...

I've given the maximum amount of adrenalin now,
still waiting for that defibrillator to sort itself out.

My thinking is a little bit clearer.

I am balancing,
try and step back.

I'm thinking maybe its some sort of latex allergy or something?
What the hell have I given that can cause?

I can see my hands,
I want to do something...
blood pressure starts to come up,
that's good.

Once I've done
things sort of relax up,
start thinking more ahead,
more to the side ...

It's a perception thing. What am I perceiving?

Things sort of relax up...
I think in my mind, maybe anaphylaxis?
It goes to the top of the list
I think this is anaphylaxis here.

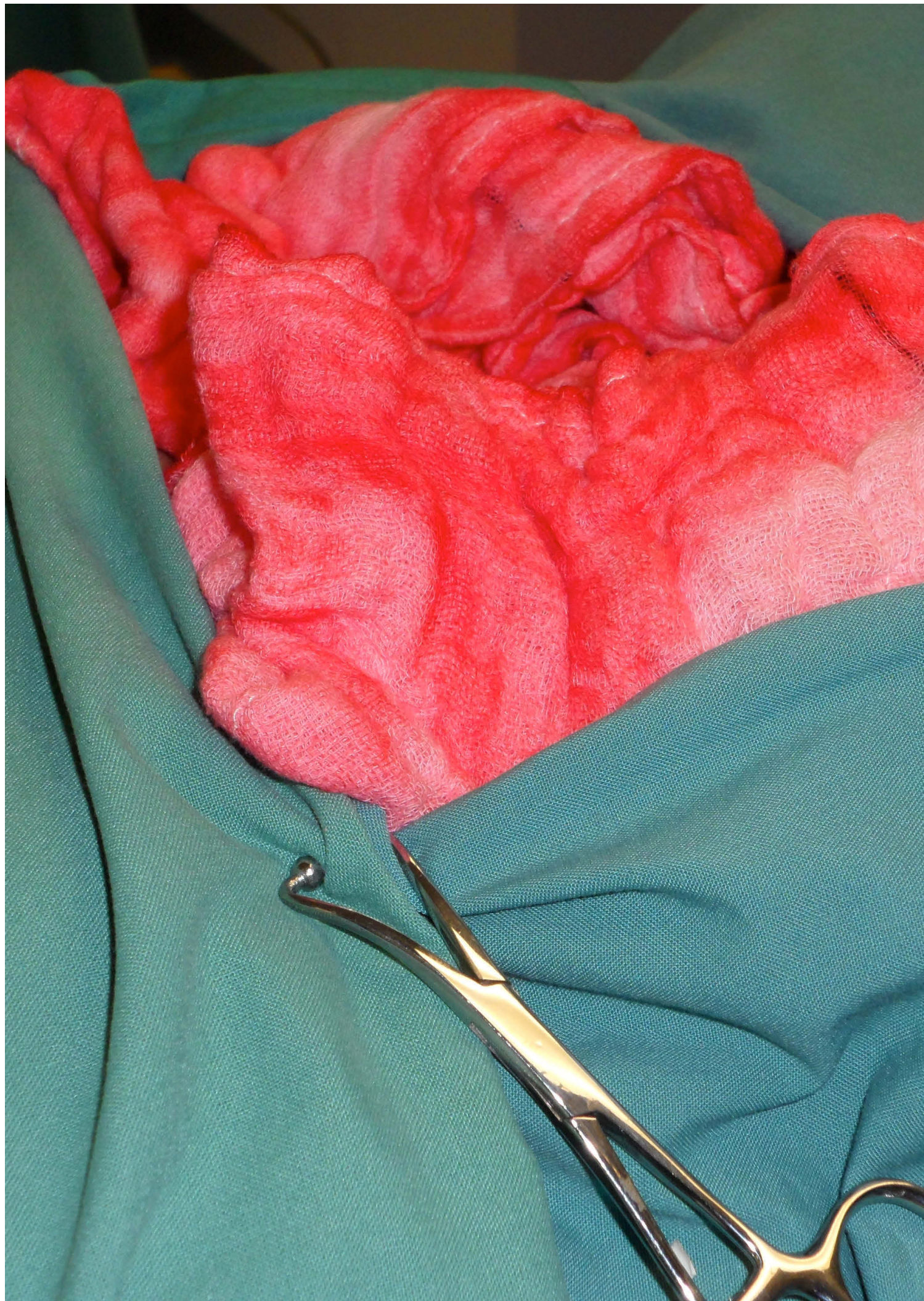
Was it always just floating there in the background?

Can't work out...
What the hell?
Can't work out what the hell the trigger is.
I go to the Registrar,
"What the hell?"
I think its anaphylaxis here.

Just had all those other things on top of it?

Registrar asks about another bag of gelofusine.
Says it right in font of me.

It clicks...



Interview with Simulation Director

Thursday April 14, 2011

Royal Adelaide Hospital - Director's Office

10.25 hrs.

"In designing a scenario and being a scenario writer for complex emergency situations you have to have clinical knowledge. Experience is important. The more experience you have, the more you are able to tweak the scenario – so it's a fine balance. You want layers of complexity but I don't think you need too many. When the scenario itself is quite stressful you only need a couple of things up your sleeve, tiny little things...like someone doesn't know how to turn the defibrillator on, or the syringe pump isn't working because it's not plugged in, things like that, to add complication. And obviously there is also a time constraint - you don't want to make it too long.

In this scenario the patient is not medically complex, but that is important because he [the patient] is about to have a massive insult. To have anaphylaxis on top of trauma is a massive physiological insult, so you need this person to be physically robust in the first place to survive that. This is part of the thing, if we make the patient technically simple – he is 27 and robust - a clinician in real life would walk in and feel: " Okay, I would rather be dealing with a patient like this than some other emergency."

But the problem in anaesthesia is that this is just one of many scenarios. There are actually many causes for falling blood pressure, particularly in a trauma patient, so it is for the clinician to sort this out as he goes through his checklist.

And if the patient is having an allergic reaction, we use a whole host of drugs that can cause reactions. Some of the more common ones are antibiotics, and the muscle relaxants to pharmacologically paralyse the muscles for surgery.

This is part of the challenge with differential diagnosis."

Interview with Simulation Director

Thursday April 14, 2011

Royal Adelaide Hospital - Director's Office

11.00 hrs.

"There is no right and no wrong ... when you get to that top level in medicine all we can measure is an outcome. You can have a bad outcome, but even if you have a bad outcome, it doesn't mean that if you did it differently the outcome would be any different."



12.00 hrs. Hospital Cafeteria

" ... What I found interesting was the concept that the penny dropped ... "

Interview with Consultant A

Monday June 27, 2011

Royal Adelaide Hospital – Unit Debriefing Room

14.00 hrs.

“If someone is going to die then there is nothing I can do about that. For example, I had a patient that clearly was not going to do very well at all. They had an arrest and it just wasn’t going to be good. But I was more horrified about the person whose nerve I was blocking on the wrong side of the leg. I think I was more affected by that, than any person who has died.

When it comes down to it, if a person is going to die there is not a great deal you can do. It’s not like in the movies or on TV where you can bring anyone who supposedly dies back to life. In some ways I am relaxed because I have a defined protocol: I know that if they are in a pretty bad place, then if I can get them back it’s a bonus - it kind of relaxes you a bit more.

The emotional stuff? I tend to reflect, have a chat to my wife...have a chat with my mate. I want perspective. The thing I can’t get, and the thing you need from other people is perspective. Genuine feedback is more useful than formal debriefs. How do you think I performed in relation to this? Do you think I made a good decision? To have peers you can talk to...

I don’t see *that* much bad stuff. I don’t think we are emotionally crippled. There are probably about four times where I have seen something that has affected me emotionally really badly. Like the two-year-old kid who died from meningitis and who we couldn’t resuscitate - stuff like that. A two-year-old drowning...stuff like that, you can’t help but be emotionally affected by it.

How did I debrief myself in that situation...in terms of my own performance? I rang one of my mates, asked what do you reckon? I was happy with that debrief because I recognise the emotional stuff as normal.

I am just a dad and a kid has just died.

Those feelings used to be internalised especially when I was doing a lot of CPR, but sometimes I just had a good old cry. I can’t remember who was there at the time... say for the kid with meningitis...I had someone else on the team who came with me ...we sat and debriefed each other and had a coffee.

You recognise the emotional stuff...I have a normal reaction to things...I get it out and move on.”

SECOND ENACTMENT

Personal Journal Entry

Monday April 11, 2011

Royal Adelaide Hospital - Simulation Laboratory

14.00 hrs.

I have been in the laboratory for several hours and the air is stale. I stare at the de-saturated grey green walls of the ward. We are on a break.

The consultant scheduled for the afternoon session is held up in the operating theatre; an unexpected development. I am reminded of the real world - there are emergencies beyond this ward and the participants for this experiment have been taken from scheduled duties in a system that is constantly on alert.

The Simulation Director scours the rosters to identify another on-duty consultant willing to participate at the last minute. In the meantime the clinician 'acting' the role of registrar for the simulation exercise (and who is one in real life) re calibrates all the simulation equipment and monitors to ensure everything is working smoothly (as he would in real life).

The screens flash images. Heart rate, pulse, temperature and saturation levels morph into coloured pulses and wave formations. Data becomes image - the lines supposedly tracing life's vital signs.

I reflect on the fact that the replacement anaesthetist will probably walk straight from an actual operating theatre into a simulated one, and from one emergency scenario into another.



Emergency Procedure performed by Consultant B

Monday April 11, 2011

Royal Adelaide Hospital - Simulation Training Laboratory

14.30 hrs.

I enter the simulation ward.

Have I been here before?

Take in the patient on the operating table, the drug trolley,
see familiar people.
Registrar needs to leave.

Happy to get into my role.

Look at the anaesthetic assessments:
the written information,
get more information from the registrar.
Listen to him,
information coming from two sources.

Scan the anaesthetic machine and monitor,
assess the gas flows,
re-familiarise myself with the machines.
Impression is one of stability.
Repeat everything to confirm that I understand.
Confirm I understand the key points.

Systematically.

Make sure I know how to contact the registrar.
Take the case as my own,
Go through the breathing situation.
Look at the monitors in a systematic way.
Talk to the Nurse.
She asks what to do with the gelofusine?
We're OK for now.

I have seen anaphylaxis to gelofusine before.

Do we have enough blood?
Get a handle on what is happening.
Hear the saturation monitor start to change.
Confirm that I can ventilate,
switch to hand ventilation,
ask the surgeon if everything is alright.

Listen for air in the chest,
check the position....check midline,
not sure if I am hearing simulated environment 'wheeze'?
Not sure if I am hearing respiratory wheeze?
Listening.
Turn up oxygen flow...turn off air plug...
have used these machines before.

Have to remember how to do that.

Transient improvement,
notice saturations improve with oxygen,
then get worse.

What now? Is this a real situation?

Need to rapidly assess the situation,
look at chest again.
Not getting a lot of air entry.
"Does he feel a bit tight to you?"
Increase air entry on one side,
sounds a bit crackly,
need to exclude pneumothorax.
Not looking good,
nurse is telling me there is a wheeze.
Concerned with patient's history,
maybe a bronchial spasm with asthma in the background...?

I have seen this in another scenario.

Ask for chest to be decompressed,
decompress his right chest.
Any bleeding?
Stats still going down...

*Have to make a decision about whether I need to decompress the chest
or whether I need to look for a further circulation problem?*

Doesn't work.
Not getting a lot of air movement.
Concerned now that there is blood in chest.
Quite concerned.
Don't know what is happening,
going back through thought process,
airway, breathing, circulation,
trying to work through things,
systematically.

Pattern recognition is important to how we do things.

Go through the process of excluding,
need to work out which to treat first,

go through and work out why
something is wrong.
Sounds of monitors, numbers and patterns,
tasks I have to perform all in my mind.

Think of the training I have done.
The steps of going through an assessment,
focus on gaining information to work out the problem.
Work out what the components of that are...
Focussed and looking at the patient,
sitting between the monitors and the patient.

*Cardio- hypertension, desaturation can go together with cardio problem,
the problem is working out the components.*

Hear alarms go off on the ventilator,
visual senses focus on patient and monitors,
listen to the heart rate,
hear alarms
hear tones...
the saturation tones to the heart rate.

Apprehension building,
patient not improving,
complex problem,
situation deteriorating.
Look at the problems.

Move from one to the other...What needs to be dealt with?

Apprehension building,
must be a circulatory issue.
Move to that.
Is the patient having an anaphylactic reaction?
Information ambiguous,
information isn't adding,
Aware that I'm not sure,
need to improve the situation,
even though I don't know what is going on.

Thought or feeling?

One: I don't know what is going on.
Two: I have to get this right.

These are my peers... need to show how I manage ... how are they perceiving me?

Patient hypertensive,
difficulty with oxygenation,
blood pressure falls,
blood pressure falling the whole time,
get blood pressure support,
give adrenalin.

No improvement.
Cardio count falling,
numbers are wrong,
numbers are wrong and rhythm is up,
search for what is wrong,
things are not right.
Consider all the diagnoses,
do intervention to include or exclude.

Slight tightness ... tension in my chest

Things were being excluded.
Think anaphylaxis at this point,
Anaphylaxis to the gelofusine.

*I can see the gelofusine.
The scenario is building up...*

Think this may well be,
I have had this before in real life,
think this is where it is going,
But try at the same time not to make it my conclusion.

I am in a simulator,
I am highly suspicious,
I am wary.

Put it out of my mind.
Manage the airway breathing ventilation issues.
Cardio count falls.
Surgeon gives me feedback.
Think we are in a cardiac arrest scenario.

Cannot step back to take a leader position,
still involved in the management,
still involved in delegating...
co-ordinating and delegating...

Cardiac arrest.
Situation clarifies things,
ask for the cardiac arrest algorithm.
Situation has to be dealt with,
no ambiguity.

*Things are crisper and clearer ... it's a crisis...
Lot less time to mull over things.*

Arrange for defibrillation and fluid,
nurse asks about more gelofusine.
Give me saline instead.

*It's a crisis ... try hard to stick to a plan ...
Go through things systematically.*

Cardiac arrest situation,
useful to have the visual,
remember the rhythms,
ask for the defibrillator.

What's this alarm?

Don't know.

Not aware.

The registrar doesn't know how to use the defibrillator.

Upset about that ...

Don't get caught in the distraction.

Need to stay focussed,
patient not improving,
manage the defibrillation,
think of the next stage of care...
push the shock button.

No sense of time with what is happening ...

Need to work out what is going on
and manage my actions.
Feeling pressured,
multiple things happening,
priority on different things at different times.
I need to be the one,
the one who knows what is going on,
the one making decisions.

Training teaches you to be very self-sufficient.

Slight sense of inadequacy.

Nagging insecurity that things aren't right.

I really want to get things right.
If things aren't clear,
need to move on,
need to take action,
act and sort,
you need to get in and make it happen
things are being excluded.

I have seen anaphylaxis to gelofusine,
have significant experience of gelofusine,
don't want that to cloud my approach,
comfortable giving fluids,
saline sort of fixed in my head,
don't want another gelofusine
don't give anything that could be potential for allergy.

Rely on doing ... actually doing rather than watching.

Getting rhythm back.

Situation improves.

Airways good,

breathing still poor,

going to hand ventilate again.

Let's get him stabilised.

Relieved.

Breathing is reasonable.

Need to go through a complete survey,

primary and secondary,

again,

systematically.

Elapsed Time 0:22

HR

Lead II

BP

(93)

SpO₂

NIBP

0:00

NIBP AUTO
START

NIBP START

(--)

Interview with Simulation Director

Thursday April 14, 2011

Royal Adelaide Hospital - Director's Office

11.30 hrs.

"The importance of this particular scenario is that once anaphylaxis is up and running, it is going to take its clinical course. Now the quicker you identify that, and the more reactive and proactive you are, then potentially you can nip it in the bud. But – and this is in real life too - if you let it go, the slower you are to react, the worse the prognosis for the patient. So rapid diagnosis is important in real life because the quicker you are to diagnose, the quicker you might be able to initiate some of that treatment, and therefore you may still end up with a severe clinical situation, but maybe not *as* severe.

I am just trying to keep story running: once it is up and running I am not changing the scenario, just marrying things that happen with the path of the scenario. Tweaking some stuff. So whether they get the diagnosis in the first minute and start treating, I am still going to play it out and the end point will still be the same. In this situation they are going to end up having to shock the patient no matter if they get it in the first two minutes. That's why getting that gelofusine up is critical because it is the catalyst for everything else going down. If they don't put up the bag of gelofusine in theory you don't have a scenario because the allergic reaction hasn't been initiated.

And I guess (this is maybe the point of the conversation) what is gelofusine?

There are different types of fluids. Normal saline is salty water but it is in the right concentration so that it basically matches your blood. But that is all it is - salty water. Salty water is made up of tiny molecules and when they go into the blood stream they move across different spaces in the body. We talk about the body being made up of different compartments. One of the compartments is the vascular compartment; the molecules move across the vascular compartments. Normal saline will spread out in amongst the body.

The difference with an agent such as gelofusine, which is a manufactured agent, is that the molecules are bigger. It is a colloid. So if you have lost blood, and you want to replace that volume in the blood stream, if you give gelofusine, because the molecules are bigger, they stay in the blood vessels for longer. They still eventually leach out, but the theory is they will stay in the blood vessel for longer and maintain blood pressure for a longer period of time.

I think it is a gelatine type derivative. It is a plasma expander. But it is more expensive and there is potential risk of an allergic reaction. But that is rare and there is no way you would know that...unless it has happened before."

Interview with Simulation Director

Thursday May 12, 2011

Royal Adelaide Hospital - Director's Office

10.45 hrs.

"When you have a severe crisis, you get them over that bump and then you think ahead. But at the time when things are rapidly crashing you are not worrying about, 'Will I get a bed in recovery? That's irrelevant at that point in time.'

You are in the moment.

I think that is the way in medicine training ... okay you are given a patient, he has shortness of breath, and so what is the differential diagnosis? And then you name five or six things it could be. Then from there you systematically go through them as to what it could or could not be, but in this crisis situation you don't have a lot of time to do that.

I think algorithms still play a role. It is a way of applying a systematic approach often when clarity is very difficult. If there is a massive crisis, I still use that process to exclude things. Algorithms are very much a learnt phenomenon. The problem is if there are too many algorithms. That's why I think the cardiac arrest algorithm - which is a very well known one- is relatively simple and where everyone will feel safe. Having said that, it is probably not as well taught as it used to be. We have become a little de-skilled.

We should be doing more hands-on training.

You can't look at two people that have come out of training and say you're consultants and you are exactly the same. You have to know about their background, their experience level and that sort of stuff. People complete their training in their own way."

Interview with Consultant B

Monday June 27, 2011

Royal Adelaide Hospital - Unit Debriefing Room

10.00 hrs.

"If I could get past the anxiety and not worry about getting things wrong ... if I could use that feeling ... in some scenarios I am more concerned about getting things right and sometimes that gets in the way of things. I wouldn't be the only person that experiences that feeling. I see it in my colleagues, beating themselves up.

How do you get over a crisis?

Many of them happen on night shift so it's a question of being glad the night is over and going home and getting sleep. You get a fair bit of replay of the event...that's one thing I do. I try and remember what the components of that event were and sometimes I think that there were points omitted that would have been good to do, but that is by the by.

Often I tell my partner about what happened and some friends I have a drink with.

I usually do my own follow up on the person and not try to cut myself off from it. Sometimes it helps, sometimes not - usually it does. I think it gives me an opportunity to talk to them about what happened to them. At times, it has helped me deal with my own emotional response to it.

A lot of what happens, occurs while people are unconscious, so saying I was really worried about what was happening to you later really humanises it.

In an ideal world I would like to be able to talk to someone senior in a safe environment. Just to be able to talk...having access to someone...I don't see it as counselling."

THEATRE BLOCK

The
**ELEANOR MERRALD
BUILDING**

UNAUTHORIZED
ENTRY INTO
CEILING SPACE
PROHIBITED

Australian
Chiropractic Unit
Neurosurgery Department
Simulation Training
Lab

Notice
Theater Block Building



INTERLUDE

Personal Journal Entry

Monday March 14, 2011

Women's and Children's Hospital – Operating Theatre

14.00 hrs.

Today I observe reality. I have accepted an invitation to observe minor surgery being conducted in an operating theatre at another city hospital. The anaesthetist escorts me to the doctors' change rooms where I get dressed in uniform surgical garb. The gown is dark blue; the hat and shoes light blue. Later in the theatre I see that some clinicians wear their own cap – a bandana of sorts - the only concession to individuality.

We walk a few steps down the corridor and I immediately find myself in an operating theatre. It takes me by surprise. I had anticipated more ritual, more protocol beyond the donning of the surgical gown, to prepare for the operating theatre; to prepare, so to speak, for the delicate task ahead, but here everything seems to proceed with an accepted casualness that borders on nonchalance.

In the operating theatre the beds and medical equipment trays are covered with coloured linen. Blue and green represent the sterile zones. I am told to stay away from the sterile zones.

Clinicians, nurses, aides, enter the operating theatre outwardly unconcerned. Some chat in a corner while a patient is put to sleep. The work is production line, routine, except for a silent, communal preoccupation in the form of a continual scanning of the patient and the room for any untoward sound, heartbeat, or movement. I could be anywhere...in a coffee bar. It seems all too incidental, too irreverent. I recall a similar sensation from the simulation trials, but this is reality.

How to reconcile this feeling?

I stay pinned to the anaesthetist, who is the floor manager par excellence. They are the ones who invigilate to ensure that all is proceeding as it should and who remain poised for every eventuality on their duty of care. They are the ones who hold the tenuous thread of consciousness in their hands.

The patient, a child, is carried, a limp rag doll and placed on the table. His tiny chest continues to stir, agitated, until the anaesthetic takes hold. It takes three stages to do this - first the brain synapses are blocked, their stillness and silence inducing form of sleep, then the pain receptors (noxious impulses) are blocked, and finally muscular skeletal responses (the so called helpful responses) are inhibited.

The wrong dose of any part of this cocktail could interfere with that slumber.

Machines mediate the proceedings. The anaesthetist stands next to a tower of digitally pulsing, beeping screens, each layer monitoring a vital sign. The first layer of screens displays graphs recording the heart rate and the oxygen rate. A second layer of equipment administers and monitors a range of anaesthetic drugs and gasses, the quantities of which can be increased or reduced with the twist of a dial.

The changing pitches and frequency of the sounds and the colours of the displays speak their own language. Blue says look at this, yellow is a warning to check and red, red is for emergency. Once, when they introduced new equipment, the right buttons didn't get pushed, the sounds weren't right – people were unfamiliar, things went wrong...

While the anaesthetist instructs me, he monitors the screens and sounds, ready to respond by tweaking a dial here, calling for more medication there - the slightest variation causing a palpable shift in his focus. He is at once relaxed and edgy. "You can easily lose your edge if you have been away from it for a few days."

His laughter neutralises any danger. It serves to mask the fact that every situation, any situation, could escalate at any given moment. There is always something unexpected on the horizon.

We get closer and the child patient falls to his slumber. A small green bag – specifically for children - is manually pumping air into the child's lungs. The anaesthetist tells me to squeeze it. I hesitate then tentatively position my hands on it. He firmly puts his hand over mine and instructs me how to add pressure. Now I – a stranger- am directly connected to the child - through this bag of air and this tube sending air directly into his lungs. Its pulse talks back to me with the breath of life. The anaesthetist describes this as the most intimate relationship possible.

Next, he gets me to feel the veins in the child's hand and arm. My touch is clumsy, too tense to feel any of the subtle movement of the blood flow within, but the anaesthetist already knows this. He takes over, sensually rubbing the skin and the veins, until he feels that flow.

Touch. This is not in the machines. This is not something they teach you - this he learnt from his mentors – it is knowledge from another generation.

"How are the young ones to learn this now? Anaesthetists are the ones charged with putting you to sleep and the ones charged with the ultimate responsibility of making sure that you wake up at the end."

He is eager to make me understand.

As I hand back my surgical gown I learn that the anaesthetist himself is now to undergo surgery – benign he says, relatively low grade he says. He tells me this in the usual casual, off the cuff manner. Today is his last day at work before the operation. This gives meaning to all the beach talk – "...we'll see you on the beach," a constant mantra as co-workers, nurses, and doctors pass him on the corridor. They laugh. There are photos on the staff pin up board along the corridor; he stops to show me one of his dogs playing in the sea with the dolphins.

Outside the hospital I thank him for the privilege of the afternoon. He nods, taking in my appreciation - it pleases him. He has taught many and will continue to teach many more. He leaves with me the parting words, "Wish me luck."

The hospital is in the middle of the city; a green belt of lawn and trees buffers it from passing traffic. I take his words with me and sit on a bench under a tree. I am alone and watch the peak hour traffic streaming by. This is designated as a place for contemplation – appointed so by the rotary club. A plaque tells me that it is in remembrance of the 'little angels', children who have passed away.

earlier...

I am once again in a waiting room. Slowly the stillness becomes movement. I am being wheeled into the operating theatre, the anaesthetist taking me through the questions for the umpteenth time - name, date, health, allergies, and pulse rate. It feels like an army drill. It is late and the operations are running behind schedule; mine is a routine procedure - routine I guess for them. Out of the corner of my eye I catch a glimpse my doctor – then nothing.

I come out of the anaesthetic thirsty, numb and aware that I have lost time.

The light tells me it must be early morning. The ward is quiet. A figure approaches me softly through the predawn shadows. I can sense by the slight limp in the walk that it is my doctor. He sits on the edge of the bed, tired - he has assisted several births across the night. There is a deep sigh; it is hard to talk, he attempts a slight touch. For a brief moment - the only moment – he shares my sorrow.

Sitting there, next to the hospital, surrounded by traffic, I find the dedication on the rotary plaque odd, lacking discretion. I think of Sasha and catching my breath at the first heartbeat, and the 'swoosh' of the ultrasound, cold and sticky. The spots of blood on Christmas day, and finding myself in the waiting room - the shock protecting me from feeling the intensity of the emotion; that would have been too big a burden to bear that day, Christmas day.

It took years for those emotions to come out, like a leaky valve that had once been over pressurised; years for the mind and body to reconcile. I sense the same disconnect in this anaesthetist: between his eyes and his smile, something fleeting in the "wish me luck."

That's where it happened I think, the severing of sensation and emotion - that connection between the conscious and unconscious story being played out.



THIRD ENACTMENT

Personal Journal Entry

Monday May 23, 2011

Royal Adelaide Hospital - Simulation Ward

10.00 hrs.

It is almost one month later, the setting is the same and also different. I arrive early to set up equipment. There is no one in the simulation ward and the door is ajar. In my peripheral vision I sense that there is woman sitting in the corridor reading. Is this the next consultant? I note the bandana on her head. She has chosen to wear it today and she is early. I sense trepidation.

The Chief Medical Scientist has requested another two trials. They want to test a halter monitor. This is unanticipated. The team is curious. The Director enters, keyed- up and preoccupied: he may be called away during the course of the morning for other hospital business. The day roster has also forced changes to the clinician 'actors' in the simulation role-playing team.

While we wait, I shoot more video footage of Mr Sim prepped for the operation in surgical garb. The respirator is on and Mr Sim's chest rises and falls as he breathes its simulated breaths.

As always I succumb, captivated by its human 'non-humanness'. It triggers hidden sensations - this struggle for breath - I have seen this before.

The Chief Medical Scientist arrives to observe. The Director reminds her to close the control room door – the simulation of reality must not be ruptured. A consultant enters wearing a bandana. The acting registrar commences his hand over.



Procedure performed by Consultant C

Monday May 23, 2011

Royal Adelaide Hospital – Simulation Training Laboratory

10.00 hrs.

27 years old, fairly healthy, with some mild asthma,
the anaesthetic has been going for about half an hour.
The registrar needs to help with the second patient.
I am asking my brain to switch on the power gear.

I am called on to deal with a passenger who has been in a car accident.
Take in a lot of information. Ok.
Get some history before hand,
get all the information now.
What do I need?

*Bombarded with information
Take it all in very quickly,
Get all the important facts before they disappear.*

Survey the scene-monitor, ventilator, and patient,
the sound of the beep of the pulse-oximeter,
the ventilator going up and down,
take in all the cues.
Make sure I have a view.
Observations all stable.
Hearing the regular rhythm of the beeps and the pitch,
the sounds are reassuring,
the surgeon's mood is okay.
Everything seems straightforward.
The patient is tubed.

*A lot of cues coming at the same time,
A lot of things to think about at the same time.*

Carbon dioxide trace looks abnormal,
patient slowly de-saturating,
warning something is going on.
The numbers drop.
I can hear the desaturation,
look for a stethoscope to listen to the chest,
listen to things to get some base line.
Ask for a stethoscope.
Saturations improve.

Put the patient back on the ventilator,
just want to get my hands free,
to work out what is going on...

There is a monitor alarm I haven't heard before.

Focus on listening to patient's chest.
Hard to work out the air entry
but I can see the chest rising and falling.
Happy the tube was in the right place,
hasn't gone bronchial...

The stats drift down.
99 to 93...quite a bit of difference!
Wait for some response.
Focus on the noise.

The numbers dropped before the pitch.

Don't know what it is.
Try to get rid of the noise.
Refocus on the patient's lungs.
Can't see the cardiograph trace.

Not acting as fast as I want...

Look.
The trace looks abnormal...
Try to feel, hand ventilate,
try to feel, hand bag.
Is there any airway pressure?
Could the muscle relaxant have worn off?

*Think! Get a bit more muscle relaxant.
Might help.... Concerned for the patient.*

Alarm comes back on,
blood pressure drops off significantly.
No cues from the chest ...
patient continues to de-saturate.

*Focus my brain on thinking,
try to concentrate...*

Go through my surgical skills of what could be going on.
Look at the monitors; re-evaluate the patient,
check where my tube is,
give more fluids.

Anxious.
Tense.

Always anxious if a patient is deteriorating.

Aware that I need to alert the surgeon
work out how the surgeon could help me.
Need more back- up.
Ask for some extra help to come back up.
This could be a tension pneumothorax?

But I haven't got particular signs...

Check anyway.
This is a crisis situation.
Think of a lot of different causes,
and eliminate them one at a time.
Think of the ones I could potentially treat.

Get out of trouble!

Aware the blood pressure is still falling.
Get some cues from the patient, from the monitor...

*Don't have stats trace,
Don't muck around with that.*

Feeling tense and uncomfortable.
Think what to do,
trying to follow through on algorithms.

Nothing...gut?... intuition?

Try to think of a lot of different causes.
Get adrenalin.
Stats in the low 90's...
Want to treat it quickly,
want to get the blood pressure up quickly.
Surgeon needs to know something significant is happening.

*It's a crisis situation...
Is this patient is gonna die?*

What signs am I getting?
What can I do to change things?
What does the patient look like?
What can I treat?
Time is really important.
Need to work it out quickly for the patient ,
can't go on with low blood pressure for a significant period.

Registrar just appears,
don't see the registrar come in.
Is there anything going on in the abdomen?
Any pulse in the anal shaft?

*Someone else that can help diagnose.
They know the patient.*

Could this be related to blood loss?
What can I ask the aesthetic nurse to do?
What can I ask the surgeon?
At what point do I tell the surgeon to stop?

I knew that the next step was some CPR.

Get the arrest trolley.
Anaesthetic nurse gets the defibrillation machine,
it gives instructions I don't agree with.
Start CPR.
Surgeon is able to do that.
And one dose of adrenalin.

Still need to work out what is going on.

CPR is just one treatment.
No output on ECG trace,
now in an EMD arrest scenario.
Go over in my head what we need to do,
see my self moving faster, going from one thing to the next,
trying to work out where I should be looking,
hoping it will finish and the patient will get better.
It doesn't.

Go through the algorithm for the emergency dispatch protocol (EMD).
Scratching my brain to get them to come out very quickly,
rule out tension pneumothorax.

*This patient is likely to suffer adverse consequences
if something isn't actively done.*

Decompress the chest.
It isn't convincing.
No immediate sound,
no gush of air,
no pneumothorax...
Give some more fluid.

What other possible causes of arrest would be...?

Eliminate one at a time.
Surgeon offers to put a needle in the pericardium.

I've never done this before.

Hand over the needle.
Feeling a little bit clumsy.
Don't get any fluid back,
no way of checking for bloods

*I have seen a patient deteriorate really quickly,
I know how fast you have to act*

Oh god what do I do next?
I need to keep going,
I need to keep thinking.
Going back on myself and trying to go forward,
feeling that time is passing slowly.
Think I've done that and what's the next step?
Pull out the bits I hadn't remembered.
Get cues from everywhere.

I have seen what a really, really, sick patient looks like.

I know what a really, really sick patient looks like!

Distracted by the noise of the defibrillator.
Ventricular fibrillation? Ventricular tachycardia?
Refractory VF?
Pulseless?

*If the patient doesn't improve, if the arrest continues,
if the patient doesn't survive...*

That means that somebody's son would have died.

Come on come on,
I am wasting precious time.
I need to be thinking,
I need to be acting.

*More confused than anxious,
at the back of my mind the thought that I will have to explain to the family.*

Thinking it's not VF,
we still have a rhythm,
we need to get blood pressure support.

Hoping it would all finish and that the patient would get better.

Distracted by the noise,
the patient starts to improve.
Pulse in the aorta,
output returns.
CPR stopped.
Adrenalin has finally kicked in,
looks like things are improving.

Don't know why the rhythm suddenly reverted and improved...

Didn't ask for the patient to be shocked.

Huge relief
He is better.
Things have come together.

I have a few cues.

Confused.

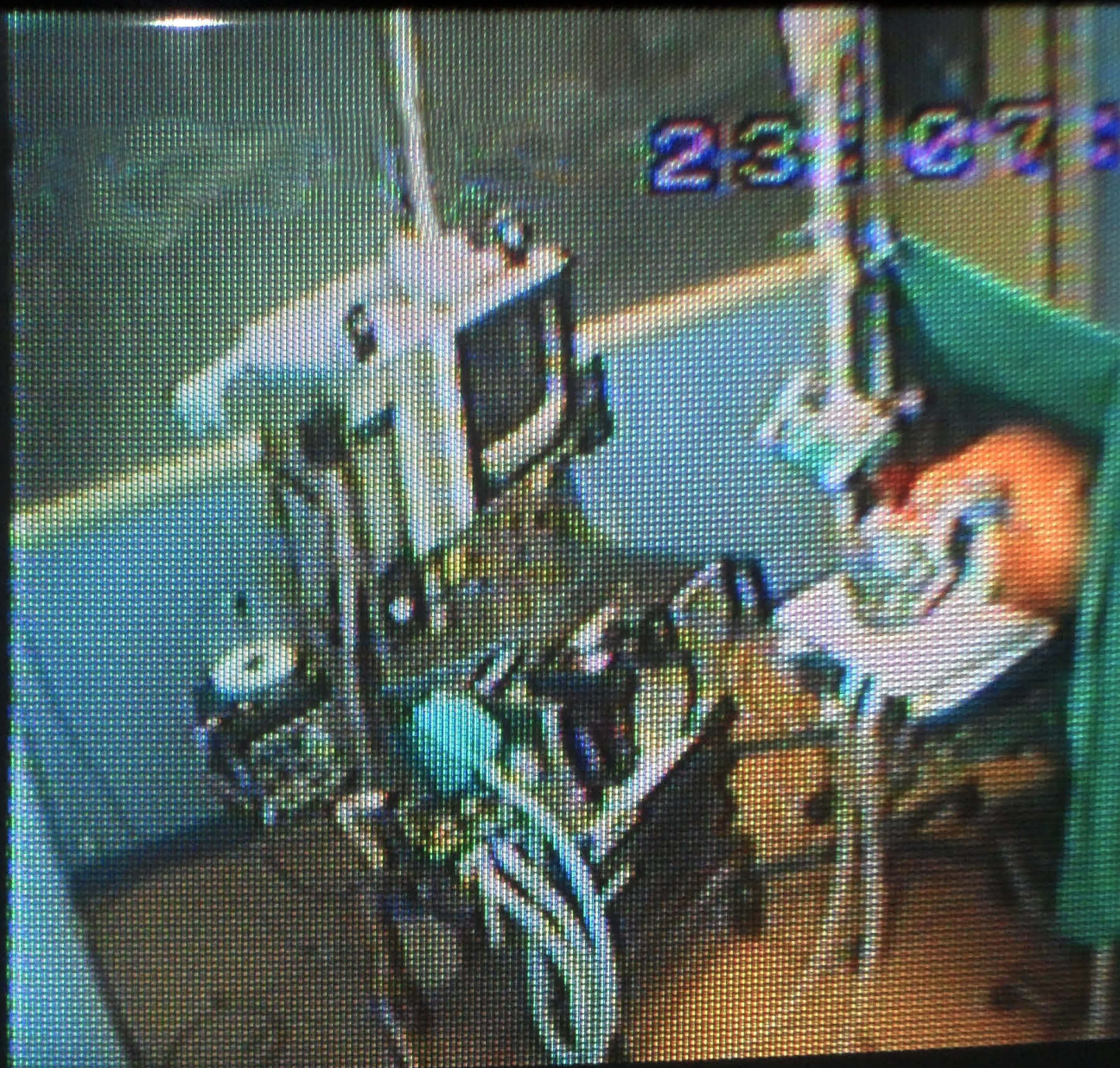
I don't have a definitive diagnosis.

Disappointed...

I haven't contributed.

The patient is better,
still a huge relief...

What do I need to do now?



Interview with Simulation Director

Thursday May 26, 2011

Royal Adelaide Hospital - Director's Office

11.00 hrs.

"The one flaw in our scenario is that the mannequin doesn't have the ability to support the wheezing breath. What often happens in simulation is consultants will focus on one deficiency, which may be relevant or not relevant, or mildly relevant, but in reality there is enough information around the scenario for the participants to work through the situation.

Anaphylaxis is a multi-system: it affects the cardio vascular system, it affects the respiratory system, but sometimes you will get purely cardio vascular symptoms, sometimes you will get just respiratory symptoms. I think when people do simulation they expect everything to be there, but in real life you don't have everything there – you may not get wheeze, or it might be so noisy in the operating theatre you can't actually get good information.

But that is the expectation, and this is an important point. In my experience everyone expects the full gamut of sensations, while often in real life with anaphylaxis you call in help. If you have a registrar assisting you might say, "Can you have a listen to the chest for me a while?" As the leader you may delegate; you might ask the registrar to listen to the breath and the information that comes back to you may be correct or not. He may say, "I didn't hear anything," so you are always going to have conflicting information or information that isn't a hundred percent ... so it is a matter of filtering information in a way to give you the best clinical outcome.

I guess it is one of those experience things ... those experience loops...

There is certainly a vibe you get with a patient. You only have to look at them and you think oh, I am going to have a hard time here. Then there are some people that on paper look terrible but you see them and you talk to them, and you think these guys sound worse than they are.

Then again if you are on call at 10 o'clock at night and you come in, there might be a nurse at the front desk coordinating, but the place is deserted.... then you go to the emergency theatre and everyone is in there ... and you try to get the complete feel or vibe – but you haven't been there from the beginning..."

Interview with Consultant C

Monday June 27, 2011

Royal Adelaide Hospital – Unit Debriefing Room

12.00 hrs.

“I have gone over it a few times in my head. I thought about why I didn’t shock the patient, that I missed the diagnosis, but I guess it is just one step in the learning. It is not a real patient - you don’t get all the same cues that you get from a real patient.

I have seen what a really sick patient looks like. I have seen really bad things happen. I have seen a patient deteriorate really quickly, and when you have seen that a few times, you know how fast you have to act. And you also know what isn’t so serious. The monitors can sometimes give you data you don’t agree with. For example, the blood pressure may be a little low, but the patient doesn’t look grey like they would in a real situation. Those are the things that have formulated for me how quickly a patient can deteriorate, how bad they look when they do, and how serious a situation can get.

There is nothing like it until you have actually been there. You can’t really do that in a simulation.

The one crisis I did have was a patient that did not survive anaphylaxis. That took me quite a long time to get over. It went around and around in my head probably for about three or four months. I felt that I was walking on eggshells with every other patient, thinking something bad was about to happen. I think it leaves you much more on edge and it takes a while to get comfortable again – even though I had been practising for ten years during which time nothing had ever happened.

It takes a long time to actually feel relaxed about your job again and it was one of those scenarios where I thought, gosh, what we do is really full on! To lose a patient unexpectedly was really, really traumatic. It is a very hard situation. You debrief with the head of the department and with other people. You can’t help going over and over it in your head: if only that drug hadn’t been given...

I don’t know whether having some time out would have helped. I am not sure. It was my first day on the job at this hospital when it happened. I guess you cope by just coming back to work and not giving up.



FOURTH ENACTMENT

Personal Journal Entry

Monday May 23, 2011

Royal Adelaide Hospital - Simulation Ward

14.30 hrs.

This afternoon our performer is a leading consultant with many years of clinical experience. I sense by the way the simulation team is waiting, prepped and standing at their stations, that this is an unusual occurrence. Although the consultant is running late, everyone is on standby. The beeping monitors in this instance somehow serve to underscore the fact that we are behind schedule. While we wait there is furtive discussion about the previous session - an inconclusive outcome – not what anyone had expected.

A door slams shut in the distance, voices in the corridor. The consultant enters the simulation ward as if it were a boardroom, then he catches himself, remembering to mute his mobile phone, and asks about the Holter monitor. He straddles clinical practice and high level administration; during the normal course of his day he already acts out many roles, above and beyond the one he will enact during this simulation exercise.

I watch from behind the glass window of the control room as he greets the team and note he is wearing glasses. Once again I detect a series of unfamiliar codes, textures and protocols of communication, codes for respect, experience, hierarchy and others too subtle for me to fully decipher.

The simulation scenario starts rolling without the consultant even noticing it has begun.



Transcript of Emergency Procedure Performed by Consultant D

Monday May 23, 2011

Royal Adelaide Hospital - Simulation Training Laboratory

14.45 hrs.

I go into the ward
and begin discussing the patient.
The anaesthetic registrar takes me through the history.
The surgeon is operating,
immersed in his job.
I am surprised there isn't anyone assisting.
Normally there are more people in the theatre.

Is this part of the scenario?

Readily calm environment,
registrar asks if he can leave.

Perfectly reasonable ask.

The theatre is completely set up.
Certainly not unfamiliar...
Everything is quite comfortable,
straightforward case.
Going as I expect...
The ventilators and monitors are working effectively.

Don't like the dim monitor.

'How are things going Mr Surgeon?'
Check the anaesthetic chart,
are these alarms set properly?
Check the drugs in the anaesthetic machine,
feeling relaxed, certainly at the outset.
The monitor doesn't seem bright enough.

Don't like the monitor...issues with the screen...

I notice the tone of the saturation monitor has dropped,
saturation levels not running 100%,
the first indication something is going astray.
Is there is equal air entry?

Tone is the first thing

The sound of pulse-oximeter,
the input causing me to react.

Is this genuine? Is this where I have to take it seriously?

The saturation monitor drops into the low 90's,
not totally happy here.

Is the start of the scenario?

Disconnect the ventilator,
manually ventilate the patient for a number of breaths.
Watch and listen to the chest,
breath sounds...

Better quality of hearing when you disconnect the ventilator.

Can't hear much air on the right side.
Air entry was equal...was it?
Ask for a stethoscope.

Don't have my own

Start to guess a diagnosis.
Concerned he has a pneumothorax.
Treatment reasonably effective,
in the first instance.
Saturations improve.

The examination of the airway sounds as though there is a decrease in air travel.

Now the blood pressure is dropping,
notice that falling before the alarm.
A number of alarms next
and the saturations falling,
from well above 80 to the mid 60's.
Working diagnosis: pneumothorax on the right hand side.

*This is threatening, need to perform well, can't do badly...
You can't rely on what you did in the past.*

Go by sensory data,
ECG a bit scratchy.
Make a diagnostic decision,
as well as treat the patient.
Can't believe that there is air on the right hand side.
Nurse answers the airway is equal on both sides.
Is the diaphragm going up on the right?
Can you see for me?

Can't believe what I am being told.

Pulse is going faster,
listen to his heart,
not sure whether I am meant to be hearing anything.

Checking the chest is going up and down on both sides,
still don't believe it is not a pneumothorax.
Make an assumption,
with the algorithm in my head.
Diagnose the problem.

The human part is deciding what is or isn't important.

Not aware of anything outside my immediate focus.
My visual is on the monitor and the patient.

Mostly the monitor...

Aware of the tactile nature of the valve,
aware the valve was over pressurised at some stage.
Need to decrease the information,
need to adjust the bag to make the ventilation easy.

Can't believe there is air on the right hand side.

Should know the ventilator better,
this is a machine I have worked with for years.
Should know to flush it out.

Feel stupid.

Signs and symptoms don't match.
That's bizarre.
I have made a diagnosis,
blood pressure is falling.
Can't quite hear,
in my mind, the diagnosis is not clear.
Start to get anxious.

Focus more on the heart.
Is there blood around the heart?
Beginning to believe there is another problem,
look at other possible causes of blood loss and hypertension.
What on earth is going on with this patient?
Where is this leading?

Anxious.

Adrenalin and CPR are the two things I go for.
I have an algorithm in my head,
one not necessarily published,
might need to do some CPR in a minute.

I am getting tacky cardy.
No blood pressure,
feeling flushed, hot...
give some adrenalin.

Minimal response.
Not really getting anywhere.
What I expect isn't working,
treatment responses not causing the outcomes I want.
It should work given the sequence of events.
Where to go from here?
Do we have an emergency button here?

Are we losing this man?

No pulse wave.
Beginning to think it is a pump problem,
beginning to lean towards cardiac tamponade.

Frustration ...what's the word?

Everything going haywire
ventilate manually.
Cardiac rhythm changes,
nurse gives adrenalin.
Worry about the blood pressure,
not distressed about the saturations.
In my mind it is not clear what is happening

If it isn't pneumothorax, then is it possibly the heart failing?

Situation changes,
move onto the next problem,
from airways to circulation,
from one diagnosis to another.
Ask for the emergency button to be pushed.

Start CPR.
Diagnosis: cardiac arrest.
Still no blood pressure.
Nothing seems to be happening,
stepping from one diagnosis to another.

Why would a twenty-seven year old have heart failure?

Ask for a central line,
a bit more adrenalin.
Frustration,
don't understand if I am looking for another diagnosis.
Frustrated and tense.

This twenty-seven year-old might die on the table.

Put on the pads,
defibrillate the patient.
"I don't know how to use it"
Nurse's response takes me aback.

What? I don't know how to use it?

Takes me aback,
I have to say,
'Place the pads on the patient.'

I have been in a situation where I have had to stop CPR.

Get some response,
ask the surgeon to put in a needle in the pericardia sack,
but there is no blood.
3rd bowl of supply 5mg adrenalin,
Blood pressure is up,
pressure is getting there.
For reasons that are unclear,
the saturations start to return.

Feel comforted that danger is averted.
Still not clear why it has got better.
Don't have the right diagnosis,
treatment okay.

Don't quite know what went wrong.



Interview with Consultant D

Monday June 27, 2011

Royal Adelaide Hospital - Clinician's Office

15.00 hrs.

"The hard part was not picking the right diagnosis... that's distressing, even though you know you probably went down the right path in terms of treatment. My concerns are two-fold, I am not doing enough anaesthetics, and I am also ageing.

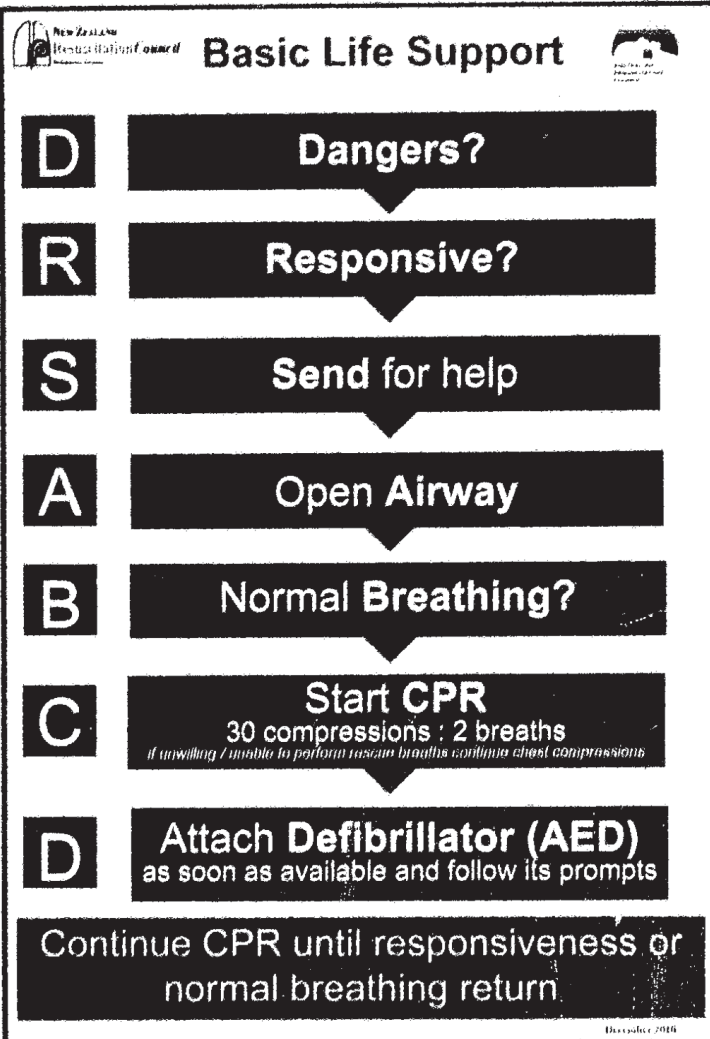
I am more in the algorithm stage of life now...I need to do more anaesthetics...I don't do enough for experience to be maintained. Early on, everything was protocol. But when I was at my best clinically – in my mid 30's and 40's - I was more instinctive. I just knew when to respond.

I have easily done over 50,000 procedures through the years. Most of my cases are traumatic cases where there are many unknowns. By my stage of life you have been through a number of scenarios, a number of incidents where there have been bad outcomes. I don't know if we preselect ourselves to do anaesthetics but we tend to have a fairly strong head in the sand approach.

In the crisis incidents that I have been involved in there is nothing specifically that I have done wrong, but I am sure that has not made a huge difference to my reaction. I guess that with the ones I have been involved with, the deaths have been inevitable – it is almost part of life.

It is usually young people dying; certainly the ones that cause me most concern are mothers of young children - they stress me more than anything else. There must be half a dozen cases that I can absolutely remember. I can't remember the individual's name but I can certainly remember the details of the emergency. Some incidents were very difficult. One occasion that I had more recently, the surgeon and I went and spoke to the relatives of the young woman who had bled out. That helped me personally get over it.

Otherwise you just tend to move on."



FINALE

Personal Journal Entry

Monday May 23, 2011

Royal Adelaide Hospital – Simulation Laboratory

16.00 hrs.

The sensation of bitterness returns... There are more - more instances of waiting rooms, more walking down endless corridors to the smell of disinfectant, and trolleys littered with hospital food. More pacing the room and looking out the window wondering when and if it will end - the sound of the respirator augmenting the human, giving false hope all through the night as the hours pass.

“Not today ...” I can feel the words sticking in my mouth. “No, not today,” when they tell me that it has not gone to plan, that there has been a complication. As if you could personally choose the day or the hour to confront loss - as if you could prepare for it.

I am in here in the emergency ward and the medication dosage was incorrectly administered.

earlier...

The nurse kept coming in at intervals to check on the respirator - a process seemingly necessary but futile. There comes a point where too much kindness risks patronising. No one bothered to explain that technically the respirator was the only thing keeping our friend alive, nor that we would be the ones to decide when it would be turned off.

That came hours later, in the morning.

We were the only ones left, in the morning, when the decision had to be made. No one told us about how, regardless, there would always be a last gasp for air. No avoiding it. That vibration the last act of life. That, and the sound of the wind howling dust across the paddock when we finally scattered ashes.

Personal Journal Entry

Monday May 23, 2011

Royal Adelaide Hospital - Reception

18.00 hrs.

I reach the bottom of the escalators. The day has ended but I can't go home. There is a metallic taste in my mouth and a sensation of stale hospital food. The sound of breathing is still reverberating in my ears.

It is the morning of the first test trial. I arrive early and decide to wait at reception. I am focussed and with purpose. Excited, yet the sight of a hospital food trolley being wheeled down a corridor makes me oddly tense. I tell myself the queasiness is apprehension.

(It was morning and I remember carrying gifts of fresh figs into a ward.)

The woman in the corridor is wearing a bandana. *"Trying to focus my brain on thinking"*. Her words resonate. Deliberate thinking as a way of commanding perception, but the body reveals other narratives - other sources of knowledge known and unknown.

Tastes, images, smells intertwine.

My emotions collide with the medical machines and protocols, uncertain where to locate themselves. I too have been present in emergencies. There is a knot of sensations at once past, present and future allied with this act. The simulations are now embodied within me.

I am both a spectator and participant. I stand alongside the clinicians to experience the commitment to hand: a dedication in the guise of tenacity and resilience; a refusal to give in that divulges human compassion and frailty.

This is now my present truth and revelation.

I too lost loved ones at this site where I have come to observe. I push through the revolving door, my private narrative spliced into these enactments - the insights serving both as a public testimonial and private transformation.

EMERGENCY

PATIENT
PICK UP &
DROP OFF
15 MIN
PARKING
(IF INDICATED)



Analysis Part One: The Mise-En-Scene

Introduction

The reader would have noted that *Emergency in the Sim Ward* is a distinct text extracted through a series of live simulation enactments. As an example of emerging narrative experiences its form cannot be readily defined. In the ensuing sections I offer a discussion of *Emergency in the Sim Ward* from a neuroscientific perspective as well as a dramaturgical perspective. The methodology for my creative experiment followed distinct protocols in an attempt to capture a snapshot of how clinicians process information in time and come to narrative meaning. By remaining faithful to this methodology across the subsequent creative distillation and reconstruction of that narrative, I suggest that *Emergency in the Sim Ward* - both in form and in content - allows insight into a potential new dramaturgy of time.

The consultants' micro narratives are considered as illustrations of a narrative cognition and sense making more aligned with the brain's information processing mechanisms; a 'neurobiological dramaturgy' - so to speak - characterised by subjectivity, embodiment, enactment, emergence and presentness. Facilitated by technology, I believe we are moving conventional narrative towards a new paradigm, encapsulated by these attributes. My analysis of the micro narratives therefore focuses on the aforementioned qualities, which I will now proceed to define more specifically.

Subjectivity:

The new narrative dramaturgy privileges a 'minimal self' – a pre reflective self that corresponds to a first person perspective unextended in time [Gallagher 2000]. Although there is an overarching framework or meta-narrative in its construction, the emerging narrative is experienced and 'read' at the micro level. Narrative meaning emerges from a series of subjective moment-to-moment experiences. The point of view is clearly subjective and no two journeys through such a framework can ever be the same. The lived narrative is inscribed through the performer/reader's neurobiology. This 'new' subjectivity inherently brings with it the attributes of embodiment, enactment and emergence and gives rise to 'presentness'.

Embodiment:

The new narrative begins as a form of embodied cognition, registered firstly 'bottom up' through the senses and the body. By integrating the narrator/performer's neuro-physiological presence into the DNA of the story building process, it reels the reader/performer's neurobiology into the narrative feedback loop; the narrative progresses, responds to and takes on meaning, through the narrator/performer's actions within the narrative.

Enactment:

In this way, the new narrative operates as form of enacted sense making. As a result of this integration of the sensorimotor system, narrative cognition manifests through action. Meaning emerges from what has salience and *is actionable*. This is demonstrated by the way in which new narratives need to be ‘performed’: they need to be ‘rendered present’ by the new co-narrator /performer’s direct physical engagement. In some instances this engagement may blend with and extend into the environment - blurring the line between the physical world and the fictional narrative. This approach means that narrative meaning is never fixed, but remains emergent and dynamic.

‘Presentness’:

The new interplay between sensation, action and reflection, conscious and unconscious feedback, leads to a different experience of time. The co-narrator/performer now hovers at the interface of our primary and secondary processing systems. Poised between retrospection and anticipation, time is experienced as a constant reconstruction of the ‘now’ and lived in the present –state of perpetual ‘*presentness*’. For the purpose of this analysis I coin the term ‘presentness’ as a descriptor of this state. Presentness collapses the notion of *presence* - a subjective experiential phenomenon, and *the present* - a temporal phenomenon.⁴¹

Fundamentally I suggest that this represents a new poetic and dramaturgy of time. This suspended condition of ‘*presentness*’ could paradoxically be described as both static and changeable – something that aligns with our very neurobiological makeup. Damasio [(1999, p. 143] speaks of the ‘*impermanence of permanence*’ of our system; of how our biology is changing continuously in response to the flood of sensory information received while maintaining enough equilibrium for us to experience those sensations - and the world – coherently.

Enactment In A Medical Context:

I begin this analysis with an overview of the live simulation set up, or *Mise-en-Scene*, delving further into how it encapsulates models of pervasive and blended reality genres, the role of technology and the senses, and how this appears to impact on the sense of presence and immersion in a medical context.

⁴¹ My exploration of presence and presentness, from a neurobiological perspective, skirts around the discipline of phenomenology. It is not my purpose within this discussion to undertake such an analysis; nonetheless, my assertions resonate with phenomenologists’ notions of time consciousness and the view of presence as a way of being in the world and a way of being in time. Husserl’s explanation of the temporal structure of consciousness for example, reinforces the idea of presence as an unfolding. [Gallagher & Zahavi 2008, p. 76]. My use of presentness also resonates with Heidegger’s notions of ‘presencing’. [Iedema et al 2005, pp. 327-337]

Professor David Gaba of the University of Stanford, a pioneer in the use of simulation in health, describes medical simulation as:

“An exercise designed to mimic a real life situation in which the learner is given an opportunity to reason through a clinical problem and make diagnostic and treatment decisions”

[Gaba 2004, p. 3]

He also notes how medical simulation can achieve a level of psychological fidelity that mirrors real life, allowing participants to suspend disbelief and act as they do in real jobs.⁴² It is important to clarify that the term *simulator* in a medical context refers primarily to a device that represents a *simulated patient* – usually a synthetic, technologically driven body or mannequin – and that interacts appropriately with actions taken by the *simulation participant* [ibid, p.12]. The simulator in this environment creates the circumstances for a medical ‘task’ or intervention, via a fictitious medical incident.

My creative ‘set up’ for the emergency scenario is as a semi-fictitious narrative, experienced through an immersive role –play and mediated by technology; in short, a form akin to the serious game, ‘half real’ narrative genres of pervasive games. Working with blended reality, this is an *action* narrative, which sets up a partially real, partially synthetic environment. There is a familiarity and correlation between the simulated environment and the routine everyday - and the focal point for the simulation experience resides in the action event.

Plot And Meta Narrative Framework

“I am just trying to keep a story running ...”

[Simulation Director]

The plot and overarching narrative framework for the medical simulation is predetermined: a young man, who has suffered a car accident, is lying, bleeding, on an operating table. During the course of the treatment the accident victim is given doses of gelofusine – a version of saline solution - and he has an allergic reaction, which causes further deterioration, and leads to anaphylaxis. The story, in a sense, is framed as a problem to be solved, and the quest resides in having to solve the puzzle within limited time, recalling games theorist Aarseth’s notions of intrigue.⁴³This

⁴² Zhao differentiates between creative and training simulations by arguing that in simulations dealing purely with creative fiction, we usually encounter something we don’t in real life; in simulations involving training, the narrative is based on experiences we know well and are called upon to reproduce regularly. The creative questions of immersion, narrative and presence however remain relevant to both contexts. [Zhao 2003, pp. 138 – 145]

⁴³ Aarseth [1997, p. 114] contributes to the discussion on the shifts in traditional plot and catharsis by arguing that intrigue, more than plot, is what builds tension in games narratives. Intrigue functions more as an ephemeral state of being, permeating the overall construction and enactment of the game; catharsis, if it occurs, results from the pleasure of having resolved the intrigue: “Intrigue is not locatable on any particular level of the text or as a separate module, but may be surmised from the overall construction and playing.” Tan [2008], argues instead that ‘interest’, as an emotion in its own right, is what propels the gamer’s experience from one moment to another, more than logical or sequential cause and effect.

relationship between what is fixed, and what is variable, is described by the Simulation Director as follows:

[...] once anaphylaxis is up and running it is going to take its clinical course. Now the quicker you identify that, the more reactive and proactive you are, then potentially you can nip it in the bud, but the slower you are to recognise and react, the worse the prognosis for the patient. The simulation will play out whatever they do - the end point is the same [...] My belief is that in simulation everyone expects a complete picture, but in real-life you don't get the complete picture. You are always going to have conflicting information or information that isn't a hundred percent...and I guess it is a matter of filtering in a way that will give you the best clinical outcome.

[Simulation Director 14/04/11]

The meta framework also establishes the characters, roles and related duties, but not necessarily the way they will be enacted, with each character adapting to the shifting circumstances of the situation. As noted earlier, here the clinicians are both performers and narrators. In the simulations, the participating consultants enter the simulation laboratory and are given a briefing, which amounts to 'setting the scene' for the game play. From then on, the situation evolves in an unpredictable and ambiguous manner. The flow of movement or navigation, within that narrative space, is therefore uncertain.

There are in fact many ways to navigate the unfolding scenario, depending on the individual actions taken. Medically, the Simulation Director describes this as a differential diagnostic procedure – a process of eliminating the multiple alternatives available - in order to shrink down the probable causes for the victim's symptoms. The Simulation Director describes how there can be many causes for a particular symptom, adding more complexity to the resolution of an already ambiguous clinical situation:

"[...] the problem with anaesthesia is that this is just one scenario, [actually] there are many causes for low blood pressure not just an allergic reaction....allergic reactions can also be had to a range of drugs used..."

[Director Interview, 14/04/11]

The consultants are left to 'solve the riddle' knowing that there is a time constraint and a danger that the patient could die depending on their actions. The stakes are high, and as in a good games scenario, this emotional intensity operates to pull the performer/narrator into the story world. We could say that the scenario, or meta narrative framework remain constant, representing the experiment's *control*, and that the *variable* is to be found in the consultant's experience and navigation of that situation. Each story will be shaped by the consultant's unique history, how they take in and process new information, and how they engage in the moment. This is not unlike the actor who, when taking on a role, to a certain extent interprets it according to his or her own history, experience and perspective, regardless of how it has been written.

Given the multiple causes for a patient's symptoms, a consultant makes individual choices about what to include and what to exclude, with the narrative meaning emerging from that ultimate subjective set of choices and perspectives. As Calleja (2012) has noted, in games it is these individual choices that shape different levels of the narrative in terms of a fixed meta narrative and a subjective, micro narrative. The micro narratives of *Emergency in the Sim Ward* will be discussed more thoroughly in the second part of this analysis.

The Mise-En-Scene

*The theatre is completely set up.
Certainly not unfamiliar...
Straightforward case.
Everything is quite comfortable,
Going as I expect,
The ventilators and monitors are working effectively.*

[Consultant D]

The spatial organisation, the working stations and the physical relationship to objects are integral to the dramaturgy of the narrative and critical for the activation of a sense of presence and immersion. The simulation lab used here is a reclaimed ward of the Royal Adelaide Hospital and a site resonant of actual medical intervention. Beds, monitors, medical machines and surgical equipment have been assembled, many taken directly from working operating theatres and reassembled in the empty ward for the simulated enactment. The scene is dressed according to medical ritual and protocol. Green and blue linen covers the bed and the patient. It is appropriately colour coded to indicate types of handling and levels of sterility required. Medical and surgical instruments have been laid out in preparation for surgery; an extended range of essential medical supplies and accessories are ready in a medication cart close by.

The consultant anaesthetist's physical working space is restricted to a cubicle-like arrangement at the head of the patient, separated from the rest of the patient by a linen barrier (referred to as the blood/body/brain barrier). This means that the consultants have a limited field of view of both the patient and of any surgery that takes place below the neck, thus making the reliance on aural and visual cues via monitors even more important. The objects, the configuration of the working stations, and the capacity of the consultant to physically navigate and function within that environment inclusive of a certain amount of sensory motor fidelity, are all important if the enactment is to bring about a suspension of disbelief.

The importance of the *mise-en-scene* and its ergonomic fidelity recalls conversations with Dr. Braden McGrath who, in his experience of pilot simulation training, recounted how it was critical that certain physical attributes be present in the correct spatial and

physical configuration – particularly features such as the position, movement and feel of the steering wheel ('stick'). But while the physical and medical configuration of the medical working stations is ergonomically accurate, the actual array of medical equipment and trolleys does not represent the totality, nor the actual status of equipment found in the real operating theatre (a fact mostly due to practical, financial constraints and resources issues). In the end, this is more in line with Zhao's [2003] notion of perceptual fracturing.⁴⁴

Characters And Role Play

My simulation experiment focuses specifically on the role of the anaesthetist within an emergency medical procedure. Anaesthesia, from the Greek, means without feeling or sensation, and in medicine it is defined as, "a controlled state of reversible loss of consciousness."⁴⁵

Such loss of consciousness, or more accurately, the loss of awareness of sensation, is induced via a mix of drugs targeted alternately at pain relief, muscle relaxation, and the inhibition of awareness, by blocking the transmission of neural impulses and information within the brain. An anaesthetist is a physician who has specialised in the medical field of anaesthesia; a consultant, in medical terminology, is a specialist with the highest level of training.⁴⁶

The participant simulation anaesthetists were in fact practicing 'consultants' with many years of experience. My choice to work with consultants [experts] for the narrative enactments was also based on Klein [2001] and Ericsson's [2006] analysis of the difference in decision-making between novices and experts; based on their analysis, the assumption was that experts would exhibit a heightened capacity for rapid decision making and information processing and thus more clearly demonstrating that capacity.

Anaesthetists have the responsibility of putting the patient to 'sleep'; they take over a patient's physiology and vital signs by intercepting the body-brain feedback loops. The continuity of the body-brain mechanism, so central to the discussion to date, is temporarily suspended, rendering the patient unconscious, and is then reactivated at the end of the procedure. The anaesthetist's role may be described as situated between the biology of the body and the consciousness of the mind. Unwittingly, the

⁴⁴ See discussion on the senses, presence and perceptual realism later in this section.

⁴⁵ Australian and New Zealand College of Anaesthetists on-line definition, viewed 29 June 2011, <http://www.anzca.edu.au/patients/anaesthetist>>

⁴⁶ Generally this amounts to approximately 13 years of training: six years of medicine training, two years as a resident medical officer, and a further five years as a trainee registrar. For the purposes of this analysis, I will continue to use the term *consultant* to refer specifically to the participating narrator/performer anaesthetists in the enactments, and I use the term *clinician* for more general references.

anaesthetists serve both as tangible and symbolic bridges across the mind-body divide, adding an unforeseen poetic and metaphoric dimension to this investigation.

The uniqueness of their position is in fact ironically observed by one of the consultants in the following comment:

"I always thought it funny that as anaesthetists we spend many years learning how to make people unconscious but without ever actually discussing what consciousness really is."

[Consultant B, 27/06/11]

The anaesthetist must in fact negotiate two brain-body systems - that of the patient, who 'surrenders' their physiology to the anaesthetist - and their own. These distinct components ultimately form one feedback loop mediated through technology. In the operating theatre it is the anaesthetist who is charged with the ultimate authority of putting the patient to sleep and bringing them back to consciousness.

The internal processing and filtering required to manage and make sense of this information matrix is layered; information must be passed from one body to another, all the while extracting what is salient and filtering what is not. Both in real life and across the simulations the anaesthetists typify embodied cognition and sense making. Even in the simplest of tasks, they must rapidly negotiate a number of dense, multi-modal information streams. The situation draws parallels with Dr. McGrath's discussion of pilots in aviation simulation.

But while both pilots and clinicians carry significant cognitive loads, anaesthetists perhaps have to deal with the most unpredictable and dynamic of information sources - the human body itself.

Production Of Presence: Technology, and the Senses

I have already alluded to the fact that presence and presentness are, for me, intertwined. In itself, the term presence summons a complex mesh of perception, consciousness, our sense of self, and our sense of self in time and place.⁴⁷ Given that neuroscientific perspectives and considerations around digital technologies drive my analysis, my discussion will focus on insights emerging from the new arena of Presence Research. The current research owes its origins to investigations that

⁴⁷ Despite being debated and examined in domains as diverse as philosophy, psychology, cognitive sciences, cultural studies and computer science – presence remains elusive. In the creative domain there remain ambiguities surrounding the undifferentiated use of the terms presence and immersion. Gordon Calleja [2012], has noted that in the digital games sector for example, the term presence is still shrouded in confusion and is used interchangeably to mean immersion and absorption in order to depict the sensation of 'being there'. Alison McMahan [2003, pp. 67 - 87], advocates a definition of presence, as used in technical and scientific domains, to provide the basis for a more precise discussion of immersion in emergent narrative expression. For more comprehensive discussions and perspectives on presence and immersion in the arts, see Grau [1995]; Bolter & Gruisin [1999].

emanate from those working with virtual and technologically mediated worlds.⁴⁸ The potential for technology oriented presence researchers and their interrelationship with neuroscientists to illuminate and inform each other represents an exciting and yet-to-be fully understood frontier.⁴⁹

The Centre for Interaction Research (UK) describes Presence Research as follows:

"The term Presence refers to an emerging research field seeking to understand the experience of being, and developing technologies to generate and augment it (being someone or something, somewhere, sometime, with others and without physically being there). The central idea is that reality is a product of our brains: we construct reality in our heads from our (actively controlled) sensorial inputs. Ergo, if we 'hack' the sensorial data stream, we can substantially alter our subjective perception of reality."

[Benyon et al 2009, p. 12]

I endorse also the following observations by Presence Researcher IJsselsteijn:

"With the advent and improvement of perceptually realistic, immersive, interactive and engaging media, the experience of presence has become an area of scientific inquiry that has the potential to bridge the gap between media and minds. To do so, research is needed that connects insights from relevant technologically oriented domains, such as computer science and display development, with relevant knowledge from sociological, psychological, and neuroscientific domains. A theory of presence is needed that builds on insights from these diverse areas."

[IJsselsteijn 2002, pp. 245 – 25]

What these comments highlight for me is not just the renewed interest in the experience of presence, but the critical role of the senses in its production, and more specifically how technology and science can now intercept this production. From a neurobiological perspective, the manufacture of presence relies on palpable inputs: it emanates from a neurobiological reality and a condition that begins with the processing of direct sensory information.

I return, therefore, to my addendum on the processing brain and James Gibson's [1966] description of the senses as perceptual systems. At the most fundamental level, our sense of presence is determined by our ability to hear, touch, smell, taste, see and physically orient ourselves in space through our sense of body movement and position. We manufacture this bodily presence through our sensory organs – organs that act as mechanical, chemical, and thermal and photoreceptors – and translate sensory information into feeling.

⁴⁸ The term telepresence was coined by cognitive scientist Marvin Minsky and driven by telecommunications research [Stuer 1992, pp. 73 – 93]. Today however, the prefix 'tele' is most often omitted, suggesting for me that our focus has shifted away from the technology to the experience itself.

⁴⁹ "Presence research was initiated and has largely remained within the ambit of technologically oriented research departments, and more recently has been of interest to psychologists and clinical psychologists. The field has remained quite separate from neuroscience, illustrated by the fact that not a single reference to presence research appears in the neuroscience literature [...] First it should be noted that VE technology provides an excellent tool in general for neuroscience research." [Sanchez-Vives & Slater 2004, pp. 141 – 147]

All of this of course correlates with Damasio's thesis that emotion and, by extension, consciousness and awareness, originate in the body [Damasio 1999]. Without a body to process sensations, we cannot *feel* or *cognise* presence. Neuroscientist Marcello Costa [2008], points to the importance of sensory signals in giving us the sense of ourselves and our place in the world including the disorders that can emerge when sensory experiences are cross-wired (as in synesthesia) and/or imagined:

"The subjective image of our body emerges from the convergence of multiple senses, the visual system, the balance system, and the sense of body position and movement (proprioception), in a particular part of the brain near the angular gyrus. This strongly suggests that the brain continuously checks and compares the sensory signals from the body with the motor signals, building a strong sense of 'embodiment', i.e. of a self localised within one's bodily borders as if the body fits like a glove." [Costa 2008, pp. 38 – 40]

Taking this into account, perhaps the more accurate understanding of the presence as being evoked in emergent narrative forms is offered by Professor and sociologist, Shanyang Zhao who describes presence in the current paradigm as:

"a collection of technologies that seek to create the perception of presence in an immersive environment through sensory simulation and extension."

[Zhao 2003, p. 138]

Zhao's 2003 article, 'Being There and the Role of Presence Technology', differentiates between different modes of presence in a mediated synthetic environment – all of which are generated through an activation of the senses. *Sensory extension* extends the person's natural senses to experience a place without being there, and *sensory simulation* brings the remote place to the person, allowing them to interact and feel it as though they were there. Importantly, the experience of the senses is both embodied and enacted.⁵⁰ Thus sensory activation and extension are just as much critical for the creation of presence in the mediated environment as in the real world. Presence researcher Thomas Sheridan affirms the criticality of the senses and, significantly, adds the qualifying attribute of agency [Sheridan 1992].⁵¹ Presence is thus affirmed both by sensory activation and by the individual's capacity to act upon and influence the environment or outcome.

⁵⁰ Technology's capacity to produce multi-sensory stimuli to emulate human cognitive processes is the new interface between technology and human cognition [Gorayska & Mey, 2004]. In the inaugural issue of the Journal of Gaming and Virtual Worlds, Alf Segeert [2009, pp. 23 – 37], draws a line from interactive fiction straight back to Heidegger. Segeert examines the capacity of interactive fiction and virtual worlds to produce 'presence' which he defines as a 'visceral feeling of actually being there.' He concludes that a critical ingredient for this sensation is the capacity for embodied interaction within that world. In other words, presence is about the feeling of 'being' in time and in space – 'Dasein'. In what essentially is an endorsement of the enactivist view, he argues that interaction is the means by which the world presents or 'reveals' itself to the user.

⁵¹ Sheridan [1992, pp. 120 – 126], proposed three categories of determinants of presence: (i) the extent of sensory information presented to the participant; (ii) the level of control the participant has over the various sensory mechanisms; and (iii), the participant's ability to modify the environment.

These assertions align and resonate within *Emergency in the Sim Ward*. Above all, my narrative experiment gives prominence to the impact of sensory simulation, sensory extension and a presence generated through interactions with technology. The incorporation of raw sensory data, movement, and agency, equate to the very neurobiological prerequisites for the production of perceptual and sensory presence – qualities integral to the new narrative and ‘digital’ aesthetics.

It now becomes clearer how my simulated re-enactments put the spotlight on a deeper, more direct engagement with the senses. I believe the enactments go even further, by ultimately suggesting a type of ‘sensorimotor correspondence’:

The experience of presence appears to be a complex perception, formed through an interplay of raw multisensory data, spatial perception, attention, cognition, and motor action, all coupled through a constant dynamic loop of sensorimotor correspondence. The fact that technology can start working as a transparent extension of our own bodies is critically dependent on (i), intuitive interaction devices which are ‘invisible-in-use’, seamlessly matched to our sensorimotor abilities, and (ii), the highly plastic nature of our brain, which is continuously able and prone to adapt to altered sensorimotor contingencies.

The perception of us as part of an environment, virtual or real, critically depends on the ability to actively explore the environment, allowing the perceptual systems to construct a spatial map based on sensorimotor dependencies. Provided the real-time, reliable correlations between motor actions and multisensory inputs remain intact, the integration of telepresence technologies into our ongoing perceptual-motor loop can be usefully understood as a change in body image perception – a phenomenal extension of the self.”

[IJsselsteijn 2002, pp. 245 – 259]

There are however several paradoxes within this sensory activation and extension which will become evident as this discussion progresses.

The Technology Paradox

*Get the arrest trolley.
Aesthetic nurse gets the defibrillation machine
It gives instructions I don't agree with
Start CPR*

[Consultant C]

*Not sure if I am hearing simulated environment ‘wheeze’?
Not sure if I am hearing respiratory wheeze?*

[Consultant B]

We struggle with technology.

[Simulation Director]

It goes without saying that medicine has historically always relied on some form of 'technology' or tools to aid its operations. It is obvious also that a level of sensory input, real or simulated, is essential to run clinical enactments in order to generate the symptoms required for medical problem solving; the physiology of the body is the clinician's source of primary data and feedback.⁵² In *Emergency in the Sim Ward*, the 'patient' is a simulator -a computerised mannequin doll - linked to a central server and computer station. The station is hidden from view, and the mannequin is controlled by the Simulation Director, who acts much like a puppet master in a games scenario, feeding in directions and vital signs as the scenario progresses. The simulator 'patient' is prepped as for an operating theatre. It wears the thermal skullcap to reduce heat loss and has various feeds and lines attached to it: for the monitoring of vital signs, supply of oxygen, blood and saline solutions as needed. It has an open incision in its abdomen, which will be attended to by the clinician role-playing the 'surgeon'.

Representing blood loss, a swab of red linen surrounds it - symbolic representations all adding texture and meaning. The mannequin is capable of emitting a range of sensory (vital) signs for the consultant/player to respond to. The director/puppet master is able to feed in and alter vital signs including pulse, breathing sounds, pupil dilation, chest respiration, heart sounds and blood pressure.

Throughout the simulation enactment the senses are manipulated through artificial sensory inputs and extensions, so as to resemble an actual encounter with a real patient. The digitally augmented mannequin in and of itself demonstrates, par excellence, the previous theoretical consideration about the relationship of presence to the senses, and technology's increasingly complex role both as a generator and a mediator of sensory data.

The Simulation Laboratory is also populated by other medical equipment and technologies representing different generations of equipment – from older, superseded medical models and machines to, for example, the latest CPR equipment. This factor contributes complexity and uncertainty to the scenario.

During normal duties a clinician would probably never confront such extreme disparity between old and new technologies but it would also not be unusual for technology upgrades and changes to occur regularly within a hospital system and thereby require of clinicians that they rapidly familiarise themselves with new operating equipment and protocols. During the tests leading to the simulation enactments, clinicians

⁵² With advances in technology, high fidelity patient simulator models continue to display an impressive array of features including: airway and breathing features; cardiac, circulation, vascular features; and sounds. One of the most recent neonatal simulators for example, can emit sounds that range from hiccups and crying, to heart sounds mimicking heart murmurs and pneumonia, to vascular access, spontaneous breathing features with variable rates, Co2 exhalation, anatomically accurate airway features, variable lung resistance, umbilical and brachial pulse, manually measurable pulse, movement in all four limbs, constricting and dilating pupils [and more]. More examples of simulation models available at: <http://www.laerdal.com/au/>

commented extensively on how this technology presented the profession with a dilemma.

Both in real life and in the simulation enactment, the relationship with technology appears paradoxical. On the one hand, the digitized tools enhance the capacity to automate certain operations by offering instant feedback with ever more detailed data, to augment or extend cognition:

"The visuals that are happening on the monitors are a bit part of my environment. I am very used to glancing at the monitor and getting all the information we need. There is a lot of subtle information ... the tone of the monitor... the shape of the waves ...I will often have that in the background and then if something changes I will pick up that change ... while I can be doing on other things."

[Consultant B 27/06/11]

"Most of the time the technology is reassuring... monitoring is a fantastic tool and I would never be without it ..."

[Consultant C 27/6/11]

On the other hand some consultants also demonstrate a wariness and distrust of these technologically automated systems and technology's capacity to interpret the dynamics of the evolving situation:

"...unfortunately it wasn't a familiar defibrillation machine...and the anaesthetic nurse and myself weren't familiar with using that one and [it] was giving us instructions which I didn't necessarily agree with which was a bit of a distractor [...] I find that a monitor that is telling what to do is more distracting because I think, 'are you telling me that is what it is...or are you telling me what the automated program is telling you to do?'"

[Consultant C 27/6/11]

Throughout the micro narratives, technology clearly intersects the anaesthetists' information processing and meaning making, in multiple, paradoxical ways. While technology creates meaning and presence by simulating sensory data, it also mediates that data, intercepting that stream - as Chan [2006] notes, along an axis of perception - augmenting inputs but also potentially reshaping them together with our perceptions.⁵³

Across *Emergency in the Sim Ward* the two sensory information streams to demonstrate this phenomenon most clearly are the haptic and aural streams. Conversations in the lead up to the simulation enactments, and observations around the role of touch and sound in anaesthesia, illustrate the point.

Touch is the most immediate of the senses in that it is the one that most gives us a sense of presence through a tangible (physical) verification of the here and now.

⁵³ "I take the view that the mediation of experience involves technology as a means of production, and that technologies amplify experience along an axis of perception. There are hearing technologies, sight/ vision technologies, writing, interaction, and other technologies. This tunneling of experience or channeling of perception conditions experience, and creates a framework within which our physical and perceptual experiences are modified." Chan [2006] viewed 25 April, 2010, <<http://www.gravity7.com>>

Touch is also a bottom-up form of knowledge - a palpable visceral exchange from body to body – and a transmitter of knowledge:

“Touch interventions are an action–dialogue. Touch uses highly developed palpation skills to contact sensory impulses as they arise bottom up to interact with top down cognitive and verbal narratives, forming a reciprocal, interpenetrating exchange between soma and psyche.”

[La Pierre 2006, pp. 43-45]

The fall out - and the irony - from the collision of medicine with these digital advances is that just as the haptic dimension is being increasingly introduced in the latest technology consumer products to increase the sensation of presence and immediacy, direct touch, real touch - in the form of body to body knowledge transfer - seems to be disappearing from the practice of western medicine.⁵⁴

Clinicians described how they could now watch a monitor to ‘read’ the pulse rate, but they no longer, for example, had to feel a pulse rate. Prior to many of these advances it was possible to get feedback from the direct feel of the skin, the sweat, the temperature, the pulse. This was knowledge – in the form of a range of unconscious, pre-reflective sensory impressions - that would build up across the entire treatment process, including the pre-operative phase. It enabled a clinician to build up a bank of subtle data, giving them a better chance of anticipating and intuiting problems in the actual operating theatre:

“... as I am assessing the patient I have a sense of what the issues are by having time with them...taking a lot of subconscious ... taking a lot of information ...also if I have actually put in the lines and I know they have been difficult ... that gives a sense of the volume and status of the patientin fact, all the different processes come together in the whole impression of the person...”

[Consultant B 27/06/2011]

While embracing the advantages of data visualisation and the capacity of modern digitised medical machines to give an immediate picture of a patient’s vital signs, the consultants confess to experiencing the loss of other modes of intuitive body-to-body knowledge and becoming deskilled in some forms of hands-on practices. The opposite however appears to be occurring with the aural dimension. In terms of sensory data, sound is the fastest to be processed. An auditory stimulus takes 8-10 milliseconds to reach the brain whereas a visual stimulus takes 20 – 40 milliseconds.⁵⁵

This feature serves anaesthetists well. Over and over again, the clinicians demonstrate an automatic, visceral response to auditory stimuli, both during the simulation as well

⁵⁴ Not surprisingly, touch provided one of the earliest forms of healing and therapy. Consider eastern healing practices of touch or the ancient Vedic pulse diagnosis. French philosopher of the ‘body’, Bernard Andrieu who notes, “touch is the original cause of therapeutic relation”, yet in the 21st Century, mediated by technology, medical physicians can treat a patient without ever practically touching them.” [Andrieu 2007]

⁵⁵ Kosinski [2010].

as in the routine execution of their every clinical duty.⁵⁶ Clinicians noted how the slightest shift in the pitch and tone of a single monitor would be registered and commented on their ability to detect, recognise and respond to a drop of shift in tone from anywhere in a ward.⁵⁷

This was something that I had a personal occasion to witness across several visits to the hospital. During a guided tour of an intensive care ward with a senior registrar, he exhibited a heightened awareness of the sounds in the ward and a palpable shift of mood when one of the monitors changed its tone. What the clinicians lose in one sensory dimension of the simulation, they appear to gain in another, demonstrating that digital technology doesn't just augment processing capacity, but is also capable of intercepting and remodelling those capacities and our narrative understandings.

Consider the following comments highlighting both the reliance on sensory triggers and the mediating role of technology:

"... the first indication that something was going astray was the saturations weren't running 100%, and the tone is the first thing that I notice so the tone of the saturation monitor dropped [...] it was obviously continuing to fall and my reaction at that stage when it went into the low 90s is to disconnect the patient from the ventilator and manually ventilate and listen to the chest because you tend to get better quality of hearing from breath sounds when you disconnect from the ventilator, you get decent volume and it might also help with the anaphylaxis so it can be diagnostic, as well as treatment." [Consultant D 23/05/11]

As noted by the clinicians in early testing, what the consultant anaesthetists lose in the sensory domain of touch they augment and compensate for in other dimensions such as sound. Sound appears to operate in two ways in the enactments, both alerting clinicians to danger, but also offering reassurance that allows them to alleviate the cognitive load and focus on other inputs.

"...it was quite reassuring hearing the regulatory sound and the pitch of it, and I was just taking that all in at the same time as well as I was taking in the mood of the surgeon and whether there was any anxiety." [Consultant C]

Sounds emitted by the medical machines and simulator, particularly the quality of breath (as in real life) provide essential cues for action. The consultants are constantly on the alert, checking for this quality of breath, listening to monitors. These sound processing signals appeared so intuitive that that they were able to short-circuit any

⁵⁶ Distributing the cognitive load across more than one sensory modality (for example the aural modality) can expand working memory. Thus the ability of sound to cut through at a faster rate than other sensory processing channels would be a significant asset in rapid decision-making. Cognitive Load Theory refers to the load imposed on working memory by the information being presented. [Mayer 2005, p. 26 & pp. 339 - 355]

⁵⁷ This needs to be viewed against the Simulation Director's assertion that even within this process there is a level of selective processing and subjective awareness: "Our senses are heightened to certain aspects, such as the monitors, the heart rate, and the saturations. But I think we prioritise, or put in a hierarchy even of the sensory information, so information coming from someone like a say a scrub nurse is not as important as some other information stream." [Director Interview 14/04/11]

other (more linear) processing loops to produce an instantaneous response. When consultant D says that subconsciously he knows things weren't 'right', I asked what specific things indicated this. He responded:

"[...] the sounds around me weren't right ... there was a change in those."

[Consultant D 23/05/11]

While Consultant B states:

"I also focus on sounds ... on the sounds that I'm tuned into ... the heart rate and the saturation."

[Consultant B 11/04/11]

These observations concur both with Damasio's theories and the view that our senses are essential "communication channels to reality", ultimate pathways to the mind.⁵⁸

Sensory Processing, Presence and Perceptual Realism

I think I moved into a real situation.

[Consultant B]

Is this genuine? Is this where I have to take it seriously?

[Consultant D]

The simulation experiment also brings to the fore another intriguing nexus between sensory processing, reality/realism, and the experience of presence. Robert Stone's experiments with realism and psychological fidelity in simulations at the University of Birmingham distinguish between physical fidelity and psychological fidelity.⁵⁹

Stone argues against a realism-based presence; instead he uncouples realism from presence to argue that appropriate and contextually relevant sensory, textual and sensory motor effects are more important in engaging the user's awareness and in creating immersive presence. The reproduction of a more accurate and detailed level of fidelity does not necessarily guarantee a more immersive presence. But it seems that sensory integration does, a factor that was also reiterated during the workshop with Dr McGrath. McGrath described how it was more important in simulation training for a pilot to hold a steering 'stick/yoke' that 'felt' and 'moved' like one normally found in a cockpit, rather than to view hyper-realistic graphics. This phenomenon has also been noted in other academic research:

"The impact of realism on the reported presence was evaluated. The results suggest that the lowest presence was achieved with the higher fidelity characters but the less varied textures."

[Brogni et al 2007, pp. 1 – 10]

⁵⁸ Sekuler & Blake [1994, p. 2], argue that the senses are not only portals to the mind but "communication channels to reality."

⁵⁹ Stone [2008].

The simulations conducted at the Royal Adelaide Hospital (RAH) are mix of a material and physical reality, a synthetic reality, and a mental/experiential event. Again, Zhao's nuanced analysis of the different types of 'presence' offers a valuable insight into mechanisms at play in generating immersion:

"Perceptual realism refers to the perceived resemblance between simulated and real-world experiences. In general, users expect a virtual environment to be life-like. For example, they would want the animated pictures of people to look like people; the artificial trees to look like trees; and the plot of a story to be realistically plausible. However, realism in a virtual environment is often perceptually fractured: an experience may be more real to some senses but less real to other senses. A black and white drawing may look real in terms of patterns but not in terms of colors; a cartoonist bird that chirps may sound real, but may not look real; and a play that may seem real in all aspects, but takes place merely on a stage. Many users have learned to tolerate such perceptual fracturing by focusing only on the targeted sensory areas and ignoring the rest."

[Zhao 2003, p. 142]

While the RAH simulation lab was set up to approximate an operating theatre, with enough core components to create familiarity and believability, it by no means offered a total and accurate reproduction. What the lab did was create the sensation of realism.⁶⁰

"...the theatre was completely set up, completely familiar but certainly not unfamiliar to me...my major concern I must admit when I entered the theatre was the monitor, the monitor doesn't seem to be bright enough...issues with the clarity of the screen but that's about all...I was surprised there wasn't anyone assisting the surgeon, but I don't know whether that's part of the scenario or not, there are normally more people in theatre."

[Consultant D 23/05/11]

The appropriate degree of realistic detail was something that had evolved over time for the Simulation Director. He had come to observe that it was not so much necessary to reconstruct a total and accurate fit-out of a ward, but to ensure that certain textures and sounds (sensory data) were present. Hence it did not matter how many surgical instruments were laid out, but it was significant to have some cloths 'stained' with red colouring to give a visual sensation of the blood that would be present during an operation. It was important to capture the sense of constrained physical space of the anaesthetist's work-station, to place a thermo skullcap on the simulator and – something all of the participants comment on – for the clinicians to wear surgical caps.

The effectiveness of props/objects to precipitate immersion in medical role-play paralleled my twenty year experience of directing theatre improvisations, watching performers rely on a hat or jacket so as to trigger a range of emotional associations, that would act as a catalyst to immerse and transform them into a different persona or

⁶⁰ Lombard & Ditton [1977] also interrogate the idea of presence as perceptual immersion and the relationship of psychological realism to what they call social (photorealistic) realism. For their more detailed perspective of the different conceptualizations of presence in computer mediated environments, see: <<http://jcmc.indiana.edu/vol3/issue2/lombard.html>>

role.⁶¹ There are also resonances with games narratives where props and costumes are used to further the narrative action.

Zhao's definition of perceptual realism gives us a way of interpreting this medical simulation environment. The description of perceptual realism as 'fractured' – realistic in some detail, abstract and missing in other features - generates for me a story world that hovers between symbolic representation and the fidelity of raw sensation. This is not at all unlike the story worlds depicted in epic computer games.⁶²

In addition, the distinction between real and non-real becomes even more layered when we look at how the actual roles and role-play are transposed into the simulated environment. The participants in this study were for the most part re-presenting themselves in a fictitious scenario surrounded by known peers and so simulating the diversity of roles normally enacted by operating theatre clinicians. The skeletal medical team assembled for the demonstrations consisted of highly qualified clinicians willing to 'act out' medical procedures from their every day working life; so much so that one of the participating consultants literally walked directly from a morning shift in an actual operating theatre, straight into a simulation scenario. This feature added a heightened dimension to the need for the suspension of disbelief.

In preparation for the scenario development, the Simulation Director and I discussed at length the difficulty of working with experts who would by their very nature be suspicious of simulation, and how to catapult them into a suspension of disbelief. In addition to the degree of fidelity of the environment, a range of other techniques were deliberately deployed: keeping the scenario fairly short, ensuring that the scenario had the right level of complexity, and introducing the occasional unpredictable component – such as unfamiliar technology in the form of a different make or model. These subtleties all served to keep the participants on edge and emotionally immersed.

Observations regarding the consultants' responses and their immersion in the simulation must be tempered by the fact that participants were all experienced clinicians highly cognisant of being observed by peers, and, the inherent risk of compensatory behaviour emanating from this fact. Indeed, several consultants, thrown

⁶¹ Actors, particularly those traditionally trained in psychological realism methodologies (e.g., Stanislavski, Strasberg) regularly use personal memories and sensory triggers to activate emotions that they then overlay into their fictitious character role to give their performances more psychological truth and 'presence'. Secondly, by activating previously stored patterns and choosing to re live them in the present, they also often blur the line between fiction and reality. Whilst acknowledging that a degree of pattern recognition (memory) is always implicated in the experience of the present/ presence, this is not the centre of interest for my experiment. Psychological realism and memory are instead viewed as part of a broader all-of-mind/body cognition. My investigation lies more in the temporal dynamics of the different information processing routes and how they converge on the neurobiological experience of 'presentness' (see Addendum 2, Considerations on the Processing Brain).

⁶² Consider for example popular video game series such as Mass Effect [Bioware 2012] and The Elder Scrolls [Bethesda Game Studios, 2013].

by knowing that they had recognisable peers acting in support roles, speculated whether this might have impacted as a negative, making them over-ride their normal instinctive and intuitive responses:

"There was a sense of having to perform for my peers." [Consultant B, 27/06/11]

"It's a slightly different scenario...if it was in theatre it may be a bit more intuitive, you would probably be questioning your monitors a lot more which you don't do so much in a simulation so its more deliberate thinking." [Consultant C, 23/05/11]

"In simulation you turn your intuition off...you over-compensateyou over-call some things and under-call others." [Consultant D 23/05/11]

The combined simulated context and the technology do generate equivocal responses in that there is an indelible gap between what can be simulated, an actual living multi-sensory body, and the depth of human-to-human exchange. Yet, as the emergency escalated, and the sensory and emotional intensity augmented, each of the participants suspended their disbelief. They unequivocally became immersed in the experience, moving on to "take it seriously" as one consultant put it, providing enough fidelity to observe genuine responses within real time decision making.

The micro narratives offer tangible evidence therefore that that sensory and emotional data drive immersion, more than realism or hyper fidelity and that 'presence' in simulation is triggered more by the narrator/performer's neurobiology through embodiment and enactment than by their psychology.

Analysis, Section Two: Micro Narratives

The New Subjectivity

Having examined the medical simulation mise-en-scene together with the technical and environmental factors affecting role-play and presence, I will now delve into the process proper of information processing and narrative sense making. The core of my hypothesis and experiment lies in what I will describe as a 'new subjectivity' being privileged throughout emerging narrative forms. Some recapitulation of this thematic thread is warranted.

Ricouer [1985] alludes to the paradox presented by the action and time of story and plot (as described by Aristotle), and the temporal character of lived human experience (as described by St Augustine). The tension between the time of story, and the time of lived experience, goes to the heart of this investigation. With the subjective perspective of emergent narratives in general, and my experiment in particular, the focus falls on the sensual, felt experience of an event, such that cognition and meaning reside increasingly with the individual's sensory perception.

I argue that this move towards an increasingly 'experiential' paradigm⁶³ is disrupting conventional representation and forging a different relationship between self, presence and the structuring of narrative time. So much so that the quest behind many new forms is not so much 'what story am I telling', but 'what kind of experience am I creating?'

This subverts traditional story development – described earlier as a reflection on experience – to locate narrative meaning in the moment-to-moment. Drew [aka Bucksbarg] describes this difference between traditional narrative development, utilising retrospective cognition, and experiential meaning based on real time sensory engagement as follows:

*"... [traditional] Narrative does not factor in other means of constructing meaning based on the experiential [...]. This seems even more evident when we expand creative practices into socially performed and improvised realms, where participants play and engage in momentary creative acts. [...] Meaning is levelled in the experience, whereas [traditional] narrative begs for some overarching, connective construction of knowledge formed in retrospect"*⁶⁴

⁶³ "And so we enter the era of what I'm calling Experience Design. A quick scan of our socio-cultural landscape suggests that, in terms of artistic practices, mass entertainment, sports, and emerging technologies of pleasure, productive forces are increasingly targeting experience itself – that evanescent flux of sensation and perception that is, in some sense, all we have and all we are." Davis [2001] viewed 10 March 2010 < <http://www.techgnosis.com/experience.html> >

This experiential perspective interestingly resonates with John Dewey's pragmatist view of "Art as Experience," Dewey [1934]. See also Shedroff, [2001].

⁶⁴ Drew [2011], viewed 3 March 2012, <http://www.vjtheory.net/web_texts/text_bucksbarg.htm>
105

Games veteran, Rob Fulop, goes so far as to radically suggest that the primary experiential response, in the form of the sensation and stimulus of the cursor, is the new narrative experience. He highlights for example, how the process of game character identification is totally intertwined with the movement of the cursor:

"When you play a game 10,000 times, the graphics become invisible. It's all impulses. It's not the part of your brain that processes plot, character, and story. [...] If you watch a movie, you become the hero - Gilgamesh, Indiana Jones, James Bond, whomever. The kid says, 'I want to be that.' In a game, Mario isn't a hero. I don't want to be him; he's me. Mario is a cursor."

[Fulop, cited in Rosenberg, 1995, p. 4]

For me this fundamental shift to the subjective experiential perspective is ultimately responsible for bringing neurobiological sense making to the fore in narrative. It is subjectivity lived as a physical navigation of the narrative space and characterised through embodiment, and enactment.⁶⁵ *Emergency in the Sim Ward* demonstrates this subjectivity through the four micro narratives that originate in the neurobiology of the consultants, with their sensorimotor processing and 'bottom-up' responses, instead of a dominant linear narrative based on a 'top-down', logical structuring and manipulation of time.

Consequently, my analysis differentiates between the meta-narrative or architectural framework provided by the setting and plot of a story scenario (as outlined in Part 1 of this Analysis) and the micro-narrative, which traces the subjective individual journey through that framework. Although the meta-narrative does not change, each micro-narrative – represented by the four enactments of the clinicians - highlights miniscule shifts in narrative cognition as each individual processes the information in their own way, and via their own timing.

My approach is informed by readings of Calleja [2012] together with the theories of Manovich [1998, 2004] and Jenkins [2004]. Manovich conceptualises new narratives as a landscape to be navigated by the reader. For Manovich, the visual and spatial configuration of narrative compositions in the digital space has introduced the notion of 'space time', requiring the reader to select and navigate a pathway across multiple story possibilities. The new reader is given agency to map his or her autobiographical journey by linking actions and events in any direction, as opposed to necessarily following a linear sequential arrangement.⁶⁶

Jenkins [2004] concurs, arguing that in interactive narrative spaces, spatial development and navigation supplant plot development as the main structuring

⁶⁵ Consider for example the publicity for a recent video game, *The Elder Scrolls*. It reads, "You are what you play." viewed 19 August, 2013, <<http://www.elderscrolls.com/>>

⁶⁶ Manovich describes a '*new poetic of augmented space*'. He argues that if the 1990's were about 'virtual', the 21st Century is about augmented space. Manovich believes that as technology becomes more ubiquitous, we will find ourselves negotiating a landscape of augmented physical spaces. [Manovich 2006, pp. 219 – 240]

device.⁶⁷ Every movement within the architectural 'space-time' is a way of building character, creating drama or facilitating a particular mode of perception.

For me, this navigation is a powerful metaphor. The movement across time and space in story is no longer something that happens solely in the mind's imagination. The new journeying is enacted and actively embodied by the reader/performer; it requires direct real time physical engagement - even if it is just through the click of a mouse.⁶⁸ Navigation brings together our sensory motor system (movement) and orientation (subjective perspective) giving the reader/performer agency to enact the story according to their preferences⁶⁹. Narrative cognition emerges through this movement across the compositional framework; the only central tenant in the narrative landscape is the narrator/performer who becomes both the axis and the interface for the unfolding meaning.⁷⁰

"In Doom and Myst - and in a great many other computer games - narrative and time itself are equated with the movement through 3D space, the progression through rooms, levels, or worlds. In contrast to modern literature, theatre, and cinema which are built around the psychological tensions between the characters and the movement in psychological space, these computer games return us to the ancient forms of narrative where the plot is driven by the spatial movement of the main hero, travelling through distant lands to save the princess, to find the treasure, to defeat the Dragon, and so on." [Manovich 2004]

Thus the protagonist and centre of my narrative experiment is the anaesthetist; the consultant becomes in fact both performer and narrator. The micro narratives and the consultants' work stand – as Cunliffe and Coupland note – as embodied narrative performances.⁷¹

⁶⁷ Jenkins portrays modern storytellers as "narrative architects" and argues that "games designers don't simply tell stories; they design worlds and sculpt spaces." [Jenkins cited in Harrigan et al, 2004, pp. 118 – 130]

⁶⁸ "It is in the code of search engines and the aesthetics of navigation that the new conceptual field work lies for the artist." [Vesna 2007, p. xi]

⁶⁹ Thus in a game scenario for example, the player/reader enters and navigates a 'meta' story world that for all intents and purposes is pre determined. But exactly how, and by which path, the player travels through that world depends on the individual choices of the player.

⁷⁰ Transmedia specialist Christy Dena [2009], argues that such re-centering and self-world orientation merely represents a different implementation of the Aristotelian unities of time, place and action. Essentially, it is the readers who sit at the centre of the transmedia story world, and travel across the different expressions, who propel the fiction across the different formats, taking key understandings with them. I concur with Dena's views about self-world orientation and subjective navigation as a way of approaching new forms of transmedia and emergent narrative. However, my thesis and ultimately my experiment diverge from Dena's argument in that my focus on neuroscience and neurobiology problematizes what happens at that subjective, experiential level of narrative processing. As a result, I speculate that cognition in narrative is now being activated in different ways - many of which ultimately question the Aristotelian construct.

⁷¹ "We argue that we make our lives, ourselves and our experience 'sensible' in embodied interpretations and interactions with others. We suggest this occurs within contested embedded narrative performances in which we try to construct sensible plausible accounts that are responsive to the moment and to retrospective and anticipatory narratives." [Cunliffe & Coupland 2011, p. 63]

And, as a subjective 'self narrative' of lived time, the perspective is unrelentingly that of a first person point of view, focussing on the nuances of individual perception attention, emotion and logic. The micro narratives for the most part depict the singular experience of the emergence of meaning – as felt from within, adjusting to each event and changing circumstance.

Moreover, this concentration on navigational flow, and the appeal to direct sensation through moment-to-moment experience, impacts on another Aristotelian tenet - that of catharsis. Classic dramatic narrative hinges on the drive towards a single cathartic climax and resolving action.⁷² Through mimesis, the reader, in the position of passive witness, would normally psychologically empathise with the emotional journey of the protagonist, to experience a parallel release of tension at the story's climax. While the new narratives maintain the nexus between action and emotion, the reader/performer's experience is no longer channelled towards a *single* climatic action.

Jarvinen [2009] explains this phenomenon in *Video Games as Emotional Experiences*. In game narrative for example, emotions are embedded into the game design via objects, agents and events – all of which are capable of triggering sensation. Games function by building up to game states representative of different levels of the game play. Each game state in turn triggers an emotion-action (such as run, fight, hide). The level of emotion is related to the player's investment in the play or goal. Emotion and empathy therefore are not necessarily invested in a character but elicited through the design of goals and game states. Consequently, the reader/game player does not work towards a single climax. Instead the player moves from one game state (or emotion-action) to another game state (emotion-action).⁷³ Kallay describes these game states as micro narratives culminating in mini-cathartic moments:

"With the absence of a cohesive, time-limited overarching storyline in many interactive narratives, the closest to structured narrative (including closure) to which an interactive format comes to is within the micro narrative. So within a micro narrative 'mini-cathartic moments' can be found, as releases of the prospect-based emotions when a mini-goal has been achieved and obstacles overcome." [Kallay 2010, p. 27]

The narrative shape of *Emergency in the Sim Ward* falls in line with these observations. The consultants' micro narratives do not follow a trajectory leading towards a single cathartic moment; instead the narrators/performers move from one sensation (or game state) to another, at the most accumulating a series of temporary micro-cathartic experiences along the way. This new subjectivity of emerging forms is captured in my creative experiment primarily through what I have called 'micro

⁷² Catharsis in dramatic narrative refers to the purging of emotion through a release of tension set up through dramatic conflict, and culminating in resolution and closure. German dramatist, Freytag, further refined Aristotle's classic model in 1863 by outlining a dramatic structure and arc consisting of exposition, complication, climax and dénouement. Freytag [2008]

⁷³ Jarvinen in Perron & Wolf [2009, pp. 85 – 108].

narratives'. What now follows is a consideration of the micro narrative as a subjective sense making process.

The Micro Narratives As Sense Making

In approaching the simulation enactments as micro narratives of lived experience, 'sense making'⁷⁴ offers a better lens through which to understand and analyse the narrative trajectory. It aligns with neurobiological notions of emergence and enacted cognition, which trace the attribution of meaning on a moment-by-moment basis. Indeed, the critical attribute of sense making is the understanding that cognition remains fluid, each action resulting in the need to reinterpret the situation, resulting in a new appraisal or 'story'. Sense making also clearly centralises the reader/performers within the narrative construction process, and allows them to navigate across modalities and sensory responses to formulate their own unique understanding.⁷⁵

This proposition of narrative cognition as embodied and enacted sense making, is underpinned by Varela & Maturana's theory of autopoiesis⁷⁶. Autopoiesis considers the sense making and cognitive capacity of life in its minimal neuro biological and cellular expression. [Thompson 2001, p. 66] Each organism fundamentally generates and specifies its own meaning and organisation, even at a cellular level. Rather than being locked down in any one component or instance, cognition *emerges* from the flow of interactions, both within the organism and through its interaction with the external environment. This concurs with my assertion about how, as a result of the new narrative privileging self-referentiality, narrative meaning moves through one action state to another.⁷⁷

Medical Sense Making

*In my mind, not clear what is happening.
Situation changes,
Move onto the next problem
From airways to circulation,
From one diagnosis to another.
Ask for the emergency button to be pushed.*

⁷⁴ Sense making is formally grounded in the disciplines of organisational studies and information science. My specific encounter with the field of sense making was precipitated through conversations with Dr. Braden McGrath and its use in the defence sector as a descriptor for the processes of creating understanding and meaning making in critical situations. [Leedom 2001, p. 8]. For my research I draw on the work of Wieck. [1988,1995]

⁷⁵ This approach also falls in line with the afore-mentioned thesis by Cunliffe & Coupland [2012, p. 66] about how we make ourselves 'sensible' through narrative enactment.

⁷⁶ See Addendum 2. Also Thompson [2001, pp. 66- 69]; Thompson & Varela [2001]; Pasquinelli, [2006,pp. 33 – 35]

⁷⁷ "Regarding cognition as a process of interaction between the parts of a self-generating [autopoietic] system seems an interesting analogy to the implications of the database (narrative) form, which forsakes sequence in favour of simultaneity." [Veel 2005, p. 4]

Start CPR.
Diagnosis cardiac arrest,
Still no blood pressure
Nothing seems to be happening
Stepping from one diagnosis to another.

[Consultant D]

Wieck, Sutcliff & Obstfeld use the term ‘*acting thoughtfully*’ for medical sense making and describe sense making in a clinical scenario as follows:

“Medical sense making is as much a matter of thinking that is acted out conversationally in the world, as it is a matter of knowledge and technique applied to the world. Nurses (and physicians), like everyone else, make sense by ‘acting thoughtfully’, which means that they simultaneously interpret their knowledge with trusted frameworks, yet mistrust those very same frameworks by testing new frameworks and new interpretations. The underlying assumption in each case is that ignorance and knowledge coexist, which means that adaptive sense making both honours and rejects the past. What this means is that in medical work, as in all work, people face evolving disorder. There are truths of the moment that change, develop, and take shape through time. It is these changes through time that progressively reveal that a seemingly correct action ‘back then’ is becoming an incorrect action ‘now’. These changes also may signal a progression from worse to better.”

[Weick et al, 2005, p. 412]

In the emergency enactments, consultants enter an operating theatre and are given a hasty handover of a trauma patient. Without any prior background or history with the patient, they are required to ‘make sense of’, and diagnose the situation based on partial, sometimes even missing information. All of this mirrors the uncertainty of real life where clinicians are called in to assist in emergencies at the last minute, without knowledge of the circumstances leading to the crisis event.

Meaning shifts with the unfolding circumstances underscoring the dynamic nature of medical diagnosis.⁷⁸ The consultants enact their roles in a state of constant vigilance - scanning, scouring for patterns while simultaneously testing and trialling possibilities:

“...it wasn’t immediately obvious, trying to think of a lot of different causes and eliminate them one at a time and thinking of the most likely ones first, the more significant ones you can potentially treat and get out of trouble with.”

[Consultant C 23/05/11]

“...I decided to inflate the lungs a little bit more to try and offset the collapse of the lungs, so did that, and the saturations came up again, did another listen and it seemed like things were stabilising a bit and then decided to try a bit of suction.”

[Consultant A 11/04/11]

⁷⁸ During the simulation debriefings the difficulty of having to work through ambiguity, confusion and uncertainty, is commented on by all of the consultants. In essence, they describe how any new information is capable of shifting their diagnosis – all of which aligns with Weick’s analysis of medical sense making. “To focus on sense making as the experience of being thrown into an ongoing, unknowable, unpredictable streaming of experience in search of answers to the question, ‘what’s the story?’ Plausible stories animate and gain their validity from subsequent activity.” [Weick et al, 2005, p. 410]

“... even though the cues weren't quite there for tension pneumothorax I felt that it was necessary to treat for that because the patient was likely to suffer adverse consequences if something wasn't actively done ...” [Consultant C 23/05/11]

Charged with the responsibility of another individual's physiology and consciousness, the anaesthetist's role cannot be passive. The micro narratives illustrate how the consultants remain poised and ready for action, working continuously to maintain stability within the system. Proactive more than reactive, they are, to use Arvidson's definition, an “attending process”.⁷⁹ I describe them as in a perpetual state of *presentness*.

Within that state of *presentness*, the individual consultant's experience moves in cycles, from moments of ambiguity to instances of clarity, when a known and common pattern is recognised.⁸⁰ Instances of clarity coincide notably with a physical response often described as a relaxation of physical tension, as the consultant applies a learnt protocol. In this way, the most critical moments of the scenario - such as the cardiac arrest moment - become paradoxically the moments when the consultants describe themselves as most comfortable and in control:

“[...] and then the patient went into a broad complex technicality, which is where I felt a bit more comfortable because I could do something about that.” Consultant A 11/04/11]

“Yes, in some way the cardiac arrest somehow clarified things, it was a situation that had to be dealt with, there wasn't the ambiguity.” [Consultant B 11/04/11]

Yet in an emergency scenario such as this, even these feelings can be quickly overridden by the evolving dynamics – forcing the clinicians to constantly reassess their story. Asked how they manage these shifting circumstances and the inevitable frustration at not being able to get accurate information about the patient's airway status, one consultant replies:

“[...] I didn't have to...the situation changed...I had to move on to the next problem, from airways to circulation [...] I didn't get the right diagnosis [...] it was more a case of stepping back from one diagnosis to another.” [Consultant D 23/05/11]

Thus the consultants appear to cycle through in mini story or feedback loops, across a stream of micro interactions and considerations. Within these non-linear loops the consultants hover - just as in games scenarios – across changing emotion states. In addition, because a patient may improve [or deteriorate] as a result of actions taken and without the clinician necessarily having identified the correct diagnosis, it means

⁷⁹ “My way of putting it is that we are identified in our human being by what we attend to and how we attend [...] we are an attending process [...] the attending process is the fundamental and essential way we give meaning to the world.” [Arvidson 2006, pp. 115, 116 & 121]

⁸⁰ Perlovsky & Kozma [2007] describe the neurodynamics of cognition in terms of a progression from vague, uncertain, and less conscious states, to more concrete, certain, conscious states, which correspond to processes of perception, cognition and decision-making.

that some of the consultants also get to the end of the enactment without recognising the true causes behind the crisis. There may be moments of relief when they pinpoint a protocol or pattern, but in an imitation of 'real life', the micro narratives do not necessarily conclude with a traditional sense of catharsis, and often leave the consultant with unresolved questions and emotions.

I would argue that this unresolved and paradoxically open-ended form of closure acts to keep the consultants suspended in that ever-present, '*emergent/emergency*' condition, shifting from one emotional state to another.

"... that was disappointing, that I didn't get any feedback, that something I had done had contributed...they might have been just general things that had come together, but I was still left at the end of the scenario quite confused as to what the patient's problem had been [...] because I didn't have a definite diagnosis in my head [...] I was bamboozled as to what happened ..."

[Consultant C 23/05/11]

"[...] knowing that you may have gone down the right way in terms of treatment, but not picking up the right diagnosis ... that's distressing"

[Consultant D 27/06/11]

"...I was probably getting tacky cardy....feeling flushed, I guess hot...what I expected to be causing the response wasn't working...so there's a sense of loss [...] unsure. [...] Absolutely tense ... this is a twenty- year old person who might die on the table..."

[Consultant D 23/05/11]

Enaction - Actionable Perception

*Need to move on,
Need to take action,
Act and sort,
You need to get in and make it happen*

[Consultant B]

...a lot of it is see, do, see, do...

[Consultant A]

Intertwined with navigation and flow, is the principle of enaction. Across the micro narratives, the kinaesthetic dimension is as critical to making meaning as in any narrative games scenario. Meaning may start as a sensation, but it is given expression through what is actionable. Consultants stand in attendance, deploying action as the basis for their next decision. Essentially they move from one action response to another:

"I knew that things were not right on the monitors so I was searching for what was wrong with the patient, my emphasis was shifting between the monitors and the patient, glancing at the monitors to look at what the situation was, then trying to keep my focus on the patient, thinking through what action I need to take [...] in a situation where things weren't clear. I needed to move and the way to move on was to take actions ..."

[Consultant B 11/04/11]

In what is almost a paraphrasing of Weick [2005], one consultant summarises his *modus operandi* as, “*you know, a lot of it is see, do, see, do...*”:

“I am going to give a bit of adrenalin to test and see what is going on because the other thing in my mind going at this stage is ... is there bleeding going on that I am just not picking up? [...] If it is something like anaphylaxis adrenalin will treat that, it will also buy me a little bit more of time.”

[Consultant A 11/04/11]

In this respect, the consultants adopt a methodology identified by Klein [1998] as common to many experts: rather than losing time evaluating *all possible options*, they make a rapid decision to *act* first, then evaluate from there:⁸¹

“...you need to treat and assess as you go...if you wait until you have all the information there you don’t start any treatment at all you might miss the boat.”

[Consultant A 11/04/11]

“...most of the time in the first twenty- thirty seconds of when you turn up the most experienced would act and say I think it’s that ... and act...”

[Consultant A 27/07/11]

It is a form of ‘actionable perception’. This is consistent with cognitive scientist Alva Noë, who states that for sensation to rise to a level of understanding, it requires sensorimotor knowledge.⁸² Noë insists that “when we experience something, we experience it as a result of movement; everything so to speak has a ‘sensorimotor profile.’” While not universally accepted, Noë’s theory of enactive perception is informed by the understanding that there is a complex link between sensation, action and perception. Perceiving is a way of ‘*acting*’ and what we perceive is determined ‘*by what we do*’ [Noë 2004: 1 & 101]. Enactment extends the idea of embodiment, integrating it with action, suggesting our sense of meaning and ultimately presence emanate from this capacity to act in the world:

“Our sense of the presence of objects and properties around us, in perceptual experience, is understood in terms of our being skillfully poised to reach out and grasp them. Instead of thinking of perceiving on the model of seeing, which is in turn understood on a kind of quasi-photographic or optical-projective model, we should think of perceiving on the model of touching.”

[Noë 2005, pp. 235 – 264]

Noë’s premise of ‘enactivism’ has been both contested [Prinz 2006], and celebrated as a new cognitive science [Andrieu 2006, p. 360]. I allude to it because the enactive approach appears to consolidate views put forward by James Gibson on the role of the senses and their relationship to the world.⁸³

⁸¹ For an extensive overview of expertise and expert performance, see Ericsson et al [2006].

⁸² “My proposal is that what brings the world into focus for perceptual consciousness is our understanding of the ways movement alters sensory events. Mere sensation does not rise to the level of perceptual experience. For perceptual experience we need sensation that we understand. Perceptual presence requires that the perceiver possess and exercise sensorimotor understanding.”
Noë [2007, p. 532]

⁸³ Noë’s thesis could be considered as a progression of Gibson’s theory of affordances.

Gibson's analysis of the senses also proposed that perception and movement needed to be considered relationally. According to Gibson [1997], one does not just perceive an object in its environment but also its 'affordances' – the perceived possibilities for actions within it. In Gibson's terminology, the individual thus perceives the environment as a set of affordances, with perception dependent upon one's interaction with the environment. [Greeno 1994, pp. 336 – 342]

When considering the new features of contemporary narrative, enactment is just as much a quintessential marker of the new presence as is embodiment. The link between activity, and the sensation or physiology of presence was previously alluded to in my discussion on 'agency' - a property much discussed by ludologists, and emanating from interactive navigation and choice. Games theorist Seegert explains how the interactive digital environment allows '*users to generate presence through their own actions.*' In what essentially is an endorsement of the enactivist view, he argues that interaction is the means by which the world presents or 'reveals' itself to the user. [Seegert 2009, p. 23] The micro narratives, and the consultants' enacted sense making⁸⁴, inscribe the idea of an *actionable present*, reinforcing a link between activity and the sensation of presence throughout the experiment.⁸⁵

Doing is the new way of being. This is a long way from Aristotle's mimesis and representation. By engaging our sensorimotor skills such enactment also ensures that the narrator/performer is firmly engaged in the present. The consultant is both the centre and active agent of the narrative process. There is obvious correlation between the ideas of Gibson, Noë and the theories of autopoiesis, especially those expounded by Varela, Thompson and Rosch [1991] in *The Embodied Mind*. The living sentient being generates its own meaning and presence through a dynamic interaction with the world.⁸⁶ I suspect that a parallel interrogation has also recently led computer scientist Calleja to propose an entirely new metaphor for the conceptualization of the experience of presence in games narrative. He proposes that the metaphor of incorporation – (which has its origins in the Latin *in-corporare* or, in body) is in fact a better descriptor of presence.

⁸⁴ Wieck [1988, pp. 305 – 319].

⁸⁵ In a pilot study into the subjective feeling of presence generated in computer games, Xavier Retuax [2002] observed that users felt present in an activity not in a location. viewed 19 August, 2011, <http://www.temple.edu/ispr/prev_conferences/proceedings/2002/Final%20papers/Retaux.pdf>

⁸⁶ In *Supersizing the Mind: Embodiment, Action and Cognitive Extension*, Andy Clark [2008, p. 217] expands on this inter-relationship between embodiment and enaction. By focussing on the dynamic between the brain and the environment, Clark wraps the notions of embodiment and enactment into a broader concept of cognitive extension; a form of cognition that spreads across the mind and body into the world and back again as an interconnected, whole-of-system feedback loop. He argues that we are not 'brain bound' and what goes on in the mind is not simply an internal phenomenon, but is influenced and modified by what we feel and see in the environment. Cognition may take place in the brain, but ultimately it 'leaks' out into the world. In this fluid system, we cannot just rely on the internal mechanisms of the mind or the biological brain for cognition, but on a combination of internal and external influences.

Calleja's *incorporation* is achieved by the activation of multiple mechanisms including kinesthetic, affective, ludic, and narrative. In particular however, he specifies that the condition of *incorporation* be met in computer games, when the player is embodied into the space, and the space is conversely inscribed into the players mind.⁸⁷ [Calleja, 2007]

Calleja not only refines Murray's earlier thesis of immersion in interactive fiction by giving full weight to the attribute of embodiment, but significantly; he characterizes incorporation as a feedback loop between the internal world of the player and the external world: a feedback loop that locates presence as the moment-to-moment lived experience: presence as immediacy, i.e., a mind-body-world loop evoking Varela's notion of autopoiesis.⁸⁸

The consultants and the micro narratives of *Emergency in the Sim Ward* give voice precisely to this type of 'incorporation'. Along with navigation therefore, incorporation remains a significant metaphor across my creative experiment.

Narrative Sense Making as Information Processing

*I have made a diagnosis,
Blood pressure is falling.
Can't quite hear
In my mind, the diagnosis is not clear
Start to get anxious.
Focus more on the heart.
Beginning to believe there is another problem,
Look at other possible causes of blood loss and hypertension,
What on earth is going on with this patient?
Where is this leading?* [Consultant D]

Information ambiguous, information isn't adding ... [Consultant B]

For me then, all of the attributes outlined to date - subjectivity, sense making and enactment - operate to shift the axis of narrative away from objective, logical structuring and away from the manipulation of time according to an Aristotelian order (narrative and information processing from the top down dictated by the sovereign author) to the privileging of a micro subjective sensory driven processing (narrative and information processing from the bottom up).

⁸⁷ Calleja defines incorporation as "the absorption of a virtual environment into consciousness, yielding a sense of inhabitation, which is supported by the systematically upheld embodiment of the player in a single location represented by the avatar." [Calleja 2012] A more detailed analysis of this compelling theory is contained in: *In-Game: From Immersion to Incorporation*. [2011]

⁸⁸ At the 1995 Cognitive Technology Conference in Hong Kong, the process of internalization of the world into the mind and externalization of the mind into the world was noted by Gorayska & Mey as a new development happening at the interface of technology and cognition. [2004, p. 7]

In essence, the consultant's enactments offer a context to view how the reflective and the primary sensory motor systems might interact to shape a narrative outcome. The analysis of the consultant's decision-making process across the micro narratives demonstrates how the processing systems stand in tension with each other; how individuals negotiate the interface between primary and secondary processing loops – a process which also re-percusses on the experience of time.

As noted in the appended background on the brain, the negotiation between the split perceptual systems has historically been framed as a linear bottom-up/top-down process. Even Klein, noted for his less linear approach, still widely accepts a two systems approach and distils this top-down/bottom-up phenomenon into two distinct systems of decision-making. System “one”, based on experience and intuition, and system “two”, based on conceptual and analytical thinking as reflected by procedures and checklists.⁸⁹

In the end however, these binary approaches to knowledge and meaning making reduce and simplify the complex pathways of information processing, in particular, the overlapping time loops of cognition as more recently described by Damasio and Libet. In fact, the simulation micro narratives reveal a more circuitous blend of these processing modalities, interwoven across time. Cognition, attention, perception, memory and experience – each individual responds to the multiple feedback loops, and assembles their story according to their unique history and perceptual processing capacity. And while this is a complex process, it is neither random nor chaotic. Indeed, this form of narrative sense making supports Cilliers' descriptions of complexity:

“If we model complexity in terms of a network, any given narrative will form a path or trajectory through the network. The fact that there are many paths does not imply anything goes. All narratives are subject to constraint and some paths are ruled out.”

[Cilliers 1998, p. 130]

Algorithms

*Can understand this,
I can do something about this,
I've got something I can treat,
It's obvious treatment
The resuscitation protocol
I can stand back.*

⁸⁹ The Dreyfus [1980] model of skills acquisition (which has also influenced Klein), proposes that an individual moves progressively through distinct and progressive 'stages' of knowledge acquisition as experience grows, moving from novice and advanced beginner levels involving rule based, procedural knowledge to expert, intuitive knowledge. See Pena [2010] for a detailed description of common ways of grouping knowledge types as binary opposites, including conscious/unconscious, tacit/explicit, know-how/know-that.

*I've off loaded some of the process,
I don't have to think about it any more,
I've got a direct protocol that I can use,
The script for that is already in my head* [Consultant B]

My discussion of the information processing systems will begin with a consideration of the role of algorithms in clinical problem solving, thus recognising that they are fundamental markers of a consultant's conceptual and analytical processing framework. A medical algorithm is a procedure or set of rules to be applied in problem solving. As such they form the basis of a consultant's "pattern recognition". Transformed into automated learnt responses through repetition, they help order information, to support decision-making and the formulation of clinical responses. While they assist by simultaneously including and excluding diagnoses, they can also hinder and frustrate, locking in assumptions and contributing to fixation.

"...It is a way of approaching something systematically when clarity is very difficult. The problem arises if there are too many algorithms [...] or you can also lose skills. The cardiac arrest algorithm is interesting [...] with technology there are new algorithms and protocols and we are losing the 'hands on' algorithms." [Simulation Director 14/04/2011]

Algorithms function both as analytical top-down mechanism (conceptual processes) and, by virtue of the fact that they are drilled into clinicians through rote learning, as a form of automated pre-learnt instantaneous response activated through memory and pattern recognition. A consultant's consideration and use of algorithms therefore offers an intimate snapshot of the interplay between experience, memory, reflective and pre-reflective processing. In addition, because algorithms and pattern recognition contribute to how the problem is interpreted, an inappropriate algorithm can lead to incorrect framing and diagnosis. For that reason, good decision making requires flexibility - a capacity to stand back from time to time in order to reframe the problem (or algorithm) as necessary and based on emerging information.

The *Emergency in the Sim Ward* micro narratives portray a complex interaction between the incoming sensory flood of information and pre-existing associations. They also demonstrate advantages and disadvantages in the application of a fixed set of pre-learnt, automated rules.⁹⁰

Predictably, the consultant's starting point in the emergency is to rely on learnt algorithms and procedures to pattern match, and to identify potential causes for a patient's deteriorating condition. At face value then, it appears the most obvious determinant in shaping cognitive and narrative meaning is the logical, analytical system. The on-going importance and function of checklists and algorithm procedures

⁹⁰ Both Klein [1998] and Dreyfus [1980] comment on the importance of accumulating a large bank of experiences in order to draw upon a large repository of possibilities when tackling a critical situation; for them this experience 'bank' is the distinguishing feature of experts.

was clearly evident both in the dominance of technical analysis during the preparatory trial debriefing sessions, as well as in the enactments. Consultant B's micro narrative repeatedly emphasises the need to be procedural and systematic:

"...go back through thought process, airway breathing, circulation, trying to work through things, systematically."

Across the overall span of the simulation enactments however, it becomes evident that an over-reliance or fixation on analytical and systematic thinking (viz. the algorithm) does not actually lead to a faster, more satisfactory resolution. Closer investigation starts to unpack layers of processing loops reeling in sensory and intuitive feeling. The *logic* of the decision-making and micro narrative therefore unravels as something intertwined and underpinned by a mass of sensory input, unconscious processing and emotion:⁹¹

"....I was listening to the saturation monitor; I was listening to the heart rate... I heard the alarms going off on the ventilator [...] I was quite focused... I'm looking at the patient, my visual senses were focused on the patient and the monitors I heard the alarms, I heard the tones and the saturation ones to the heart rate. I was feeling just making sure the line was in [.....] I was apprehensive....I felt very apprehensive..." [Consultant B 11/04/11]

Unconscious Processing

*Have to take a decision
The gut thing is going
this is something more than the usual hypertension.
The gut feeling was, you know, the pucker factor was up ...* [Consultant A]

There is relatively limited literature on non-technical skills, and even less dealing with subjective, unconscious and subliminal processes in anaesthetists' decision making. Gaba [2002] goes part way, offering a four-tiered framework for analysing the non-technical component of anaesthetists' decision-making. The four levels include:

- i. Processing of sensory data from the environment and controlling action.
- ii. Following the rules (procedural).
- iii. Solving problems (abstract conceptual).
- iv. Co-ordination of attention and interaction.

Interestingly even Gaba's clinical categorization starts with sensory processing and ends with enactment.

The case study micro narratives illustrate that despite the consultants appearing to navigate through this uncertainty by applying rational and analytical procedures - albeit in some instances automated - the actual information processing mechanism

⁹¹ Damasio [1994, p. 79] also suggests that emotion and reason intersect.

extends beyond the purely analytical, to incorporate a dynamic flow of data that moves from raw sensation to thought, to memory and from one action event to another.

The following response illustrates how this cocktail mix of ambiguity, sensation, thought, and action, intertwines in a state of being that is at once emotive and analytical:

"...I notice that I am tense; I notice that I am worried and slightly frustrated...so yeah I was aware of that, feeling like I needed to get this sorted out straight away...It was building as my initial assessment of what the problems were likely to be wasn't improving um...my apprehension was building and I felt then it must be a circulatory issue so I moved to that, and I was also wondering...if the patient was having an anaphylactic reaction...so I was aware that I wasn't sure what was going on, I needed to get on and improve the situation as much as I could even though I didn't know what was happening [...] it was more an overall picture of the way things were changing, yeah it was a feeling of what I should do next, rather than thinking it through."

[Consultant B 11/04/11]

Pattern recognition may involve an automated, memory-based cognizing of patterns but the actual repertoire of patterns embedded in any system is always shaped by multiple factors. Throughout the enactments it is not enough to recognise patterns – it is instead the totality of an individual's responses and their selective processing that ultimately shapes their understanding:

".... Ah I don't think I would have picked that [gelofusine] up quickly...there are a few key experiences I've had, emergencies which sort of make me wary once I see some particular drugs being used."

[Consultant B 11/04/11]

"I am working on experience, so I am thinking this is where I think the money is."

[Consultant A 11/04/11]

As a result, despite individual consultants all activating and focussing on a remarkably similar range of algorithms and common operating room diagnoses - such as cardiac arrest, pneumothorax and bronchospasm - no two clinicians undertake the exact same cognitive journey nor do they enact the same story. What's more, when they arrive at analogous decision points, they do so for different reasons, according to their subjective experience and processing flexibility.

Mind–Body Schisms

*Can't believe what I am being told
Pulse is going faster,
Listen to his heart,
Not sure whether I am meant to be hearing anything,
Checking the chest is going up and down on both sides,
Still don't believe it is not a pneumothorax.*

[Consultant D]

In considering the relationship between the different processing streams, the consultants who most mistrust the non-analytical and sensory information streams are, it seems, the ones, who in the end have greater difficulty in identifying the correct diagnosis. Consider for example, Consultant D. He makes an initial diagnosis based on pattern recognition at the hand over - *"my concern is that there is a pneumothorax"* - and although this diagnosis is subsequently invalidated by the sensory information emerging from the scene, this consultant struggles to let go of that particular deduction. In a form of fixation or tunnelling, his focus continually returns to the issue of air in the lungs, and because a supposedly pre-learnt logical assumption has already been made, the consultant overrides and mistrusts any real time sensory cues to the contrary.⁹²

In this way he seems to create an internal dichotomy between the pre-learnt algorithm with pre-existing associations and the tangible sensory information cues (or in his case lack of sensory cues) in the environment. The logic of his first assumption turns into suspicion and frustration, impeding his ability to take in new information and to reframe his perspective so as to allow for a different diagnosis.

"I am quite sure that I can't hear air [...] I still can't believe there is air on the right-hand side - despite the nurse telling me there is air on both sides I couldn't hear it...I have made a diagnosis and the symptoms don't match [...] There was a conflict between the algorithm and the feedback."

[Consultant D 23/05/11]

The distrust is rendered even more complex and layered when viewed against an underlying internal predisposition that appears to have been carried by this consultant into the simulation from the beginning: a manifest nervousness around the ability to register sensory information, together with the concern about not seeing (*"the screen monitors are too dim"*) and not hearing (*"not sure whether I am meant to be hearing anything"*). This mistrust of his own sensory apparatus has the effect of augmenting anxiety; a widening of the schism between his primary and secondary processing capacity. In effect, reflecting back on his performance and the tension between the analytical and intuitive processing modes, this consultant concludes that he is now in a more 'algorithmic' stage of life and that this impeded him in responding to other sensory and intuitive inputs:

"I need to do more anaesthetics... I am more in the algorithm stage of life now...I don't do enough for experience to be maintained. When I was at my best clinically – in my mid-30's and 40's - I was more instinctive..."

[Consultant D 23/05/11]

⁹² There is a considerable body of literature examining the phenomena of attention fixation or tunnelling the inability to perceive a stimulus because the subject is attending to something else and the phenomenon of change blindness – failure to detect non-trivial changes. Ericsson et al [2006, p. 36] acknowledge that attention and working memory can act at times as *"intellectual bottlenecks of human thought"*. For the purposes of my discussion I interpret this fixation as an inability to move across the diverse processing streams and inputs.

Consultant C's enactment provides another variation of this phenomenon. The tensions between C's mental state, the body and the sensorimotor responses, literally become a barometer clearly demonstrating the dichotomy of the mind body schism. Observing video footage of this simulation, one can witness as a physical state the anxiety enacted as this consultant literally runs from one object to another and while fretting over thinking processes. During the interviews, this consultant self describes as:

"...trying to go over in my head what we need to do [...] I can see myself moving faster and faster going from one thing to the next, trying to work out where I should be looking, hoping that something is going to change but it doesn't." [Consultant C 23/05/11]

The excessive focus on one processing mode, by this consultant typified as anxiety about the need to concentrate and identify algorithms, ultimately causes more uncertainty than clarity, and does not lead to a more successful prognosis. In both these examples the consultants appear locked into one information-processing stream. This preoccupation limits the capacity to integrate other real time sensory information, reducing the ability to reframe the subjective narrative.

The correlation between the mind and body is again highlighted by the fact that those consultants, who describe a more restricted visual focus, are also those who exhibit a higher level of fixation. The lock-down in attention is both a mental and an embodied reality. Consider the following literal shifts in the consultants' visual perspective and attentional scope during the emergency procedure:

"I wasn't aware of anything else outside the immediate focus of attention." [Consultant D 23/05/11]

"... I wouldn't have seen the Registrar walk back again...he just appeared, which was good, I was much more focussing on patient monitor and what I could do...focussing on about 1½ m perimeter." [Consultant C 23/05/11]

The physical link is further affirmed by the consultants' occasional awareness that they must first free themselves physically before they can do so mentally:

"I just want to get my hands free...put the patient back on the ventilator so I can work out what is going on." [Consultant C 23/05/11]

By contrast, consultant A exhibits a more fluid visual focus and expanded perceptual stance:

"[...] it almost comes down to when I am in that situation...I can see my hands...I want to do something, get to something and then once I've done it and things have started to relax up, I can start thinking more ahead, more to the side....it's a perception thing..."

[Consultant A 11/04/11]

Not only is this consultant fluent and comfortable enough to expand and contract his visual sphere of awareness, he is also forthright about his gut or intuitive reactions versus his analytical process. He demonstrates a capacity to acknowledge and integrate diverse states of being.

It would seem that his capacity to act effectively is underpinned by subliminal physical impulses and sensation:

"...so the sort of gut thing I think to me was I have been in this sort of situation before and what I was doing was ah not working...so the gut feeling was, you know...um the sort of the pucker factor was up, I was a bit puckered yeah..." [Consultant A 11/04/11]

"Intuition...it's difficult for me to analyze that, I tend to be quite visceral. I respond to things whereas other people will stand and quite literally analyze but I am totally influenced by the pucker factor...that's something I learnt a long time ago." [Consultant A 11/04/11]

A's micro narrative appears to affirm both Damasio's arguments underlining intuition's neurobiological dimensions well as Libet's 0.5 second gap theory, suggesting a subliminal body sensation is registered before any rational explanation or diagnoses. The consultant in this case study uses sensory and physical triggers to deliberately guide his decision-making. He considers physical states to be a self-monitoring device, and deliberately uses his awareness of bodily sensations, particularly discomfort, as a way of precipitating action - his 'pucker factor' precedes action:

"If you feel uncomfortable about a situation then it means you have reached some sort of threshold for action..." [Consultant A 11/04/11]

This narrative journey contrasts markedly with Consultant C's experience, which continues as a heightened state of mental anxiety and physical agitation; C is unable to decouple from the mental fixation, to trigger a different understanding or perspective. Again the body seems to mirror the mind, so that those who move fluidly between a detailed task focus and a broader situational overview are those that best adapt and are those who can integrate the diverse information streams.

Regardless of their individual style and processing path however, the consultants acknowledge, and the micro narratives verify, that the subjective decision-making and narrative sense making process is influenced by multiple factors – conscious and unconscious. One consultant retrospectively explained it as a Venn diagram:

"I wouldn't put it in a linear spectrum saying at one end there is gut decision and at one end there is knowledge...I think there is an interplay of all of those and I think I would be working strongly with experience, with some knowledge but also with some gut decisions as well...I would see it more as a Venn diagram and in different scenarios I would use it differently...I think there is an instinct of things. I can recall several experiences of looking at a patient well before their anaesthetic thinking things are going to go terribly and then they have...and that there was nothing to formally predict that...God knows how you pick that..." [Consultant C 27/06/11]

Time, Presence And Presentness

All discussion to date serves as a foundation for my proposal that contemporary narrative experiences are increasingly predicated on a mind-body relationship that is underpinned by a new (neurobiological) temporal presentness.

The analysis of the consultants' subjective decision making has provided insight into how the interaction between the different processing systems affects the sense making and story building process. The subjective perspective of the micro narrative revealed how the integration of real time sensory and motor responses (sensations and actions) keeps the narrator/performer in a constant state of attendance (presentness) focussed on the minute-to-minute unfolding of the situation at hand.

Working within an overarching meta narrative structure, the individual consultants demonstrated that their subjective narrative and story building process does not unfold according to a linear, sequential Aristotelian paradigm. Instead the emergent narrative process relies on a complex weave of sensations - conscious and unconscious - pre-reflective and reflective processes. Compare the deliberate linear sequential structure of the scenario for example,⁹³ with the loops of unfolding awareness described throughout participants' sense making experience - shaped as it is by the sensory cues, they chose to attend to and lived in the neurobiological real time.

Thus the focus returns full circle to the quintessential question of time. I refer not to chronological time, but to the subjective mind-body experience of time. What kind of relationship do the micro-narratives suggest exists between our information processing loops, presence and time? How is this depicted in *Emergency in the Sim Ward*?

Through the process of "incorporation" and ensuing real time body engagement, the four enactments of *Emergency in the Sim Ward* are constructed on a temporal mix of retrospection, speculation and present procedural enactment.⁹⁴ I would suggest that the micro narratives operate within a window of the lived 'now' – a neurobiological presentness - collapsing notions of past, present and future. Meaning unfolds as a dynamic interaction of intersecting data streams - a highly complex matrix with many cycles of processing folding backwards and forwards over each other in time. This in turn is something akin to how our brain processes the world.

Metzinger [2009] summarises this neurobiological process of the lived now as follows:

⁹³ See Addendum 1.

⁹⁴ These conclusions find a parallel in Cunliffe & Coupland [2002, p. 66], "We offer an alternative to sense making as representational, cognitive, information processing and contest the idea that sense making is purely a retrospective and linear activity."

"In a more general sense, the principle is that the almost continuous feedback loops - from higher to lower areas (of the brain) - create an ongoing cycle, a circular nested flow of information, in what happened a few milliseconds ago is dynamically mapped to what is coming in right now. In this way, the immediate past creates a context for the present- it filters what can be experienced right now."

[Metzinger 2009, p. 3]

In *Emergency in the Sim Ward*, both the Libet factor and the principle of a "dynamic nested flow of information" constantly being mapped onto the present are, for me, strongly suggested when tracing the individual clinician's response to what I will call the gelofusine 'trigger' – and how it is or isn't woven across their narrative.

The Gelofusine Trigger

From a time perspective, each simulation 'begins' with the registrar or anaesthetic nurse putting up a bag of gelofusine. This action is both the origin of the allergic reaction, and lynch pin for the unfolding emergency.⁹⁵ In addition, the anaesthetic nurse adds regular reminders of the gelofusine trigger by asking the consultants whether they need an additional supply at intervals throughout the simulation. Thus the trigger or cue to the simulated crisis is present in the environment for the consultants to register from the moment they walk in – as well as continually punctuating the scenario. However, this initial action is registered by only two of the consultants.

The two consultants, Consultants A and B, who perceive the bag of gelofusine early in their narrative, are eventually those who make the correct final diagnosis thereby suggesting that even a subliminal recognition of this trigger early in the enactment might indeed have assisted the formulation of a more accurate diagnosis. The narrative path to final diagnosis however, is arrived at through a variety of loops and cycles of recurring awareness, at times with a quite significant lag between the initial registering of the gelofusine trigger and the translation of that cognition into a meaningful action.

Consultant A's rapid cognition of the gelofusine during the simulation is accompanied by a recurring intuitive hunch that the problem might in fact be anaphylaxis. But it is a hunch that remains unrecognised and subliminal: it has to weave through the logic matrix of competing algorithms and protocols across time until he finally integrates the various data streams. The cues only resurface for him with absolute clarity and meaning towards the end of the scenario. He describes his response to the gelofusine trigger:

⁹⁵ It is necessary here to also acknowledge that in relation to the duration and timing of the actual anaesthetic procedure, the entire medical practice and management of anaesthesia is inherently dependent on a delicate calibration of time. For a detailed case study of these clinical temporal constraints see Keyser & Nyssen in Klein & Salas [2001, pp. 171 – 189].

"...I think its always just floating there in the background, it just had all those other things on top of it which I thought were more immediate, and I suppose I was supressing it, but as I started excluding those things I became happier...then the thing that sort of popped through was the registrar's 'gelofusine'."

[Consultant A 11/04/11]

Compare this with Consultant B who sees the gelofusine upon entering the scene but then proceeds to dismiss it. In his case, the rapid cognition of the situation is attributable to prior experience (a mix of pattern recognition and memory), but its suppression is attributable to a form of hyper vigilance, an over analytical reaction and suspicion of the simulated environment:

"I tried, I tried very hard in those crises to stick to a plan and to go through things systematically even though, my initial thought was this could be a gelofusine but I didn't want that to cloud my whole approach to the scenario...it was building up, I guess when I saw the gelofusine there in the scenario, I thought this may well be...I have had anaphylaxis before in real life, so when I saw that I thought this is where its going to go...and then trying not to make that as my initial conclusion [...] I guess I am highly suspicious when I come to a simulator about everything that could possibly be happening...I actually had put the gelofusine out of my mind and for quite a while [...] and then I came back to it...it was at the cardiac arrest point where I started to think about that again."

[Consultant B 11/04/11]

Neuroscientist Dehaene's [2006] "*signatures of consciousness*" theory suggests that some stimuli remain subliminal or preconscious either because the initial bottom-up stimulus signal is too weak, or because there is a temporary withdrawal of top-down attention.⁹⁶ Consultants A and B appear affected in part by these mechanisms, but as the stimulus and processing loop gains strength, the attention returns to the gelofusine, and the diagnosis surfaces.

The perception and registering of the initial gelofusine stimulus competes across time with a range of simultaneous top-down, bottom-up processing loops. Consider the other two consultants, both of whom appear to not register the use of gelofusine. Although they went through many of the same actions, algorithms and protocols as Consultants A and B, both came to the end of the session without solving the puzzle or identifying the causes behind the crisis. As noted earlier, these were also the consultants who appeared the most mistrustful of the real time sensory information being presented to them.

⁹⁶ "Instead of the classical binary separation between non-conscious and conscious processing, we introduce here a tripartite distinction between subliminal, preconscious, and conscious processing. The key idea is that, within non-conscious states, it makes a major difference whether stimuli invisibility is achieved by a limitation in bottom-up stimulus strength, or by the temporary withdrawal of top-down attention. The first case corresponds to subliminal processing, the second to preconscious processing." [Dehaene et al 2006, p. 208]

Driver [2001, p. 58] argues a slightly different position suggesting that the latest brain imaging technology points to the fact that even *unattended* stimuli can also be processed at some level without our conscious awareness of its impact on meaning making.

The impact of Consultant D's lack of confidence in his own sensory processing and how it unwittingly led to a form of top down fixation has already been described. Coming from a different set of personal experiences, Consultant C on the other hand demonstrates a different form of mind/body schism. She describes for example, how in having witnessed the deterioration of a patient in real life, she found it difficult to read or trust the feedback from the mannequin/simulator.

"...because the mannequin doesn't give you as many cues as the real patient does. I think if it had been a primary loss problem then I might have got a bit more cues as to the patient's colour."
[Consultant C 27/06/11]

This mistrust, combined with a preoccupation about needing to think their way through the crisis (*"going over in my head what we need to do", "need to keep going, need to keep thinking"*), keeps this consultant vacillating. And in the end, the over analysis and reliance on logic does not actually provide an answer (*"I have a few cues...I don't have a definitive diagnosis"*).

Processing In And Across Time

*Decision time!
Things really get compressed.
Grab some adrenaline
Give little bowls of adrenaline
See what happens.
Buy me a bit of time
Difficult to sequence events...*

[Consultant A]

I didn't have a sense of time while this was happening. [Consultant B]

By contrast, Consultant A appears to cultivate a capacity to *hover* across the different time frames of the discreet processing streams rather than lock into any single processing mode. He moves fluidly across that gap between reflective and pre-reflective. This manifests as a porous capacity to remain witness to the different data streams assailing him, to keep attuned to the subtlest of sensory impulses.⁹⁷

His decoupling from automaticity and fixation offers a glimpse of how these instances also give rise to a timeless integrated sensation. It is a form of meta-cognition to which he also attributes a physical (embodied) dimension:

"You see a lot of people become task focussed and my trick to get around that is I try and put myself out looking at it...that's where I try and put my brain [...] I try to almost have an out of body experience and be a witness...it's a place that I have arrived at by clinical experience [...] It's not so much that I don't care but that I don't get so much involved that

⁹⁷ In real life, Consultant A was the clinician with the broadest background in trauma retrieval and emergency medicine, and according to Klein's theories, his responses possibly stand out from the other enactments precisely because of this extensive experience bank, making his responses more flexible.

my thinking becomes narrow [...] You see a lot of people become task driven...and my cognitive trick to get around that is that I try and place myself outside of that...zooming in."

[Consultant A 27/6/11]

"I will often...for clarity of ideas for a fraction of a nanosecond I think I will often focus... shut down everything around me for clarity of thought...'cause if you are bombarded by so much information...even if it is for a nanosecond...almost to chart a plan for the future...the time frame of that is undisclosed."

[Simulation Director 14/06/11]

Meditation practitioners sometimes describe a state of 'meta' awareness in which the knower (the self/subject), the known (the object or sensation) and the act of knowing (witnessing) are held and experienced simultaneously in our consciousness [Yoghi 2010]. Again, the key attribute of this experience is an unbounded duration or the transcendence of linear time [Tagini & Raffone 2010]. Indeed, during the final debriefing interview Consultant A not only makes reference to himself as getting in the 'zone' and 'becoming a lot more 'Buddhist', but also aligns his particular stance and strategy in emergencies and simulation with computer game play:

"Some of the things that these gamers do...how the hell do you do that? They must build up...pick up processing cues...top-down strategy and bottom-up sensation...yes that's essentially what I do... part of the thing about the first person shooter is you get into the game and because I can stand back and I am out of the game, I can actually get that situational awareness...and thinking back at what I am like in that simulation is sort of the same thing...out of body...I would agree with you that simulation is part of that same game thought process...and part of the reason I have an advantage in that simulation."

[Consultant A 27/06/11]

Ultimately there are quite different subjective experiences and descriptions of time across the micro-narratives. Beyond the real time constraints of the emergency context, the sense of lived personal time is highly mutable and alternately expressed as dilated, compressed, or suspended. As in Meadow's reference to "*dwell time*", it is experienced according to how the individual moves through, dwells and enacts the different events in the narrative enactment.⁹⁸

"...look it was fast and I think the whole thing um must have taken 10 - 15mins but I felt like I didn't have a sense of time while this was happening."

[Consultant B 11/05/11]

"...I can see myself moving faster and faster going from one thing to the next, trying to work out where I should be looking, hoping that something is going to change but it doesn't [...] there is a long period of time where nothing happens...feeling that time was passing more slowly..."

[Consultant C 23/05/11]

⁹⁸ Meadows [2003, p. 51] explains how interactivity incorporates the individual decision making time of the reader, giving them choice as to how fast to progress through a section of narrative or where to go back and spend more time.

And as the sense of time shifts, the linear ordering of events across that time is also called into question:

"It is interesting you know, my immediate perception of it is a whole lot of different events which is difficult to sequence in your head...To me the entire time is very compressed...in fact the sequence of some things I was doing I probably got wrong." [Consultant A 11/04/11]

Throughout their descriptions of the lived moment-by-moment experience, consultants frequently jump backwards and forwards across time to cyclically repeat sequences:

"...a combination of all those...I was trying to take on board where we've been...what the history had been and what was happening now, and where it might go to which was probably concerning me more, where it might go...so I was trying to tie all those things together [...] the feeling of being a little bit clumsy and a little bit like oh God, what do I do next, I've checked that...uh I've given that...but it's not helped. I need to keep going I need to keep thinking...and probably going back on myself and trying to go forward trying to think I've done that and what's the next step." [Consultant C 23/05/11]

Not surprisingly then, the compositional thread to emerge from this process of sense making reveals a processing of time that is at once *retrospective* - reflecting on what has just occurred, *speculative* - thinking about the immediate future, and *present* - procedural. In order to respond to the present these consultant experts draw on their past and learnt understandings of similar situations, while simultaneously looking ahead to predict what is likely to happen in the future (Klein 1998). Massumi describes an immediate 'pastness' infused with becoming - being poised between retrospection and anticipation. The result is a narrative in dynamic suspension between the reflexive self and the experiencing self, immediate past, present and immediate future, in a demonstration window of that '*presentness*'.⁹⁹

*Oh god what do I do next?
I need to keep going,
I need to keep thinking
Going back on myself and trying to go forward
Feeling that time is passing slowly
Think I've done that and what's the next step?
Pull out the bits I hadn't remembered.*

[Consultant C]

All of my explorations and arguments to date then converge on this proposal, this state of presentness, which hovers across the multiple neurobiological information processing systems, to leave the narrator/performer and the narrative suspended in

⁹⁹ For Massumi, emergent potential is the multiplicity of possibilities materially present in a single moment, both of the immediate future and past. He suggests that registering of a sensation is also a direct registering of its emergent potential thereby reinforcing the view of a dynamic on-going flow laden with time: "The space of experience is thus the space of possibility and movement, en-capsulated by a distinct temporality." [Massumi 2002, p. 184]

the now – a cognitive state of ‘presence’ that is neither reflective nor speculative but both.

If we abandon linearity, reflection and interpretation as the underpinning paradigm for narrative, potentially it is this suspended gap between our perceptual systems, our time-based loops of cognition, between our conscious and unconscious awareness, that captures our being in the world and the making of our narrative as a flow of sense making in the now - that moves from one feedback loop to another.

My proposal therefore and my speculation is in fact that Libet’s 0.5 second delay might indeed be the window where past, present and future coexist in suspension. And while such an interval is without time, it is also inherently dynamic and full of potential, on the edge of a constant becoming and unfolding.

Conclusion

Revisiting the Research Question and Findings

As stated in my introduction, this creative experiment and investigation into the impact of digital technologies on contemporary narrative dramaturgy has been guided by the following two questions:

- How are emerging narratives renegotiating our traditional Aristotelian senses of time and presence?
- Can we enhance our understanding of contemporary narrative experiences by considering a model that is informed by neural processes?

I also noted that latent in the above questions was the belief that these same tools of digital production offered an opportunity to construct and model narrative according to the brain's processing systems.

All of these speculations originated from challenges in my live art practice. I had been exploring forms of dramatic text and montage that had increasingly been demanding a new configuration of time, place and audience presence; the cracks in conventional models of dramaturgical construction were fuelling turmoil both in my personal practice and in broader creative industry debates.

The collision of the narrative arts with digital technology, and the resulting new forms, appeared to be prising open the Aristotelian paradigm. Key tenets such as representation, mimesis and catharsis were being challenged by complexity and multimodality as narrative evolved more and more into a temporal and spatial landscape that required navigation.¹⁰⁰ For me the disruption was attributable to two core developments: the foregoing of linear logic and sequencing as a compositional device, and, the shifting role of the reader/spectator.

Agency and the new interactivity required the author to abdicate control of the (linear) narrative journey and experience. At the same time it allowed for a more active engagement and involvement of the reader/spectator within the work. As story became something to be inhabited, the reader/spectator moved beyond the role of passive witness to that of co-narrator/performer. And this, in turn, demanded that a new relationship be forged between the reader/spectator's 'self' and classic re-presentation. In this way, the disruption of narrative resulting from the impact of digital technology seemed in fact to be weaving itself into our very cognitive processes.

¹⁰⁰ Phenomenologist and archaeologist Christopher Tilley [1994, p. 32], defines landscape as a narrative to be navigated – a mass of locales, action events and experiences, a space-time, that can only be brought together and understood through agency.

These realisations have motivated the neurobiological underpinnings of my inquiry. The search for a space and a form to test these observations drove me, albeit unexpectedly, to live simulation and specifically to the simulation of an emergency medical scenario with anaesthetists. Live simulation brought together all the attributes that I had been investigating: from the participatory engagement of the narrator/performer as a co-author of the narrative, to the interface with technology and the half-real, mixed reality experiences being explored in pervasive games. As a director of live performance I was also drawn to live simulation as an extension of trends in so-called 'performed' documentary and verbatim theatre genres.

The choice of an emergency context was significant on several levels. Given that I was working from a neuroscientific perspective, it was important to find a context where information processing and sense making process were critical issues, and where time scales mattered. Dynamic, time-pressured crisis situations offered such an environment, a space where emergent sense making and the interplay of our primary and secondary processing systems might be more clearly discerned.

In the quest to understand the new temporal and compositional dynamics of contemporary narrative, this doctorate has thus endeavored to integrated practice-based perspectives with understandings of brain function. I have drawn on theories and questions across disciplines to investigate how the brain's information processing systems construct meaning through time.¹⁰¹ And I have subsequently folded these understandings back onto the question of dramaturgy. The exploration of these notions through creative practice resulted in the creation and analysis of a performed narrative, *Emergency in the Sim Ward* - a simulated emergency medical enactment, documented and creatively distilled through a series of micro narratives - in order to provide insight into our meaning making processes.

Drawing on the recent neuroscientific and neurobiological perspectives of Damasio, Varela, and Libet, my discussion has revolved around a window of speculation about biological time, mind time and narrative time. The rejection of Descartes's mind-body divide by these scientists, together with emerging notions of the brain as a generative, complex, system of networks, encouraged me to focus on the interaction between our

¹⁰¹ While the cognitive disciplines continue to illuminate our understandings of the workings of narrative including perspectives from cognitive science and linguistics [Lakoff 1980, 1999; Turner 1996, 2006; Aldama 2010], the field of 'neuro aesthetics' was only formally defined in 2002 as "the scientific study of the neural bases for the contemplation and creation of the work of art." [Nalbantian 2008, pp. 357 – 358]. Much of the research in this arena seeks to combine neurological understandings with aesthetics and has focused on Zeki 's [2003] examination of the brain's processing of visual aesthetics. It has been furthered by scientists such as Ramachandran's [1998, 2004, 2009] work on neural mechanisms, sensorimotor perception and mirror vision feedback, and Gazzaniga's [1979, 1988, 2002] exploration of how neural mechanisms enable the mind and conceptual thinking.

The tenuous relationship between narrative and neurobiology however is still a frontier to be fully explored. So recent is the discipline and so rich the potential for new perspectives that in 2011, the Defense Advanced Research Projects Agency solicited research proposals on the "Neurobiology of Narratives" as a means to survey "the neurobiological processes related to narratives bridging the cognitive neurosciences and the story stimulus." [DARPA 2011].

information processing systems and, in particular, the time gap between reflective and pre-reflective processing, and how that time gap impacts our meaning making.

This bio subjective perspective reinforced the view that narrative experiences were no longer a top-down process predetermined by an omniscient author. Influenced by the thinking of Calleja and Rovner, my experiment and analysis distinguishes between a meta (macro) narrative or overarching scaffolding, and a bio-subjective micro narrative.

The meta-narrative functions as a 'canovaccio'¹⁰², setting the scene, defining the characters, plot and actions; it is an overarching framework sustained and fixed across time. The micro narrative is the individual's subjective sense making within that framework, which is dynamic and mutable.

I suggest that *Emergency in the Sim Ward* provides an exploration of the interaction between the meta and micro. By aligning these distinctions with neurobiological understandings, it begins to speculate how these levels might correlate with our primary and secondary processing systems. It has, as its starting point, the understanding that cognition – and ultimately narrative - begins as a mass of intricate networks firing in incremental, miniscule units of time; it is the recognition of pattern with its weavings of bits of experience and sensation into increasingly more coherent links, and longer durational meanings, that underpins our sense making.¹⁰³

The micro narratives of my experiment suggest that within this self-referential processing, narrative meaning emerges as a subjective mix of attention, sensory perception, pattern recognition, memory and personal history.¹⁰⁴ My over-arching dramaturgical experiment thus illuminates several significant developments in contemporary narrative and the role of reader/spectator within the work.¹⁰⁵

¹⁰² The term 'canovaccio' harks back to the earliest examples of dramatic script utilized by travelling bands of commedia dell'arte troupes and entertainers. The canovaccio traditionally outlined the scenery, the characters, props, plot and actions, but it was up to the actors to enact the scene through improvisation. Each enactment therefore was totally unique. In this instance the canovaccio is represented by the Simulation Director's clinical scenario. See Addendum 1.

¹⁰³ "Cognition begins with the recognition of meaningful regularities within an entity's sensory experience of its external or internal world. These regularities may involve almost any stimuli detectable to the entity's sense organs, as well as combinations of stimuli that may span sensory modalities and temporalities." [Forsythe & Xavier 2006, p. 9]

"The human person can thus be seen as a sentient-agent being (neural organism) that is connected with the world via sensory inputs and its motor output, forming thus a "loop". We can call this an experiential loop, made of the organisms with its nervous system and the external world. The body and extensions of the body (tools) are also part of the world, and are in a privileged situation of being directly attached to the brain via sensory and motor nerves. During development the self becomes increasingly 'embodied' with greater awareness (sentient) and control (agent-motor) of the body. This sense of self is also accompanied by increased awareness of the world around us forming a horizon of sentience." [Costa M., Personal email, 18 March 2009]

¹⁰⁴ Bruner [1991] argues that the mind structures its reality through language and narrative, while Colombetti [2008] argues that meaning and experience are created by, or enacted through the continuous "reciprocal interaction of the brain, the body and the world."

¹⁰⁵ In this respect it also validates Rovner's [2009] argument that the new dramaturgy is predicated on

Above all it has demonstrated how emerging forms are moving away from the construction of story as an exclusive reflection back on experience, towards an 'experiential narrative' that is shaped at the interface of our primary sensory motor and secondary *reflective* processing systems. For the purposes of this thesis I have described this development as the appearance of a 'new subjectivity': the rise of a narrative that privileges the subjective - or more pertinently, the bio-subjective point of view - by incorporating the reader/spectator's sensory motor presence into the story loop. Within this new subjectivity, raw sensation and primary processing are foregrounded, and traditional story development and temporal conventions subverted, in order to locate narrative meaning in the moment.

My creative experiment and research findings ultimately suggest that we are witnessing the emergence of a new dramaturgical aesthetic and poetic of time: one that is predicated on a form of 'neurobiological' dramaturgy. It is an aesthetic that is subjective, embodied, enacted, and characterised above all by '*presentness*' – a state where presence and the neurobiological present coincide.

Final Considerations And Future Speculations

It may seem somewhat paradoxical therefore that while creative narrative is predominately constructed for audience and social consumption,¹⁰⁶ contemporary narrative experiences appear to be privileging a return to self referential, subjective, neurobiological (sensory) dimension.

The insights provided by *Emergency in the Sim Ward* into the consultant anaesthetists' micro narratives as a *non-linear mesh* of raw sensation, memory, analysis and action, fall into line with descriptions of the brain as a matrix of firing neurons and synapses, processing sensation and information in a nested flow of time-based loops. Within this mesh, flow remains a significant phenomenon. Indeed, across the evolution of the digital mediums, navigational flow turns up as the corner stone of a new syntax for the construction of meaning. It places the reader's cognition and understanding of narrative within a fluid state of continual becoming across that flow.

I had previously noted that in Varela's autopoietic system, intelligence and meaning fold out of the interactions taking place; that nothing is fixed. The plasticity of the brain ensures that the network of connections is always in movement, transitioning from one state into another.

methexis, rather than Aristotle's mimesis and representation.

¹⁰⁶ While narrative allows us to order experience and construct our understanding of reality on a subjective level, it also acts as an interface between the self and society - providing us with a mechanism to communicate that meaning to others and create social coherence. For a more detailed discussion on narrative as social cognition, see also Ochs & Capps [1996] and Bruner [1991].

It seems that our very biology is underpinned by this paradox of stability and instability [Damasio 1999]. In such an emergent system, cognition and narrative could well be described in terms of Scott McLeod's 'durable mutation'.¹⁰⁷ That is, as a continuously unfolding stream, mutable yet enduring: narrative as a vector with staying power stretched over innumerable biofeedback loops and strings of atomic meanings, weaving together an experience that has a larger coherence.

Certainly within this durable mutation, there is no culminating climax or resolution; instead, as we have seen across the micro narratives, everything seems dependent upon the last action taken, supplementing the Aristotelian notion of catharsis with an open-ended closure, a never quite fulfilled promise of consummation and which for me continues to perpetuate a state of attendance and presentness.¹⁰⁸ Driven by a new subjectivity that is embodied, enacted and emergent, it is this neurophysiological presence that most disrupts Aristotle's psychological immersion and mimesis.¹⁰⁹ Through this new mind/body relationship, narrative cognition is reinforced as a form of instantaneous sense making and the performer/narrator's attention is focussed accordingly in the 'now'. The net effect of this is to keep the narrative hovering in what I have coined as a form of neurobiological 'presentness', or to borrow a term from Gumbrecht, in a state of 'presentification'.

¹⁰⁷ American cartoonist and theorist Scott McCloud [1999, p. 31; 2005] provides an excellent case study of precisely this shift through his articulation of the impact of the computer space in online comics. Comics are a unique narrative form in that they are medium simultaneously called upon to represent text, image, sound, texture, time and space. For McCloud, the transfer of his medium from print to the online computer space, with accompanying simultaneous perspectives and navigational paths, required a shift in the time-space configuration of the narrative. It has led him to hypothesize the search for narrative meaning in this new context, as a search for a durable mutation. Story no longer presents as beginning, middle and end, but flows as "an ever-transforming thread with staying power." In his outline of the new syntax that is evolving out of the transition from mechanical cinema to electronic (digital) cinema, Youngblood [2003, p. 158] notes a similar transformational flow: "In electronic cinema the frame is not an object but a time segment of a continuous signal. This makes possible a syntax based on transformation not transition [...] A cut is a cut, but a transforming or metamorphosing operation is open ended."

¹⁰⁸ As early as 1995 artist filmmaker Weinbren spoke of the phenomenon of "*open ended desire*" in interactive cinema:
 "The basis of the interactive cinema is that the viewer has some control over what is on-screen. He or She knows that what is there will change if she or he acts, that it would have been different if he or she had acted differently earlier. Thus, the viewer is aware of a fundamental indeterminacy. I have called this epistemological state a subjective relationship to the screen - the viewer is constantly aware that things could have been otherwise. This state is grounded in the viewer's continual knowledge that what is on screen is a result of her interactions - inaction, naturally, counting as decisively as action [...] To find interactive forms in which desire can be sustained will require the construction of a new cinematic grammar. And, to be successful, this search, this construction-process, must foreground that aspect of cinematic communication that is fundamentally a grammar of temporality." [Weinbren 1995, p. 15 – 30]

¹⁰⁹ "Bodily experience of presence involves a complex integration of: (a), automatic, bottom-up sensory and organizational processes (body schema) with (b), higher order, top-down bodily and perceptual representations (body image)." [Giummarra et al 2008, p. 145]

"In the experiential loop model, presence is the process of 'feeling' with the present experience of the here and now, including one's body. Interactivity is the evolving of the sensori-motor loop and the 'immersion' feeling (emotion) of being part of the world." [Costa M., personal email, 6 May 2009]

These comments align with my belief that the new story building comes just as much from what one senses and feels, as from the knowledge one holds.

Gumbrecht's [2004] thesis is that contemporary society is moving towards a culture of presentification – a culture lived and relived continuously in the present.¹¹⁰ And while acknowledging that the contestation of presence as psychological immersion in the creative arts began well before the proliferation of digital technology, I argue that digital technology has accelerated this phenomenon.¹¹¹

Presentness and this shift in the construction and experience of time strike at the very core of dramaturgy. As a creative practitioner I am not alone in noting the challenges to our creative structuring of time. Prominent contemporary artists have intuited and signalled a need for a new conceptualisation. In answer to the question, "What will count as artistry in the future?" Ross Gibson has said:

"WE need to develop an art of TIME, an art other than any existing phenomenon. This art will take the form of some phenomenological route that will offer each participant a compelling, fully conscious experience of perceptive intensification followed by alteration. People will partake of this new art in order to be differently in time, to be in time whilst also having time in them. If our occupancy of time gets altered with nuance and precision then space will take care of itself, because the experience of time will be so strange and new, so compelling and preoccupying that the coordinates of consciousness will all shift radically."

[Gibson 2003, p.570]

Gibson's description of the future implies a narrative that is not so much reflective as embodied, the subjective experience of which precipitates us into a new grammar of temporality. Grahame Weinbren, media artist/ filmmaker and a pioneer in the early exploration of interactivity, expresses similar sentiments:

"There is the very central question of what function is left to Narrative in our Cybernetically Determined, Information Laden Era, as we travel along the Information Superhighways without stirring from our desks. Do we still need narrative to provide lessons in living and dying, do these lessons come to us through other channels...or don't we need such lessons any longer? Then there is the very important and subtle idea, expressed by philosophers in the wake of Heidegger such as Paul Ricoeur, that the conceptual relationship of narrative and time is reversed: that we impose a (false) linearity on time because our stories about

¹¹⁰ In referencing Gumbrecht's term I am also tweaking it to overlay my neurological descriptions and interpreting it as an expression of that narrow temporal band of the present moment - that window that hovers between past, present and future, sensation, action and reflection. David Gelernter also underscores the growing cultural preoccupation with 'the present as now': a reality that is lived right here, right now, at the meeting place of the present tense with the present moment:

"Returning to our fundamental riddle: if this is the information age, what do our children know that our parents didn't? The answer is 'now.' They know about now [...] Internet culture is a culture of nowness [...] Nowness is one of the most important cultural phenomena of the modern age: the western world's attention shifted gradually from the deep but narrow domain of one family or village and its history to the (broader but shallower) domains of the larger community, the nation, the world [...] no moment in technology history has ever been more exciting or dangerous than 'now.' As we learn more about 'now', we know less about 'then'." Gelernter [2010], viewed 20 March 2010 <<http://www.edge.org/documents/archive/edge313.html>>

¹¹¹ So much so, that Sherry Turkle, pioneer commentator on the role of technology in our lives, believes that recent technology is so powerful and so demanding of our 'present' attention, that it risks removing our capacity for 'reflection'. Turkle [2012], viewed 28 April 2013 <http://www.ted.com/talks/sherry_turkle_alone_together.html>

ourselves and others, our formation myths of what it is to be human, take shape as linear narratives, and upsetting this notion will change our understanding of temporality and hence our understanding of the world and ourselves." [Weinbren 1995, pp. 15 – 30]

The analysis of *Emergency in the Sim Ward* has suggested that our neurobiology might well hold the key to the alternate dramaturgies of the future. While many artists have noted the need for a reconfiguration of time, my hope is that this experiment and the neurobiological approach to dramaturgy might offer some insight into how and why this is occurring.

Undoubtedly, this doctorate has gone a long way towards answering the questions that plagued my practice across the nineties. Above all I understand now that the narrative and dramaturgical problems I faced could not have been fully resolved by simply rearranging the dramatic elements or modifying conventional frameworks.¹¹² I believe that the ramifications of an alternate dramaturgy based on neurobiological presentness are complex, so profound in fact, that this emerging poetic may well be calling for a different literacy. By rejecting the mind body schism, such literacy would move away from an exclusively logical, analytical approach to meaning, knowledge formation and narrative construction.¹¹³

A potential new literacy for real time dynamic narrative experiences will be one that more closely replicates our neurobiology,¹¹⁴ a space where reflection and experience can coexist as part of a changeable flow. Narrative would be understood as a dynamic continuum of sense making that oscillates between sensation and reflection between presence and interpretation. These attributes would no longer be opposing elements, but part of a movement that loops from one to the other, and back again.¹¹⁵

¹¹² When recently tasked with the narrative re-design for a "philosophical" computer game, heavy with linear story development, instead of struggling with an Aristotelian framing, I was for example, able to segment the narrative requirements into meta and micro levels, and focus on the reader journey across those dimensions to ensure a subjective flow between game play and story development.

¹¹³ "For a long time people believed that intelligence is equivalent to conceptual logical reasoning. Although it is obvious that the mind is not always logical, since the first successes of science many people came to identify the power of intelligence with logic. This belief in logic has deep psychological roots related to the functioning of the mind. Most of the mind processes are not consciously perceived. For example, we are not aware of individual neuronal firings. We become conscious about the final states resulting from perception and cognition processes; these are perceived by our minds as 'concepts' approximately obeying formal logic. For this reason many people believe in logic." [Perlovsky 2007, p. 76]

¹¹⁴ My experimentation has indeed led me to agree with Manovich [2004], Frasca [2003] and ultimately, Jenkins [2006], that we are forging a new literacy, one they describe as simulational:
"Traditional media are representational, not simulational. They excel at producing both descriptions of traits and sequences of events (narrative). A photograph of a plane will tell us information about its shape and color, but it will not fly or crash when manipulated. A flight simulator or a simple toy plane are not only signs, but machines that generate signs according to rules that model some of the behaviors of a real plane [...] Video games imply an enormous paradigm shift for our culture because they represent the first complex simulational media for the masses."
[Frasca 2003: pp.223 – 224]

¹¹⁵ Literary theorist, Hans Ulrich Gumbrecht [2004, p. 98] outlines the difference between what he calls the presence effect and the meaning effect. Gumbrecht looks back at the humanities, and modern literary history, summarizing the various prisms or models through which we have responded to work at different times in history. He contests the central position that 'interpretation' (the attribution of

The term 'paradigm shift' was coined by Thomas Kuhn to describe the process of change in the basic assumptions or mode of perception in the sciences. However much paradigm shift has been overused as a term, the process he describes deserves consideration:

"[...] the transition from a paradigm in crisis to a new one from which a new tradition of normal science can emerge is far from a cumulative process [...] rather it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalisations as well as many of its paradigm methods and applications. During the transition period there will also be a decisive difference in the modes of solution. When the transition is complete, the profession will have changed its view of the field, its methods and its goals." [Kuhn 1962, p.84]

The ever-ubiquitous digital technologies have indeed been transforming the fundamentals of production and creation across all facets of the arts and sciences. We are only just beginning to understand how this is changing our field of view and how we might conceive of, construct and in the future, even perceive our art. Technology's capacity to interact with and simulate our world - in all its sensory dimensions – demonstrates that our meaning making, (and now our narrative) is no longer exclusively defined by linear logic.

It is not surprising then that, parallel to the polemics around narrative and interactivity described across this thesis, many cultural theorists, philosophers and scientists share the opinion that we are entering a new paradigm as a result of this technological progress. For example, Science author Steven Johnson describes our culture as:

"slowly translating itself into a new digital language," and the computer interface as: *"a new cultural form hovering somewhere between medium and message."* [1997, p. 35]

Vilem Flusser, previously quoted in relation to logos and linearity, speaks of a post-historical condition, one made possible by the spatial dimensionality or 'surface' of current media: a condition that differs from the linear dimension of a text-based culture. Moreover, Flusser believes that the synthesis of surface and linear media may result in 'a new civilization'.

"I am impressed by the fact that one of the most important dimensions of the present cultural revolution, namely that linguistic communication, both spoken and written word are no longer capable of transmitting the thoughts and concepts we have concerning the world and new codes are being elaborated." [Flusser 2004, pp. 21 & 30]

meaning), has had within the humanities, as the primary mode of viewing. Gumbrecht describes two topologies - a meaning culture and a presence culture – and draws a distinction between the production of 'meaning' and the production of 'presence', the latter revaluing Heidegger in his notions of materiality and the body. He suggests that aesthetic experience is "an oscillation between presence effects and meaning effects", and that art sits in tension with these things. Gumbrecht concludes his discussion arguing for a new paradigm (shift), suggesting that western culture is moving away from the attribution of meaning through interpretation to a presence culture where aesthetic experience is not considered through interpretation but through presence, and accessed through epiphany and intensity.

In *Post Modernism and Complexity*, Paul Cilliers speculates that our technologies have become more powerful than our theories and that “*we can do with technologies what we cannot do with science.*” [Cilliers 1998, p.135]

My hypothesis was based on the conjecture that if it is possible for models emerging from computer and information sciences to illustrate brain function, could we not contemplate the reverse? Could we look at how digital technologies might now allow us to consider narrative according to the brain’s own internal system of processing?¹¹⁶ The interrelationship between the body, brain and technology seems to be forging new possibilities for human evolution. Could this alternate ‘neurobiological dramaturgy’ that I am suggesting be an expression of the co-evolution of technology with the mind as heralded by Murray?¹¹⁷

If narrative is amongst the highest expressions of human cognition, these developments, and the insights gained through *Emergency in the Sim Ward*, raise many other questions for the future. Donald Norman [2007], leading academic in cognitive science, design and usability, recently declared that we are entering a new phase with technology, and suggested that we are on the brink of an era of augmented humanity.

Andy Clark [2008, pp. 30-33] describes a new ‘negotiable body’ as technologies become integrated into our thinking and acting systems; they serve to transform us, renegotiating our own sense of embodiment, something that leads him to speculate whether human minds might not eventually be extended by technological tweaks.¹¹⁸

Biocca speaks about our emerging cyborg dilemma, and raises profound questions about the locus and stability of our individual identity:

“The pursuit of presence and the telecommunication of the body pushes a tight coupling of the physical body and the computer interface. To the degree that cognition and identity are embodied in the simulations run by our sensors and effectors, then the mind, in advanced virtual environments becomes also adapted to a mediated body, an avatar, and a simulation of the cyborg body. Observing the day-to-day movements of our consciousness between the experience of our unmediated body and our mediated virtual bodies, we may come to ask: Where am ‘I’ present? [...] At the close of this century, the development of

¹¹⁶ Masumi [2006] describes for example, how the new generation of digital software in architecture design allows architects to go beyond virtual explorations of artificial environments; to create responsive, intelligent environments reflective of neural functioning: “Architects are no longer just representing forms taken from pre-existing repertory as in postmodern architecture. They’re setting things up so that new forms evolve.”

¹¹⁷ Murray [2006]; See also Gorayska & Mey [2004].

¹¹⁸ “This fluid integration of technology into the perceptual-motor loop eventually may blur the boundary between our ‘unmediated’ self and the ‘mediating’ technology. Naive definitions of ‘self’ as everything contained within our bodily boundaries, and ‘non-self’ as the world outside our own bodies become much less obvious when we regard the intimate dependencies and co-adaptation we can experience when technology starts working as a transparent extension of our own bodies and minds. As cognitive scientist Andy Clark convincingly argues in his wonderful book ‘Natural Born Cyborgs’, what ‘I’ am is not defined by the outer limits of the ‘biological skin-bag’.” [Jsselsteijn 2005, p. 25]

advanced computer interfaces appears to be increasingly characterized by what we might call progressive embodiment. Progressive embodiment is defined as the steadily advancing immersion of sensorimotor channels to computer interfaces through a tighter and more pervasive coupling of the body to interface sensors and displays.”

[Biocca 1997, p. 20]

Is Biocca's '*progressive embodiment*' simply another descriptor for what is currently taking place in narrative? What new expressions and social dilemmas are yet to emerge from this process? If we grant Moore's law regarding the speed of change and technological innovation, it would be foolish to lock down any single development.¹¹⁹ The fluid current day narrative expressions are still redefining the status quo. Each technological innovation provides potential impetus for new permutations of narrative and re-presentation.

Accordingly, whatever the conclusions arrived at via this thesis, they can only hint at future directions. Boria [2006] argues that narrative is our most robust system for making sense of the world, and as such, becomes even more important in times of cultural transformation. I believe that our creative narratives will continue to act as a barometer for how we determine ourselves as humans.

Emergency in the Sim Ward has covered a wide interdisciplinary trajectory; it has provided answers to my creative dilemmas and it has also given rise to broader cultural considerations. But perhaps the most unanticipated reward of this dissertation has been the arts-science exchange, both in theory and in practice, via my dialogue with neuroscientists and the subsequent partnership with the clinicians in the simulation laboratory. It has opened up rich new perspectives against which to reference my questions and my practice.

Furthermore, by way of antidote, it offered the consulting anaesthetists a different way of examining their clinical process – a snap shot of their lived experience, previously unanalysed through conventional, technical medical debriefings. The unit has gone on to pursue a more formal program of simulation exercises and debriefings with experienced clinicians as a result of this research.

I found this exchange most profound. It is fitting therefore that I end my deliberation with the words of Damasio:

“Placing the construction of conscious minds in the history of biology and culture opens the way to reconciling traditional humanism with modern science, so that when neuroscience explores human experience [...] human dignity is not only retained, but reaffirmed.”

[Damasio 2010, p. 30]

¹¹⁹ Moore's law describes the tendency of technology and technological innovation to accelerate and exponentially drive social change. Stokes [2008].

Addenda

Addendum 1: Performance Canovaccio and Clinical Scenario

Anaphylaxis to Gelofusine

Clinical Scenario by Dr. Graham Lowry.

Time of Events: 22.00hrs

Setting: Large Tertiary Teaching Hospital and Trauma Centre.

Background History

An anaesthetic registrar on night duty has been asked to anaesthetise a 27-year-old male who has been involved in a motor vehicle accident. The patient was a front seat passenger of a car that left the road and collided with a tree. The point of impact was on the driver's side, and the driver has sustained life threatening chest injuries.

The patient, who was the passenger, had a GCS (Glasgow Coma Score) of 15/15 at the scene of the accident and was transferred to the hospital by ambulance. On arrival at hospital his observations were GCS 15/15, BP 110/60, HR 95, SpO₂ 98% on 6 L/min O₂. Initially he responded well to 2L intravenous crystalloid fluid (Normal Saline) but his blood pressure then started to trend downwards.

Other Relevant Medical History:

Past Medical History: nil significant.

Medications: nil regular.

Allergies: none known.

Smoker: 15-20 cigs/day.

Clinical Examination Showed:

Deformed right wrist – backslab plaster applied.

Seat belt bruising left chest.

Tender abdomen.

Tender neck – spinal precautions taken according to trauma guidelines.

Investigations Performed on arrival to the Emergency Department:

C-spine Xray: no abnormality detected (NAD).

CXR: NAD.

Xray Pelvis: NAD.

X-match blood: 4 units of packed red cells ordered.

CT Abdomen: free fluid detected.

Surgical Plan

Laparotomy for investigation of free fluid and persisting hypotension despite fluid resuscitation.

The anaesthetic registrar has had to ask the second on-call consultant (the participant in the study) to take over the case as the night registrar is required to assist the first on-call consultant with the more critical patient (the driver of the motor vehicle) with chest injuries. The participant is playing the role of him/herself throughout the scenario.

The second consultant arrives in the operating theatre shortly after induction, and just as the surgical registrar has opened the abdomen of the anaesthetised patient. There is blood in the abdomen that appears to be from a splenic injury. There was a small fall in BP upon opening the abdomen for which the registrar has just commenced a bag of intravenous colloid Gelofusin™, 500ml. Surgically, the bleeding has been controlled. The anaesthetic registrar gives a hand-over to the consultant and just before the registrar leaves the room he turns on an intravenous line with the Gelofusin™ connected.

Action Events

Start of Scenario

Present in the operating theatre:

- Consultant anaesthetist (subject)
- Anaesthetic nurse
- Surgeon
- Anaesthetic registrar (initially)

Patient's clinical status at the commencement of the scenario:

- HR: 95 bpm
- BP: 105/56 (recorded via a radial arterial line)
- SpO₂: 98% on 50% oxygen
- ECG: sinus tachycardia

Stage 1 (duration 3 minutes):

Shortly after the anaesthetic registrar relieves himself from the case to assist in another operating theatre, there is a gradual deterioration in the patient's condition. This is when the scenario commences.

At this point the patient starts to decrease his oxygen saturation (SpO₂) down to 92% over a period of 1 minute, his blood pressure starts to fall to approximately 90/50 and his heart increases to 121 b.p.m. over a 2 minute period. Capnography also shows a degree of bronchospasm on the waveform. At this point all surgical issues have been addressed. Despite all anaesthetic interventions the deterioration continues.

Stage 2 (duration 3 minutes):

Further deterioration of patient: Heart rate increases to 132bpm, SpO₂ falls to 85% and the blood pressure falls to 70/40. There is an associated decrease in ETCO₂ and continuing bronchospasm. All interventions by the anaesthetist are unable to reverse this trend. Help has been summoned, the registrar returns to the operating theatre to assist with the resuscitation.

Stage 3 (duration 2 minutes):

Further deterioration of the patient: The ECG shows ventricular ectopic beats, the blood pressure continues to fall to a level approximately 60-70mmHg systolic. SpO₂ is now un-recordable and ETCO₂ ranges from 15 - 20 mm Hg. After the two minutes the patient has a cardiac arrest as he develops ventricular tachycardia at a rate of 152 b.p.m. The patient will not progress through the scenario until CPR and defibrillation is performed using a biphasic defibrillator that has been brought into the operating theatre. Following the first shock, the patient converts to ventricular fibrillation. A further shock sees the patient revert back to sinus rhythm.

Stage 4:

Return of spontaneous circulation following the successful defibrillation. The patient's blood pressure becomes recordable and steadily improves. There is also an improvement in the patient's oxygenation and ventilation. At this point the scenario is terminated.

Addendum 2: Considerations On The Processing Brain

"Let me tell you about the problem confronting us. The brain is a 1.5 kilogram mass of jelly, the consistency of tofu; you can hold it in the palm of your hand, yet it can contemplate the vastness of space and time, the meaning of infinity and the meaning of existence. It can ask questions about who am I, where do I come from, questions about love and beauty, aesthetics, and art, and all these questions arising from a lump of jelly. It is truly the greatest of mysteries. The question is how does this come about?" ¹²⁰

The difficulty in undertaking a neuroscientific investigation of my creative questions has been the explosion of perspectives and suppositions on the workings of the brain - particularly the elusive mind-brain relationship - through a discipline that is still evolving and coming to new understandings. During the course of my analysis I do of course reference key neuroscientific theories underlining my argument. But in addition to the layered inclusions of such citations on a needs basis across the text, I felt it was necessary, given the complexity and interconnectedness of many of the concepts, to present a more holistic framework for the choice of certain scientific theories and views of the brain.

This addendum provides precisely that framework: 'Considerations on The Processing Brain' is designed as an overarching narrative, to be used as a companion and backdrop to the main analysis. Its purpose is to equip the reader with an overview of the neuroscientific premises informing my work.

My readings begin with the understanding that first and foremost the brain is a biological phenomenon. It is a complex architecture of neurons with each neuron consisting of an axon and branching dendrites along which impulses received from other cells at synapses are transmitted to the cell body. With innumerable combinations available in this network of impulses firing at synapses, our brain circuitry is unique to each and every one of us. But the transition from the biological reality that underpins all brain processes to the mind and that which shapes our cognition and sense of self (consciousness), has yet to be fully explained, and remains the subject of intense speculation across disciplines.

Historically, the brain has been analysed utilising a variety of lenses from behaviourism to psychoanalysis and clinical pathology. More recently the new discipline of cognitive science has reeled in perspectives from other domains such as philosophy and psychology. Many of these methodologies have produced distinct metaphors and paradigms for conceptualising the brain across different eras. The growth of computer science during the 1950's for example, saw the gradual overlay of

¹²⁰ Ramachandran 2012, viewed 15 March 2012, <http://edge.org/conversation/adventures_behavioral_neurology>

information processing theory and computational modelling onto descriptions of the working brain and its memory function.

Computer modelling in some form or other remained a guiding metaphor for a considerable time in the cognitive sciences, particularly though the seventies and the eighties. It coincided with the move away from the study of the brain through the observation of behaviour - a bottom-up mode of analysis - to a cognitive approach, which reaffirmed a top-down mental analysis. [Sperry 1998]

Today we can witness that neuroscience, together with complexity and dynamic systems research, is fuelling new developments. The multidisciplinary nature of the neurosciences is facilitating a rapid convergence of knowledge. When coupled with advances in digital technology, the latest findings seem to be changing our understanding of the brain. They are allowing us not just to theorise the brain, but also to see into the brain in ways that have not previously been possible. Technologies such as magnetic resonance imaging (MRI) - which utilize responses to a magnetic field to produce images of internal organs - or positron emission tomography (PET) - when used for brain scans, literally make the invisible 'visible'. By expanding our visual bandwidth, this neuroimaging revolution is giving scientists the opportunity to directly monitor processes in the brain.

Neuroscientist Stanislas Dehaene (referenced in the main body of this thesis) describes the *modus operandi* at the NeuroSpin research centre in the following manner:

*"About 150 researchers, physicians, clinicians, biologists, engineers and technicians will work together at NeuroSpin. The methodology teams will be in charge of pushing the current technical limits of imaging and create new approaches, from imaging methods to mathematical models and software for image analysis, to map the basic biological parameters needed to understand the brain. The neuroscientists, neuropsychologists, and clinicians will benefit from these methodological contributions for their own research programs, whether it consists of molecular or cellular biology, neurobiology of development and post-genomics, neurosciences or cognitive sciences. This specific interface between methodologists, neurobiologists and physicians creates an exceptional environment necessary to break the current limitations of neuroimaging in order to better understand the workings, development and dysfunction of the human brain".*¹²¹

¹²¹ CEA is a public research body (French EPIC statute), which conducts strategic multi-year research and innovation programmes of national importance. It is based at the CEA Campus of Saclay Pitie Salpetriere Hospital, France. CEA Promotional brochure, viewed 18 June 2010.

The Processing Brain

At its most fundamental level the brain appears to take in the world by continuously and spontaneously processing sensory stimuli. These stimuli activate neural activity in the brain, and perception is generated through the brain's ability to recognise patterns of neural activity.

James Gibson's authoritative thesis on *The Senses as Perceptual Systems* [1996] explains how our senses – taste, touch, smell, hearing, sight and movement – automatically take in 'data', and function as a stable perceptual 'input system' for the processing and storage of information.

What information is stored will depend on the weight, duration and intensity of the input. Central to this function, the brain needs to register and recognise patterns of neural activation for perception to occur.¹²² When it receives a new stimulus it first searches for similar patterns from prior experience. The brain does this based on the intensity of the original sensation or stimulus (events that are more intense '*stick more*') and on pattern recognition, the latter involving the referencing of pre-existing schemata and scripts, locked in our memory from prior learning or experience.

Memory therefore plays a significant part in our ability to recognize and understand the world; yet there is no unifying theory on the function of memory,¹²³ or the ability of the brain to encode, store, and retrieve data.¹²⁴ What we do know is that information moves through the system in stages, and that there are diverse theories to describe the different memory processing systems, information storage mechanisms and associated neural pathways.

Traditionally these have included notions of vertical – top-down, bottom-up – processing pathways. In the so called '*staged*' model of memory for example, information moves from original stimulus to a short term storage system (iconic or flash memory) lasting less than a second, then to working memory (short term memory) which has both a storage and retrieval function of a few minutes and a final stage of more permanent long-term memory storage system.¹²⁵

Long-term memory is further divided into explicit memory, that which is consciously

¹²² "The brain recognises patterns of neuronal activation within the brain itself. For perception to occur, the brain searches for a match between the current pattern of neuronal activation and patterns stored from prior experience." [Pally 2000, p. 30]

¹²³ "Human memory is not a simple unitary entity; it is rather a system of interacting systems which have the job of storing and retrieving information." [Baddely 2004, p. 6]
"The neurobiology of learning and memory is a young discipline [...] an open cross level synthesis of cellular, systematic and behavioural investigations." [McGaugh 1992, p. 3]

¹²⁴ According to Norman [1969], the act of remembering requires one to have successfully acquired, retained and retrieved information within the brain.

¹²⁵ Atkinson & Schiffrin [1968]. See also Baddely [1999].

recalled, and implicit memory, that which is unconsciously stored via priming, habit, and emotion response. The latter indicates that information can be stored consciously and unconsciously without us even being aware of it. While descriptions of memory processing and storage systems vary, there seems to be broad consensus that there are two identifiable circuit routes for the processing of data:

- A short sensory route that bypasses the cortex and does not involve conscious awareness; and,
- A slower route that involves the cortex and conscious awareness. [Pally 2000]

Findings in neuroscience now suggest that we are no longer dealing with a single split perceptual system or top-down, bottom-up process, but with a complex circuitry of superimposed loops operating both vertically and horizontally. From this perspective, the brain emerges as a complex system of non-linear interactions, loops and connections. [McGaugh 1992, Eagleman 2000]

Hence, by acknowledging that information once taken into the brain may be stored and reactivated through memory, new neurobiological and connectionist approaches begin to speculate more complex pathways to meaning making. [McClelland 2000]

Accordingly my interest gravitates around the following two insights:

- Firstly, that there is a temporal factor involved in the different information processing and storage pathways; and,
- Secondly, that not all of the information we receive is consciously perceived - some is processed unconsciously.¹²⁶

Brain as Biology, Brain as Mind

Within descriptions of the brain as biology, it would seem that our sense of being in the world, and consequently our making of narrative meaning, rests on millions of neural networks and processes operating both at a conscious and unconscious level, firing at differing intervals and levels. But how do neural firings and chemical reactions give rise to experience and meaning? To answer this I chose to reference Antonio Damasio as an influential neurobiologist working at the edge of these issues. Damasio combines clinical studies with philosophical underpinnings in a hypothesis that amounts to a '*neurobiology of consciousness*'.

Using as a point of departure the somatic feeling theory first put forward by William James,¹²⁷ Damasio carefully tracks what occurs in the body and brain, from the

¹²⁶ "At all times the brain is constantly bombarded with stimulation – and yet we are only aware of a very small part of it [...] There is a basic distinction between all the stimuli that enter the nervous system, and a much smaller set of stimuli that make it into our conscious awareness." Dehaene [2009]

¹²⁷ In the seminal work, 'What is Emotion?', psychologist and philosopher William James advocated that "the emotional brain processes not only resemble the ordinary sensorial brain processes, but in very truth are nothing but such processes variously combined." [James 1884, p. 188]

registering of an initial stimulus to the full-blown conscious feeling of that stimulus in the form of a recognizable mental state. What starts as a chemical reaction and change in the body becomes a feeling, the feeling then becomes knowledge, until finally, according to Damasio, the feeling becomes meaning. [Damasio 1999]

In essence, Damasio's account offers insight into how we might be able to track the intricate and mysterious body-brain-mind relationship through our senses and emotions. He begins by acknowledging that emotions are complex physiological processes, chemical and electrical reactions triggered automatically in response to external or internal stimulus - such as a thought or memory- and that they serve, above all, to regulate the organism. The ability to sense fear, pain or fatigue, to cite obvious examples, has been essential to our survival and critical to our evolution by motivating us to respond when we are in danger or when we feel pain.¹²⁸

From these biological reactions and neural activations, patterns form within the brain, which ultimately result in mental images and thoughts. Whilst Damasio concedes that the passage from such neural 'sensory maps' to a mental image still remains enigmatic, he nonetheless cites a chain of reactions that move from the physical to the mental via a considered articulation of what he calls "stages of processing":

"I separate three stages of processing along a continuum: a state of emotion, which can be triggered and executed non-consciously; a state of feeling, which can be represented non-consciously; and a state of feeling made conscious i.e. known to the organism having both emotion and feeling."

[Damasio 1999, p. 33]

Emotion corresponds to primary sensation and represents known neural patterning; feeling is the emotion that 'becomes image' taking on a tangible thought association, and the 'knowing feeling' the result of emotion becoming reasoning. Implicit in his proposal is the understanding that emotion and feeling underpin human reason; that all thinking essentially starts out as a chemical or electrical stimulus - a biological process - and moves through the system to a higher order or second stage mental processing [Damasio 1994].

As an example, consider a heart that starts to beat faster. A beating heart is a bodily change that creates emotion. It could be caused equally by joy or fear. That which defines whether it is joy or fear is the cognitive appraisal that gives the physical phenomenon its emotional significance [P Prinz 1994].

¹²⁸ "The function of emotion is to coordinate the mind and body...emotion organises perception, thought, memory, physiology, behaviour, and social interaction so as to provide an optimal means for coping with the particular situation that is generating the emotion." [Pally 2000, p. 73]
"[...] emotions are complicated collections of chemical and neural responses forming a pattern; all emotions have some kind of regulatory role to play...and their role is to assist the organism in maintaining life." [Damasio 1999, p. 51]

From this perspective emotions are defined as embodied appraisals, both bodily *and* cognitive states.¹²⁹

It becomes clear from this approach that Damasio (together with emotion research theorists) dismisses the historical mind-body division so as to put forward different views about how sensory input and emotions underpin cognition and reason.¹³⁰

Informed by our bio-chemical responses, the ebb and flow of our emotions critically shapes our consciousness and leads ultimately to the attribution of meaning:

"The fabric of our minds and of our behaviour is woven around continuous cycles of emotions followed by feelings that become and beget new emotions, a running polyphony that underscores and punctuates specific thoughts in our mind and actions in our behaviour."

[Damasio 1999, p. 43]

This premise of a connective feedback loop between conscious/unconscious emotion, and reason, is also coincidentally supported by recent neural imaging experimentation which suggests that conscious and unconscious sensory processing coexist and intertwine, and are at some point momentarily processed in the same regions of the brain.¹³¹ [Damasio 1994, p. 79; Morris 2002, p. 319; Dehaene 2009]

¹²⁹ There appears to be a high degree of agreement concerning the fact that sensory systems are intimately involved in the storage and processing of information. Many cognitive scientists and emotional theory researchers support this description of a passage from an initial biological reaction to rising emotion, and the appraisal of that emotion to become a knowing feeling. Prinz argues from a perceptual theory perspective, consistent with Damasio, that emotion is a form of perception of patterned changes in the body that take on meaning through 'appraisal'. [2004, p. vii] Le Doux [1998] acknowledges the neural and biological basis of emotion and examines the "*stimulus to feeling sequence*" by recognising that emotions are unconscious processes that can give rise to conscious content. [1998:43] Both highlight the resurgence of scientific interest in emotional research and the seminal work of William James and Karl Lange [Le Doux 2004, p. vii]. See also [McGaugh et al 1992, pp. 37 - 39].

¹³⁰ This is the main argument of *Descartes Error*. Damasio [1994]

¹³¹ Notions of pre conscious, conscious and unconscious recur across my research and investigations. In an overview of meanings attributed to consciousness, Vimal identifies some forty meanings attributed to the term and concludes that, "*the prospects for reaching any single, agreed theory independent definition of consciousness thus appear remote.*" [Vimal 2009, pp. 9 – 27].

Explanations of consciousness oscillate between reductionist explanations of consciousness as a physical process, the functional result of dynamic interactions amongst groups of neurons [Dennet 1991], to consciousness as subjective experience and awareness. Philosophers such as Searle [1992] combine the two, by arguing a '*biological naturalism*' in that consciousness is a real subjective experience caused by the physical processes of the brain. Damasio himself draws a distinction between different kinds of consciousness: '*core*' consciousness that constitutes a basic state of wakefulness; and, a more complex consciousness that involves self-awareness [Damasio 1999, p. 16].

David Chalmers [1995] famously defined the '*really hard problem of consciousness*' as one of '*experience*': namely, whilst it is generally accepted that experience and emotion arise from a physical basis, there is no explanation of *how it is actually generated*. Through my investigations I have come to adhere to the non-reductive view of consciousness and my creative experiment clearly places subjective experience at the centre of all considerations.

The Senses as Information in Time

Significantly then, these readings re-affirmed for me firstly, that cognition and narrative originate as “an assembly of selected neural firing patterns”¹³² and secondly, that meaning is constructed from the grouping and recognition of integrated connections between these networks of neural circuits as they permeate into feeling and emotion.

My conversations with neuroscientist Marcello Costa however, confirmed that the temporal factor also needed to be taken into consideration. According to Costa, it takes time for the brain to build even the simplest subjective experience:

“Time is then the context that frames most aspects of our behaviour, from the fastest sensations and movement, measured in fractions of seconds, to the annual cycle of celebrations and beyond.”

[Costa 2006, p. 55]

Previously, in my introductory reference to Gibson [1966], I described how information is taken in and processed through the senses. While the senses in themselves have no ‘time’, the sensations they produce are in fact sensations processed in time. How much and what we process of any stimulus is affected by multiple factors ranging from the duration, frequency, and intensity of the input, to the order in which input is received, with different senses being received and perceived at different rates.¹³³

To further understand the temporal factor, the following analogy proved extremely useful. Neuroscientist David Eagleman directs a laboratory for perception and action at the Baylor College of Medicine. He illustrates ‘brain time’ as follows:

“At some point, the Mongol military leader Kublai Khan [1215–94] realized that his empire had grown so vast that he would never be able to see what it contained. To remedy this, he commissioned emissaries to travel to the empire's distant reaches and convey back news of what he owned. Since his messengers returned with information from different distances and traveled at different rates (depending on weather, conflicts, and their fitness), the messages arrived at different times. Although no historians have addressed this issue, I imagine that the Great Khan was constantly forced to solve the same problem a human brain has to solve: what events in the empire occurred in which order?”

[Eagleman 2009]

In this way, the question of narrative cognition and meaning reveals itself to me as a matter of the brain’s temporal dynamics, and how it processes information (stimulus events) in time. It is not just how we take in information, or where we might process and store it, but how that information is managed in time to shape a coherent narrative. The brain builds meaning in and through time. Ironically, the ubiquitous

¹³² [Siegal 2007, p.143]

¹³³ Eagleman [2009] explains: “To illustrate the problem, snap your fingers in front of your face. The sight of your fingers and the sound of the snap appear simultaneous. But it turns out that your brain laboriously constructs impression. After all your hearing and your vision process information at different speeds. A gun is used to start sprinters, instead of a flash, because you can react faster to a bang than to a flash. This behavioral fact has been known since the 1880s and in recent decades has been corroborated by physiology: the cells in your auditory cortex can change their firing rate more quickly in response to a bang than your visual cortex cells can in response to a flash.”

presence of digital technology in our lives has increased the amount of sensory and information stimulus we are exposed to, exponentially multiplying the amount of information that needs to be processed and integrated in time.¹³⁴

Time, Cognition And Neuronal Synchronisation

The above considerations pose a related question. How does the myriad of micro events at the physical level, fold into one single reality? How does the brain integrate all of the information, which comes to us in different times, to give us a sense of coherence and meaning?¹³⁵ This so-called binding problem is referred to as the problem of how “unity of perception is brought about by the distributed activities within the system”.¹³⁶

Philosopher and scientist Thomas Metzinger for example argues that the real problem for neuroscientists tackling consciousness and meaning is one of integration [2009, p. 26]. Damasio concurs that the problem of integration needs to be reconsidered:

“[...] the idea of integration by time has surfaced over the past decade and now appears prominently in the work of a number of theorists. If the brain does integrate separate processes into meaningful combinations by means of time, this is a sensible and economical solution but not one without risks and problems.” [Damasio 1994, p. 95]

Experimental evidence from neurobiology is starting to suggest a relationship between synchronization of neuronal activity and perceptual consciousness. Crick and Koch tentatively put forward the theory in their study of the integration of visual information in the brain.¹³⁷ It appeared to me that a number of neuroscientists were supporting the idea that the binding together of different stimuli to enable cognition and meaning was the product of neural synchronisation and that there is a neural correlate to consciousness [Pally 2000, p. 27; Grind 2002, p. 243; Varela & Thompson 2003].

Two of the most experimental and influential theories in relation to *Emergency in the Sim Ward* were those proposed by Stanislas Dehaene [2009] and Benjamin Libet [2004].

¹³⁴ This fact, and Eagleman’s military analogy, resonated deeply in my discussions with Dr. Braden McGrath. For McGrath, who was part of the research team on a NATO study on tactile displays, the capability of new defence technologies to supply ever more detailed data stimulus was outstripping the capability of any human in the loop to process that information. This was especially of concern in the technology rich domain of aviation training – where pilots of modern day cockpit displays needed to negotiate a plethora of data and technological inputs – and where the slightest miscalculation in that processing could be matter of life and death.

¹³⁵ “Bringing together all this into one state, associated with the strong experience of being a unified in-control self, is one of the most dramatic events in biology, and one that happens continuously in every human as result of the ongoing interaction of our organism, brain and body in a life-long dance with the environment.” [Costa 2008, p. 38]

¹³⁶ Revonsuo & Newman [1999, p. 23]. And in a follow-up article on, ‘Binding and The Phenomenal Unity of Consciousness,’ Revonsuo also acknowledges that there is in fact a lack of clarity around the issue: “The main message of the present paper is that the science of consciousness needs to establish a clear theoretical view of the relation between binding and consciousness and to encourage further empirical work that builds on such a theoretical foundation.” [ibid 1996, p. 173]

¹³⁷ “We suggest that the time is now ripe for an attack on the neural basis of consciousness. Moreover, we believe that the problem of consciousness can, in the long run, be solved only by explanations at the neural level.” [Crick & Koch 1990, p. 263]

Dehaene's neural imaging experiments at *NeuroSpin* led him to put forward a working hypothesis about temporal and neural synchronicity and integration which he has coined 'signatures of consciousness'. He argues this proposition in terms of a threshold of consciousness. According to this theory there is a period of subliminal processing, a period of approximately one quarter of a second, wherein *all sensory processing is identical*. After this brief period, sensory information may or may not cross over the threshold into consciousness depending on a process of amplification or synchronisation wherein individual cells oscillate at the same frequency across the brain. Dehaene uses the term 'signatures of consciousness' to describe this process of amplification and synchronisation.¹³⁸ If there is enough neuronal synchronisation, there is conscious awareness. In addition, he proposes that temporal and neural synchronicity is not located in any single area of the brain but instead distributed across the neuronal network - hence the term '*signatures*' - and creating the sensation of a unified conscious experience.¹³⁹

Libet: Backward Referral and the Experience of the Present

The seminal work of Benjamin Libet [2004] on the temporal dynamics of the brain delved further into the connection between neural activity patterns, experience and conscious processing. For Libet [2006, p. 322] the conscious mind could only be regarded as subjective experience. His temporal lag theory questions the relationship between our conscious and unconscious processing functions. In Libet's theory, not only is sensory information processed at different speeds across different neural networks, but there is also a notable temporal factor at play between any neural activation or stimulus and our conscious sensory awareness of that stimulus event.

Libet's experiments document a 0.5 sec delay in conscious sensory awareness, and reveal a perception lag between the physical timing of neural response to a stimulus, and the mental timing required to consciously register that stimulus as experienced response.

"So we have the strange situation in which the actual awareness of the present is really delayed, but the content of the conscious experience is brought into alignment with the present. Subjectively then, we do live in the antedated present for up to 0.5 second after the sensory signal arrives at the cerebral cortex."

[Libet 2004, p. 7]

¹³⁸ "I am now happy to report that we have acquired a good working hypothesis. In experiment after experiment, we have seen the same signatures of consciousness: physiological markers that all, simultaneously, show a massive change when a person reports becoming aware of a piece of information (say a word, a digit or a sound)." [Dehaene 2009]

¹³⁹ This hypothesis in a sense extends Baars' more established global workspace theory of consciousness [GWT]. The global (neuronal) workspace theory proposes that consciousness has a widespread integrative function, in that it enables multiple networks within the brain to cooperate to access meaning [Baars 1988; 2003, p. 46]. Dehaene concurs that the synchronous activation of neurons across the brain appears to actually enable consciousness offering widespread access to brain information and functions. [Dehaene & Changeux 2011, p. 201]

It appears that the brain re-synchronises to account for the temporal lag by performing something tantamount to a '*recalibration*' of subjective timing.¹⁴⁰ Our experience of the 'present' then is, according to Libet, the result of a subjective, *backward referral in time* - back to the time of the initial primary response of the sensory cortex. In this way the content of that experience is brought into alignment with the present.¹⁴¹ This notion of a delay in conscious perception raises many questions.

If there is in fact a temporal lag between the initial registering of a stimulus and our conscious awareness of it, what constitutes the 'present'?¹⁴² Add to this Dehaene's earlier speculation that there is about a quarter of a second where conscious and unconscious stimulus appear to hover together¹⁴³ and there are intriguing issues raised about the timing between pre-reflective primary processing, conscious secondary processing, and what actually constitutes our experience of the 'present' moment.

This speculation around what constitutes the present from a neurobiological perspective posed an interesting juxtaposition to how we have traditionally constructed time and the present in our narratives; it provided a foundation for my subsequent experimentation.

Complexity And Emergence

A consequence of these neurobiological views about how the brain arrives at conscious meaning - from Damasio's examination of emotion to Dehaene's signatures of consciousness and Libet's temporal thesis - is that they go against the design of the brain as a linear or hierarchical top-down/bottom-up processor.

They favour an understanding of the brain as a complex system - a system where the temporal boundaries between past, present and future blur.¹⁴⁴

¹⁴⁰ "[...] continuous feedback loops from higher to lower areas (of the brain) create an ongoing cycle, a circular nested flow of information, in which what happened a few milliseconds ago is dynamically mapped back to what is happening right now. In this way, the immediate past creates a context for the present - it filters what can be experienced as right now." [Metzinger 2009, p. 31]

¹⁴¹ While Libet's time thesis is influential, the 'backward referral' proposal remains the most controversial aspect of his work.

¹⁴² "[...] brains do not passively track time they actively construct it." Eagleman [2009 b]

¹⁴³ "[...] the difference between a non-conscious and a conscious percept occurs quite late in processing. Let's call time zero the point at which the word first appears on the screen, and let's follow this activation from that point. What we see is that, under the best of conditions, it can take as long as 270 to 300 milliseconds before we see any difference between conscious and unconscious processing. For one fourth of a second, which is extraordinarily long for the brain, you can have identical activations, whether you are conscious or not. During this quarter of a second, the brain is not inactive and we can observe a number of lexical access, semantic access and other processes (and subliminal processing can even continue after this point)." Dehaene [2009]

¹⁴⁴ Theories of complexity, and concepts of dynamic systems evolved originally from mathematical, computational and economic modelling in an attempt to describe how dynamic agents change over time. For a more comprehensive discussion on the growth of complexity thought, see Cilliers [2001, 2004].

This led me to further consideration of the notions of complexity and emergence. Paul Cilliers [2004, p. 25] outlines the characteristics of complex systems as: consisting of a large number of elements that in themselves can be simple; separate elements interacting dynamically; interactions that are rich and non linear; many direct and indirect feedback loops; open and exchanging information within their environments; having memory but rather than it being located in a specific place, being distributed throughout the system; and, their behaviour being determined by the nature of the interactions and being adaptive.

Under this definition, the brain is dynamic in that it is changing continuously in response to the stimulus that it receives; it is complex in that it is dependent on inter-relationship between the components of its unique networked systems; and, it is emergent and generative in its capacity to self organise and give rise to coherent patterns and properties. Its constantly changing and adaptive nature also suggests that meaning *emerges* from a flow of interactions rather than being locked into any particular component.

The notion of *emergence* therefore is deeply interconnected with complexity and dynamic systems. Emergence acknowledges that coherent patterns and structures emerge spontaneously from complex systems via an organic process of self-organisation. Intelligence becomes apparent from the complex connections and feedback loops between the separate parts of a system [Varela & Thompson 2001, p. 420]. This proposal is sympathetic with the view of cognition as something that arises from neuronal synchronicity.¹⁴⁵

My particular consideration of emergence as another lens through which to read the mind brain connection references the work of Chilean biologists Francisco Varela and Humberto Maturana. Both focused on the emergent processes in cells and living systems and expounded a biological view of cognition, one of cognition as embodied and enacted. In 1972 Varela and Maturana co-authored the theory of *autopoiesis* to describe a continuum of creation and re-creation and the perpetual cycle of (re) generation in living systems:

"An autopoietic system is characterized by being an autonomous and self-maintaining unity which reproduces itself. It stands in opposition to an allopoietic system, which produces something other than itself."

[Veel 2005, p. 4]

Life was not a property of a system's parts, but emerged as a result of the interaction of its parts, and cognition was the process of this interaction. In essence they

¹⁴⁵ Emergence theory today spans across philosophy, systems theory, computer science, art and science. Nobel Prize winning physicist, Robert Laughlin [2005] asserts that we are partaking of a 'new age of emergence' in the form of a paradigm shift that has been slowly overtaking the reductionist view of organisational systems and matter. See also Cilliers [1998].

attempted to understand the basis of cognition through the mechanism of *autopoiesis*.¹⁴⁶

Varela rejected the computational theory of the mind and any view of the nervous system as an input, output processing system [Pasquinelli 2006: 33]. Instead he approached it as a biological organism and argued that “*living things manifest themselves in particular actions in their appropriate environments*” and that the individual and the world created each other:

“*Cognition is, as I would claim, the bringing forth of a world; it is embodied action.*”

[Varela & Peorksen 2006, pp. 35 & 37]

Varela, Thompson, and Roach further elaborated this thesis in their 1991 publication *The Embodied Mind*. This text clearly outlined the difference between what they describe as three quite separate methodologies for understanding and describing cognition. The first, the *cognitivist* methodology, adopts the digital computer or computational model. The second, the *emergence* methodology, takes the view that cognition emerges from the interactions within the distributed and networked neural system and as such, resonates with global workspace theory. The third, which is their proposal, is that of *enacted* and *embodied* cognition: that cognition does not just emerge from interactions within the system but does so by being embodied, present and enacting itself within the environment. [Varela, Thompson & Roach 1991, p.7]

My particular focus remains on the latter. It is here that the neurobiological present (presentness), and presence as embodied, enacted cognition, coincide. As a consequence of these readings, my experimentation is ultimately founded on a picture of the processing brain not as a hierarchy of top-down, bottom-up processing pathways, but as a complex matrix – a dynamic ecosystem of neurons firing in and across time.

¹⁴⁶ “Maturana and Varela also held that autopoiesis defines cognition in its minimal biological form as the ‘sense-making’ capacity of life; and that the nervous system, as a result of the autopoiesis of its component neurons, is not an input-output information processing system, but rather an autonomous, operationally closed network, whose basic functional elements are invariant patterns of activity in neuronal ensembles.” [Thompson, E., 2001, p. 66]

Bibliography

- Aarseth, E. 1997, *Cybertext Perspectives on Ergodic Literature*, John Hopkins University Press, Baltimore, USA.
- Aarseth, E. 2004 a, 'Genre Trouble: Narrativism and the Art of Simulation', in Harrigan, P. & Wardrip-Fruin, N. (eds), *First Person: New Media as Story, Performance and Game*, MIT Press, Cambridge, Mass. USA, pp. 45 - 55.
- Aarseth, E. 2004 b, 'Quest Games as Post- Narrative Discourse', in Ryan, M-L. (ed), *Narrative across Media*, University of Nebraska Press, Lincoln NE, USA, pp. 361 - 76.
- Abbott, P. 2002, *The Cambridge Introduction to Narrative*, Cambridge University Press, Cambridge, UK.
- Aldama, F. L. 2010, *Toward a Cognitive Theory of Narrative Acts*, University of Texas Press, Austin, USA.
- Anastopoulou, S., Baber, C. & Sharples, M., 2001, 'Multimedia and Multimodal Systems: Commonalities and Differences', *Proceedings of the 5th Human Centred Technology Postgraduate Workshop*, University of Sussex, 26 - 27 Sept., viewed 18 July 2012, <http://www.syros.aegean.gr/users/manast/Pubs/Pub_conf/C03/C03.pdf>
- Anderson, M., & Wilkinson, L., 2007 'A Resurgence of Verbatim Theatre: Authenticity, Empathy and Transformation', *Australasian Drama Studies* 50, pp. 153 - 169.
- Andrieu, B., 2006 'Brains in the Flesh: Prospects for a Neurophenomenology', *Janus Head* 9:1, Trivium Publications, Amherst, New York, USA, pp. 135 - 155.
- Andrieu, B., 2007, 'Touch in the Skin's Culture of Modern Medicine: The Birth of Bio-Subjective Care', *Touching Places/Placing Touch: Space, Culture and Tactility*, The Royal Geographical Society Annual Conference Paper, London, 28 - 31 August, viewed 13 July 2011, <<http://en.youscribe.com/catalogue/educational-resources/education/tuition/touching-places-placing-touch-space-culture-and-tactility-the-royal-1712111>>
- Aristotle [c350 B.C] 1997, *Poetics*, trans. M. Heath, Penguin Books, London, UK.
- Arnheim, R.1982, *The Power of the Centre - A Study of Composition in the Visual Arts*, University of California Press, Berkley, USA.
- Arvidson S., 2006, 'The Sphere of Attention: Context and Margin' in *Contributions to Phenomenology*, Vol. 54, Springer Publishing, New York, USA, pp. 1 - 13; 115 - 121.
- Ascott, R. (ed) 1999, *Reframing Consciousness - Art Mind Technology*, Intellect Books, Exeter, UK.
- Atkinson, R.C. & Schiffrin, R.M., 1968, 'Human Memory: A Proposed System and its Control Processes', in *The Psychology of Learning and Motivation: Advances in Research Theory* Vol. 2, Academic Press, New York, pp. 89 - 195.
- Auslander, P., 1994, *Presence and Resistance*, University of Michigan Press, Michigan, USA.
- Auslander, P., 1999, *Liveness: Performance in a Mediatized Culture*, Routledge, New York, USA.
- Austin, T., 2008, *Rethinking Documentary – New Perspectives, New Practices*, Open University Press, McGraw Hill International, UK.
- Australian and New Zealand College of Anaesthetists Website n.d., 'What is Anaesthesia?', viewed 29 June 2011, <<http://www.anzca.edu.au/patients/anaesthetist>>
- Baars, B., 1988, *A Cognitive Theory of Consciousness*, Cambridge University Press, Cambridge, Mass., USA.
- Baars, B., 2003, 'Global Workspace Theory of Consciousness: Toward a Cognitive Neuroscience of Human Experience', in *Progress In Brain Research* Vol. 150, pp. 45 - 54.
- Baars, B. & Cage, N., 2010, *Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience*, 2nd edn., Elsevier Press, San Diego, USA.
- Baber, C., Borrás, C., Hone, G., Macleod, I., McMaster, R., Salmon, P. & Stanton N., 2005, *Cognitive Task Analysis: Current Use and Practice in the UK Armed Forces and Elsewhere*, Human Integration Defence Technology Centre, UK Ministry of Defence, UK, viewed 9 August 2012, <<http://www.hfidtc.com/research/methods/methods-reports/phase-1/cta-review-armed-forces.pdf>>
- Baddeley, A.1999, *Essentials of Human Memory*, Psychology Press, UK.
- Baddeley, A., 2003, 'Working Memory Looking Back and Looking Forward', *Nature Reviews Neuroscience*, 4 Oct. 2003, pp. 829 - 839.
- Baddeley, A., 2004, *Your Memory A User's Guide*, 2nd edn., Firefly Books Ltd, Ontario, Canada.

- Bajjal, S. & Srinivasan, N., 2010, 'Theta Activity and meditative States: Spectral Changes during Concentrative Meditation', *Cognitive Processing* 11, pp. 31 - 38.
- Banks, W., 2002, 'Timing relations between Brain and World', *Consciousness and Cognition* 11, Issue 2, pp. 141 - 143.
- Barthes, R., 1975, 'An Introduction to the Structural Analysis of Narrative', *New Literary History*, Vol. 6., No. 2, pp. 237 - 272.
- Barthes, R., 1977, *Image Music Text*, trans. S. Heath, Noonday Press Edition, New York, USA.
- Benjamin, W. & Arendt, H. 1999, *Illuminations*, trans. H. Zohn, Pimlico, New York, USA.
- Benford, S., Magerkurth, C. & Ljungstrand, P., 2007, 'Pervasive Games – Bridging the gaps between the Virtual and the Physical', in Borries, F., Walz, S. & Bottger, M., *Space, Time Play – Computer Games, Architecture and Urbanism: The Next Level*, Birkhauser Verlag AG, Basel, Switzerland, pp. 248 – 250.
- Benyon, D., Smyth, M. & Helgason, I., 2009 'Presence for Everyone: A Short Guide to Presence Research' Centre for Interaction Design, Napier University, Edinburgh, UK, viewed 2 June 2012, <<http://www.peachbit.org>>
- Bhaya, R., 2003, *Narrative Gravity: Conversation, Cognition and Culture*, Routledge, London, UK.
- Bethesda Softworks LLC. 2013 'The Elder Scrolls' Bethesda Game Studios Maryland, USA, viewed 19 August 2013, <http://bethsoft.com/en-us/games/the_elder_scrolls_online>
- Biocca, F., 1992, 'Communication within Virtual Reality: Creating a Space for Research', *Journal of Communication* Vol. 42, Issue 4, pp. 5 - 22.
- Biocca, F., 1997, 'The Cyborg's Dilemma: Progressive Embodiment in Virtual Environments', *Journal Of Computer - Mediated Communication* Vol. 3, Issue 2, Sept., pp. 12 – 26.
- BioWare, 2012, *Mass Effect*, Video Game, Electronic Arts, CA, USA.
- Blair, R., 2009, 'Cognitive Neuroscience and Acting: Imagination, Conceptual Blending, and Empathy', *The Drama Review* Vol. 53, No. 4, pp. 92 - 103.
- Block, B., 2001, *The Visual Story*, Focal Press, Woburn, Mass., USA.
- Boal, A., 2000, *Theatre of the Oppressed*, 2nd edn., Pluto Press, London, UK.
- Bolter, J.D. & Grusin, R., 1999, *Remediation: Understanding New Media*, MIT Press, Cambridge, Mass., USA.
- Bond, W., Deitrick, I., Eberhart, M., Barr, G., Kane, B., WorriLOW, C., Arnold, D. & Croskeyy, P., 2006, 'Cognitive versus Technical Debriefing after Simulation Training' *Academic Emergency Medicine*, Vol. 13, No. 3, pp. 276 – 283.
- Bonds, S., 2009, 'Why so Serious? 360 Alternate Reality Experience' at XMedia Lab., Screen Hub, reported by Lyn Norfor, viewed 2 December 2009, <<http://www.screenhub.com.au/news/shownewsarticle.php?newsID=30478>>
- Borries, F., Walz, S. & Bottger, M., 2007, *Space, Time, Play: Computer Games, Architecture and Urbanism - The Next Level*, Birkhauser Verlag AG, Basel, Switzerland.
- Borsotti, M. & Bollini, L., 2009, "Reshaping Exhibition and Museum Design through Digital Technologies: A Multimodal Approach", *International Journal of Virtual Reality*, 2009-8 (3) pp. 25 – 31.
- Brecht, B., & Willet, J. 1964, *Brecht on Theatre; The Development of an Aesthetic*, 3rd edn., Methuen Publishers, USA.
- Brenda, L. 1991, *Computers as Theatre*, Addison – Wesley Publications, Reading, Mass., USA.
- Brogni, A., Vinayagamoorthy, V., Steed, A. & Slater, M., 2007, 'Responses of Participants during an Immersive Virtual Environment Experience', *Journal Of Virtual Reality*, 2007,6 (2) pp. 1 - 10.
- Bruner, J., 1987, 'Life as Narrative', *Social Research* Vol. 54, No. 1, Spring 1987, pp. 12 – 31.
- Bruner, J., 1990, *Acts of Meaning – Four Lectures on Mind and Culture*, Harvard University Press, UK.
- Bruner, J., 1991, 'The Narrative Construction of Reality', *Critical Inquiry* Vol.18, No 1, Autumn, 1991, pp. 1 - 21.
- Cahn, B. & Polich, J., 2006, 'Meditation States and Traits: EEC, ERP and Neuroimaging Studies', *Psychological Bulletin* Vol. 132, No. 2, pp. 180 - 211.

- Calleja, G., 2007, 'Revising Immersion: A Conceptual Model for the Analysis of Digital Involvement', in *Situated Play*, Proceedings of DIGRA Conference, 24 - 28 September, Tokyo, Japan.
- Calleja, G., 2011, *In-Game: from Immersion to Incorporation*, MIT Press, Mass., USA.
- Calleja, G., 2012, 'From Immersion to Incorporation', Keynote Address, 6th International Conference on the Philosophy of Computer Games, Madrid Media Lab Prado, viewed 13 March 2012, <http://blip.tv/arsgames/8410_gordon_calleja-5942007>
- Candy, L. & Edmonds, E., 2002, 'Interaction in Art and Technology', *Crossings Electronic Journal of Art and Technology* Vol. 2, Issue 1, Trinity College, Dublin, Ireland, viewed 9 May 2012, <<http://crossings.tcd.ie/issues/2.1/Candy/>>
- Carnegie Mellon University, Entertainment Technology Centre Website, Pittsburgh, PA, USA, viewed 3 May 2012, <<http://www.etc.cmu.edu/site/>>
- Casey, E., 1997, *The Fate of Place – A Philosophical History*, University of California Press, Berkley, USA.
- CEA-NeuroSpin Cognitive Neuroimaging Unit, 2010, Promotional Brochure, Paris, FR, p. 3.PDF, Viewed 18 June 2010, <<http://www.paris-neuroscience.fr/en/centre-de-recherche/neurospin>>
- Cilliers, P., 1998, *Complexity and Post Modernism*, Routledge, London, UK.
- Cilliers, P., 2000, 'What Can We Learn from a Theory of Complexity?' *Emergence* Vol. 2, Issue 1, pp. 23 - 33.
- Cilliers, P., 2001, 'What is Complexity Science? A View from Different Directions', *Emergence* Vol. 3, Issue 1, pp. 5 - 23.
- Chalmers, D.J., 1995, 'Facing up to the Problem of Consciousness', *Journal of Consciousness Studies* Vol. 2 No. 3, pp. 200 - 219.
- Chan, A., 2006, *Reading Notes: Presence Theory*, viewed 25 April 2010, <<http://www.gravity7.com> >
- Chapple, F. & Kettenbelt, C., 2006, *Intermediality in Theatre and Performance*, Rodopi Press, New York, USA.
- Chatman, S., 1975, 'Towards a Theory of Narrative' *New Literary History* Vol. 6, No. 2, pp. 295 - 318.
- Chatman, S., 1978, *Story and Discourse – Narrative Structure in Film*, Cornell University Press, New York, USA.
- Cheung, B., Van Erp, J.B.F., & Cholewiak, R.W., 2000, 'Anatomical, Neurophysiologic and Perceptual Issues of Tactile Perception', *National Research Organisation Scientific Papers - Technical Report- Human Factors & Medicine*, No. 122, NATO.
- Christiane P., 2003, *Digital Art*, Thames and Hudson, London, UK.
- Clark, A. 1996, 'Linguistic Anchors in a Sea of Thought' in *Pragmatics and Cognition* Vol. 4, No 1, pp. 93 - 103.
- Clark, A., 1998, 'Magic Words: How Language Augments Human Computation' in Carruthers, P. & Boucher, J., (eds) *Language and Thought: Interdisciplinary Themes*, Cambridge University Press, Cambridge, Mass., USA, pp. 162 - 183.
- Clark, A., 1999, 'An Embodied Cognitive Science?' *Trends in Cognitive Sciences* Vol. 3, Issue 9, pp. 345 – 351.
- Clark, A., 2008, *Supersizing the Mind: Embodiment, Action and Cognitive Extension*, Oxford University Press, London, UK.
- Cleeremans, A., (ed.), *The Unity of Consciousness: Binding, Integration and Dissociation*, Oxford University Press, New York, USA.
- Csikszentmihalyi, M., 1991, *Flow - The Psychology of Optimal Experience*, Harper Perennial, New York, USA.
- Colombetti, G., & Thompson, E., 2008, 'The Feeling Body: Toward an Enactive Approach to Emotion', in Oveton, W.F., Mueller, U. & Newman, J. (eds) *Body in Mind, Mind in Body: Developmental Perspectives on Embodiment and Consciousness*, Taylor & Francis Group, London, UK, pp. 45 – 68.
- Colombetti, G., 2009, 'What Language Does to Feelings', in *Journal of Consciousness Studies* 16, No. 9, pp. 4 - 26.
- Colombetti, G., 2010, 'Enaction, Sense-making and Emotion', in Stewart, J., Gapenne, O. & Di Paolo, E., *Enaction: Towards a New Paradigm for Cognitive Science*, MIT Press Cambridge, MA, USA, pp. 145 - 164.

- Cooke, N.J., 1994, 'Varieties of Knowledge Elicitation Techniques', *International Journal of Human Computer Studies*, No. 41, pp. 801 - 849.
- Costa, M., 2006, 'The Clock in Your Head', *Fast Thinking Magazine* 4, pp. 55 - 58.
- Costa, M., 2007, 'The Eye of the Beholder', *Fast Thinking Magazine* 5, pp. 50 - 54.
- Costa, M., 2008, 'Out of Body', *Fast Thinking Magazine* 11, pp. 38 - 40.
- Costikyan, G., 2000, 'Where Stories End and Games Begin', viewed 10 August 2013, <<http://www.costik.com/gamnstry.html>>
- Costikyan, G., 2008, 'Games, Storytelling and Breaking the String', in Harrigan, P. & Wardrip-Fruin, N. (eds), *Second Person: Role Playing and Story in Games and Playable Media*, MIT Press, Cambridge, Mass., USA, pp. 5 - 13.
- Crick, F., & Koch, C. 1990, 'Towards a Neurobiological Theory of Consciousness', *Seminars in the Neurosciences* Vol. 2, pp. 263 - 275.
- Cunliffe, A. & Coupland, C., 2011, 'From Hero to Villain: Making Experience Sensible through Embodied Narrative Sensemaking', *Human Relations* 65 (1), pp. 63 - 88.
- Damasio, A., 1994, *Descartes' Error*, Putnam Books, New York, USA.
- Damasio, A., 1999, *The Feeling of What Happens*, Harcourt Publishers, New York, USA.
- Damasio, A., 2003, *Looking for Spinoza – Joy, Sorrow and the Feeling Brain*, Harcourt Publishers, New York, USA.
- Damasio, A., 2010, *Self comes to Mind: Constructing the Conscious Brain*, Random House Publishers, London, UK.
- Davenport, G., 1998, 'Very Distributed Media Stories: Presence, Time, Imagination' in *Proceedings 4th International Euro-Par Conference on Parallel Processing*, Springer-Verlag, London, UK, pp. 47 - 54.
- Davis, E., 2001, 'Experience Design and the Design of Experience', viewed 10 March 2010, <<http://www.techgnosis.com/experience.html>>
- Defense Advanced Research Projects Agency 2011, 'Narrative: Networks (N2) The Neurobiology of Narratives', Special Notice Solicitation Number DARPA-SN-11-25, viewed 12 December 2012, <https://www.fbo.gov/index?s=opportunity&mode=form&id=f7cc131cc2dfaa859ae1ad6fb952a581&tab=core&_cview=0>
- Dehaene, S., Changeux, J-P., Nacchache, I., Sackur, J. & Sergent, C., 2006, 'Conscious, Preconscious and Subliminal Processing : A Testable Taxonomy', *Trends in Cognitive Science* Vol. 10, pp. 204 - 211.
- Dehaene, S., & Changeux, J-P, 2011, 'Experimental and Theoretical Approaches to Conscious Processing', *Neuron* 70, April 28, pp. 201 - 227.
- Dehaene, S., 2009, 'Signatures of Consciousness', *A Talk by Stanislas Dehaene*, The Edge Reality Club, viewed 19 February 2010, <http://edge.org/3rd_culture/dehaene09/dehaene09_index.html>
- Dehaene, S., 2009, *Reading the Brain: The Science and Evolution of a Human Invention*, Penguin Viking Press, New York, USA.
- Dena, C., 2009, *Transmedia Practice: Theorising the Practice of Expressing Fictional Worlds across Distinct Media Environments*, PhD Thesis, University Of Sydney, Aust.
- Dennet, D., 1996, 'Facing Backwards on the Problem of Consciousness', *Journal of Consciousness Studies* 3 (1), pp. 4 - 6.
- Dennet D., 1996, *Kinds of Minds*, Wiedenfeld & Nicolson, London, UK.
- Dervin, B., 1983, 'An Overview of Sense-making Research: Concepts, Methods and Results', paper presented at the annual meeting of the *International Communication Association*, Dallas, USA.
- Depraz, N. & Varela, F., Vermersch, P., 2003, *On Becoming Aware: A Pragmatics of Experiencing*, John Benjamins Publishing, Amsterdam, Netherlands.
- Dewey, J., 1934, *Art as Experience*, Putnam Press, New York, USA.
- Dinehart, S., 2009, 'Transmedia Franchise Development'. The Narrative Design Exploratorium, viewed 19 January 2012, <<http://narrativedesign.org/2009/06/transmedia-franchise-development/>>
- Dixon, S., 2007, *Digital Performance: A History of New Media in Theatre, Dance, Performance Art and Installation*, MIT Press, Cambridge, MA, USA.

- Donald, M., 1991, *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition*, Harvard University Press, Cambridge, Mass., USA.
- Dourish, P., 2004, *Where the Action Is: the Foundation of Embodied Interaction*, MIT Press, Mass., USA.
- Drew N (aka Bucksbarg, Andrew), 2011, 'VJING and Live A/V Practices: Performing, the Process, the Moment', viewed 3 March 2012, <<http://organicode.net/VJingLiveAV.pdf>>
- Dreyfus, S. & Dreyfus, H., 1980, 'A Five- Stage Model of the Mental Activities Involved in Direct Skill Acquisition', Operations Research Centre, University Of California, viewed 9 September 2011, <<http://www.dtic.mil/dtic/index.html>>
- Driver, J., 2001, 'A Review of Selective Attention Research from the Past Century', in *Journal of Psychology* 92, pp. 53 - 78.
- Eagleman D., 2009 a, Brain Time, *Edge* 291, viewed 2 July 2009, <<http://www.edge.org/documents/archive/edge291.html>>
- Eagleman D., 2009 b, 'Time, the Brain (or what's happening at the Eagleman Lab)', viewed 5 February 2012, <<http://neuro.bcm.edu/eagleman/time.html>>
- Electronic Arts Video Games, 2001, *Majestic*, Alternate Reality Game for Windows.
- Elsbach K, Barr, P. & Hargadon, A., 2005, 'Situating Cognition in Organisations', in *Organization Science* 16 (4), pp. 422 – 433.
- Endsley, M., 1995, 'Toward a Theory of Situation Awareness in Dynamic Systems', in *Human Factors* 37 (1), pp. 32 - 64.
- Engel, A.K. & Singer, W., 2001, 'Temporal Binding and the Neural Correlates of Sensory Awareness', in *Trends in Cognitive Sciences* 1:5 (1), pp. 16 - 25.
- Ericsson, A., Charness, N., Feltovich, P. & Hoffman, R., (eds), 2006, *The Cambridge Handbook of Expertise and Expert Performance*, Cambridge University Press, New York, USA.
- Ermi, L. & Mayra, F., 2005, 'Fundamental components of Game Play Experience: Analysing Immersion', in *Proceedings of the DIGRA Conference*, Canada, 16 - 20 June 2005, viewed 10 September 2010, <<http://www.informatik.unitrier.de/~ley/db/conf/digra/digra2005.html>>
- Eskelinen, M., 2004, 'Towards Computer Game Studies' in Harrigan P., & Wardrip-Fruin N., (eds), *First Person – New Media as Story*, MIT Press, Cambridge, Mass., USA, pp. 36 – 44.
- Eysenck, M., 2006, *Fundamentals of Cognition*, Psychology Press, New York, USA.
- Fauconnier, G., & Turner, M., 1998, 'Conceptual Integration Networks' in *Cognitive Science* 22, No. 2, pp. 133 - 187.
- Fletcher, G.C.L., McGeorge, P., Flin, R.H., Glavin, R.J., & Maran, N.J., 2002, 'Non-Technical Skills in Anaesthesia: a Review of Current Literature', *British Journal of Anaesthesia* 88 (3), pp. 418 - 429.
- Flusser, V., 1988, 'On Writing, Complexity and the Technical Revolution', Interview in Osnabruck, European Media Art Festival September 1998, viewed 28 April 2013, <<http://www.youtube.com/watch?v=lyfOCAAcoH8>>
- Flusser, V., & Strohl, A., 2004, *Writings*, trans. E. Eisel, University of Minnesota Press, Minneapolis, USA.
- Forsythe, C., Bernard, M., Goldsmith, T., 2006, *Cognitive Systems: Human Cognitive Models in Systems Design*, Lawrence Erlbaum Associates, New Jersey, USA.
- Freytag, G., 2008, *Technique of the Drama: An Exposition of Dramatic Composition and Art*, 6th edn., trans. Elias J Ewan, Bibliobazaar, UK.
- Frasca, G., 1999, 'Ludology meets Narratology: Similitude and Differences between (video) Games and Narrative', viewed 23 March 2008, <<http://www.ludology.org/articles/ludology.htm>>
- Frasca, G., 2001, 'Rethinking Agency and Immersion: Video Games as a Means of Consciousness Raising', essay presented at SIGGRAPH 2001, viewed 11 February 2013, <<http://www.siggraph.org/artdesign/gallery/S01/essays/0378.pdf>>
- Frasca, G., 2003, 'Simulation versus Narrative', in Wolf, M. & Perron B., *The Video Game Theory Reader*, Routledge, New York, USA, pp. 221 - 235.
- Frasca, G., 2004, 'Video Games of the Oppressed' in Harrigan, P. & Wardrip-Fruin, N., *First Person – New Media as Story, Performance and Game*, MIT Press, Cambridge, Mass., USA, pp. 85 - 93.

- Frasca, G., 2007, 'Play the Message: Play, Game and Videogame Rhetoric', PhD Dissertation, University of Copenhagen, Denmark, viewed 1 November 2011, <<http://www.ludology.org/2011/03/frascaplaythemessage.html>>
- Fuller M., 2008, *Software Studies – A Lexicon*, MIT Press, Cambridge Mass., USA.
- Freedberg, D. & Gallese, V., 2007, 'Motion, Emotion and Empathy in Aesthetic Experience', *Trends in Cognitive Sciences* Vol. 11, No. 5, pp. 197 - 203.
- Gaba, D.M., 2000, 'Structural and Organisational Issues in Patient Safety: A Comparison of other High Hazard Industries' *California Management Review* 43, pp. 83 – 101.
- Gaba, D.M., 2004, 'The Future Vision of Simulation in Health Care', *Quality and Safety in Health Care* 13, Suppl.1, pp. 3 - 10.
- Gallagher, S., 2000, 'Philosophical Conceptions of the Self: Implications for Cognitive Science', in *Trends in Cognitive Science* Vol. 4, No. 1, pp. 14 - 21.
- Gallagher, S., 2001, 'The practice of the mind: Theory, Simulation or Interaction?' *Journal of Consciousness Studies* 5 - 7, pp. 83 – 108.
- Gallagher, S. & Zahavi, D., 2008, *The Phenomenological Mind: An Introduction to Philosophy of Mind and Cognitive Science*, Routledge, New York, USA.
- Gallese, V., 2001, "The 'Shared Manifold' Hypothesis: from Mirror Neurons to Empathy", *Journal of Consciousness Studies* 8, pp. 33 - 50.
- Gallese, V., 2005, 'Embodied Simulation: from Neurons to Phenomenal Experience', *Phenomenology and the Cognitive Sciences* Vol. 4, No. 1, pp. 23 - 48.
- Gallese, V., 2011, 'Neuroscience and Phenomenology', in *Phenomenology and Mind*, No. 1, pp. 28 - 39.
- Gallese, V. & Goldman, A., 1998, 'Mirror Neurons and the Theory of Mind Reading', *Trends in Cognitive Sciences* Vol. 2, pp. 493 - 501.
- Gallese, V. & Sinigaglia, C., 2011, 'What's so special about simulation?' *Trends in Cognitive Sciences*, Vol. 15, No. 11, pp. 512 – 519.
- Gallese, V. & Wojciehowski, H., 2011, 'How Stories Make us Feel: Towards an Embodied Narratology', *California Italian Studies* 2 (1), 2011, UC Office of the President, University of California, USA.
- Gallasch, K., 1998, 'Time and Fear' in *Realtime @The Telstra Adelaide Festival 98*, Vol. 2.
- Galloni, G., 2011, 'Action, Emotion and Embodiment in Empathic Responses', in *Phenomenology and Mind*, No. 1, pp. 166 – 173.
- Gazzaniga, M., 1979, *Functional Neuroscience*, Harper and Row, New York, USA.
- Gazzaniga, M., 1988, *Mind Matters – How Mind and Brain Interact to Create in our Conscious Lives*, Houghton Mifflin Company, Boston, USA.
- Gazzaniga, M., Ivry, R. & Mangun, G., 2002, *Cognitive Neuroscience: The biology of the Mind*, 2nd edn., W.W Norton & Company, New York, USA.
- Gelernter, D., 2010, 'Time to start taking the Internet Seriously' EDGE 313, viewed 20 March 2010, <<http://www.edge.org/documents/archive/edge313.html>>
- Giannachi, G, Kaye N, & Shanks, M., (eds), 2012, *Archaeologies of Presence: Art Performance and the Persistence of Being*, Routledge, London, UK.
- Gibson, J., 1966, *The Senses Considered as Perceptual Systems*, Houghton Mifflin Company, Boston, USA.
- Gibson, J., 1977, 'The Theory of Affordances', in Shaw, R. & Bransford, J., [eds), *Perceiving, Acting and Knowing: Toward an Ecological Psychology*, Lawrence Erlbaum, New Jersey, USA, pp. 67 - 82.
- Gibson, J., 2011, 'Saying it Right: Creating Ethical Verbatim Theatre', viewed 1 December 2012, <http://www.arts.mq.edu.au/documents/hdr_journal_neo/neoJanet2011_2.pdf>
- Gibson, R., 2003, 'The Time Will Come When', in Shaw, J. & Weibel P (eds.), *Future Cinema – The Cinematic Imaginary after Film*, MIT Press, Cambridge, Mass., USA, p. 570
- Gibson, R., 2010, 'The Known World', in *TEXT Journal of Writing and Writing Courses*, Special Issue, Website Series, No. 8, October 2010, viewed 1 December, <<http://www.textjournal.com.au/speciss/issue8/Gibson.pdf>>

- Giummarra, M.J., Gibson, S.T., Georgiou-Karistianis, N. & Bradshaw J., 2008, 'Mechanisms underlying Embodiment, Disembodiment and loss of Embodiment', *Neuroscience and Bio-behavioural Reviews* 32, pp. 143 - 160.
- Goldberg, R., 1988, *Performance Art: From Futurism to the Present*, Thames & Hudson, London, UK.
- Gomez, J., 2010, 'The Power of Transmedia Storytelling', X| Media| Lab Archive, viewed 22 July 2010, <<http://www.xmedialab.com/news/2010-07-22/jeff-gomez-power-transmedia-storytelling>>
- Gorayska, B. & Mey, J.L., (eds), 2004, *Cognition and Technology: Coexistence, Convergence and Co-evolution, Proceedings of the First International Cognitive Technology Conference*, John Benjamins Publishing, Amsterdam, Netherlands.
- Grau, O., 1995, *Virtual Art From Illusion to Immersion*, MIT Press, Cambridge, Mass., USA.
- Greenfield S., 2000, *The Private Life of the Brain*, John Wiley & Sons, New York, USA.
- Greeno, J., 1994, 'Gibson's Affordances', in *Psychological Review* Vol. 101, No. 2, pp. 366 – 342.
- Grind, W., 2002, 'Physical Neural and Mental Timing' in *Consciousness and Cognition* 11, Issue 2, pp. 241 - 264.
- Grodal, T., 2009, *Embodied Visions: Evolution, Emotion, Culture and Film*, Oxford University Press, New York, USA.
- Grossberg, S., 1999, 'The link between Brain Learning, Attention and Consciousness', *Consciousness and Cognition*, No. 8, pp. 1 - 44.
- Gumbrecht, H. & Ludwig K P., (eds), 1994, *Materialities of Communication*, Stanford University Press, CA, USA.
- Gumbrecht, H. & Marrinan, M., 2003, *Mapping Benjamin: The Work of Art in the Digital Age*, Stanford University Press, CA, USA.
- Gumbrecht, H., 2004, *The Production of Presence*, Stanford University Press, CA., USA.
- Hammond, W. & Steward, D., 2008, *Verbatim: Contemporary Documentary Theatre*, Oberon Books, London, UK.
- Harrigan, P. & Wardrip-Fruin, N. (eds), 2004, *First – Person: New Media as Story, Performance and Game*, MIT Press, Cambridge, Mass., USA.
- Harrigan, P. & Wardrip-Fruin, N. (eds), 2007, *Second Person: Role Playing and Story in Games and Playable Media*, MIT Press, Cambridge, Mass., USA.
- Harrigan, P. & Wardrip-Fruin, N. (eds), 2009, *Third Person; Authoring and Exploring Vast Narratives*, MIT Press, Cambridge, Mass., USA.
- Hassin, R. R., Uleman, J. S. & Bargh, J. A., 2004, *The New Unconscious*, Oxford University Press, London, UK.
- Heidegger, M., 2000, *Being and Time*, trans. J Stambaugh, (reprint), University of Chicago Press, Chicago, USA.
- Higgs, J., Cherry, N., Macklin, R., & Ajjawi, R., (eds), 2010, *Researching Practice: A discourse on Qualitative Methodologies*, Sense Publishers, Rotterdam, Netherlands.
- Hill, L. & Paris, H., 2001, *Guerrilla Performance and Multimedia*, Continuum Press, New York, USA.
- Hochberg, J., 1998, *Perception and Cognition at the Century's End*, Academic Press, Elvieser, Mass., USA.
- Hodge, A., (ed), 2000, *Twentieth Century Actor Training*, Routledge, London, UK.
- Hogan, P., 2011, *Affective Narratology: The Emotional Structure of Stories*, University of Nebraska Press, Nebraska, USA.
- Holzman, R., Cooper, J., Gaba, D., Philip, J., Small, S. & Feinstien, D., 1995, 'Anaesthesia Resource Crisis Management: Real Life Simulation Training in Operating Room Crisis', in *Journal Of Clinical Anaesthesia*, Elsevier Science, New York, USA, No. 7, pp. 675 – 687.
- Hood, B., 2012, 'Essentialism – A conversation with Bruce Hood', Edge, viewed 19 May 2012, <<http://www.edge.org/conversation/essentialism->>
- Hunt, M., 1982, *The Universe Within: A New Science Explores the Human Mind*, Harvester Press, Brighton, Sussex, UK.

- Hunter, C., 1999, 'Tracking Time – Awesome Stories' *The Western Australian [X-Press Supplement]*, Thursday 11 November, p. 14.
- Hurlburt, R. & Akhter, S., 2006, 'The Descriptive Experience Sampling Method', *Phenomenological Cognitive Sciences*, No. 5, pp. 271 - 301.
- Hurlburt, R. T., & Heavey, C. L., 2001, 'Telling What We Know: Describing Inner Experience.' *Trends in Cognitive Sciences*, No. 5, pp. 400 – 403.
- Hutchins, E., 1995, *Cognition in the Wild*, MIT Press, Cambridge, MA, USA.
- Huizinga, J., 1950, *Homo Ludens: A Study of the Play Element in Culture*, Roy Publishers, New York, USA.
- Iacoboni, M., 2005, 'Neural Mechanisms of Imitation', *Current Opinion in Neurobiology* 15, pp. 632 – 637.
- Iacoboni, M., 2009, 'Imitation, Empathy and Mirror Neurons', *Annual Review of Psychology*, No. 60, pp. 653 – 666
- Iacobini, M, Gonsalves T, Bianchi- Berthouze, N. & Frith, C., 2010, 'Emotional Contagion in Interactive Art', *International Conference on Kansei Engineering and Emotion Research*, Paris, France, viewed, 12 April 2011, <http://www.tinagonsalves.com/gonsalves_1975.pdf>
- Iedema, R., Rhodes C. & Scheeres, H., 2005, 'Presencing Identity: Organisational Change and Immaterial Labor', in *Journal of Organisational Change Management* Vol. 18, No. 4, pp. 327 – 337.
- IJsselsteijn, W., Lombard, M. & Freeman, J., 2001, 'Toward a Core Bibliography of Presence,' *Cyberpsychology and Behaviour*, No. 4, pp. 317 - 21.
- IJsselsteijn, W., 2002, 'Elements of a Multi-level Theory of Presence, Phenomenology, Mental Processing and Neural Correlates', *Proceedings of PRESENCE Conference*, Portugal, pp. 245 – 259.
- IJsselsteijn, W., 2005, 'Towards a Neuropsychological Basis of Presence', *Annual Review of Cyber Therapy and Telemedicine: A decade of VR*, No. 3, pp. 25-30.
- Jackendoff, R., 1996, 'How Language Makes us Think', *Pragmatics and Cognition* Vol. 4 No 1, John Benjamins Publishing, pp. 1 - 34.
- James W., 1884, 'What is an Emotion?', in *Journal of the Mind* Vol. 9, No. 34, pp. 188 – 205.
- Jarvinen, A., 2009, 'Understanding Video Games as Emotional Experiences', Perron, B. & Wolf, M.J.P (eds), *The Video Game Theory 2*, Routledge, New York, USA, pp. 85 - 108.
- Jenkins, H., 2004, 'Game Design as Narrative Architecture', in Harrigan, P. & Wardrip-Fruin, N., (eds), *First Person: New Media as Story, Performance and Game*, MIT Press, Cambridge, Mass., USA, pp. 118 - 30.
- Jenkins, H., 2006, *Convergence Culture: Where New and Old Media Collide*, New York University Press, New York, USA.
- Jenkins, H., Purushotmoa, R., Weigel, M., Clinton, K. & Robison, J., 2009, 'Confronting the Challenges of Participatory Culture: Media Education for the 21st Century', *MacArthur Foundation Reports on Digital Media*, MIT Press, Cambridge, Mass., USA.
- Johnson, S., 1997, *Interface Culture*, Harper Edge, San Francisco, USA.
- Johnson, S., 2004, *Mind Wide Open*, Scribner, New York, USA.
- Juul, J., 2001, 'Games telling Stories', in *Game Studies* Vol. 1, Issue 1, viewed 17 April 2011, <<http://www.gamestudies.org/0101/>>
- Juul, J., 2004, 'Introduction to Game Time', in Harrigan, P. & Wardrip-Fruin, N., *First Person – New Media as Story*, MIT Press, Cambridge, Mass. USA, pp. 131 – 141.
- Juul, J., 2005, *Half Real: Video Games between Real Rules and Fictional Worlds*, MIT Press, Cambridge, Mass., USA.
- Kallay, J., 2010, 'Cyber Aristotle: Towards a Poetics for Interactive Screenwriting', *Journal Of Screen-writing* Vol. 1, No. 1, Intellect, pp. 99 - 112.
- Kelly, V., 1998, *Our Australian Theatre in the Nineties*, Rodopi Editions, Amsterdam, Netherlands.
- Keyser, V. & Nyssen, A., 2001, 'The Management of Temporal Constraints in Naturalistic Decision Making', in Salas, E. & Klein, G., *Linking Expertise and Naturalistic Decision Making*, Lawrence Erlbaum Publishers, London, UK, pp. 171 – 189.

- Khun, Thomas, (1970), *The Structure of Scientific Revolutions*, International Encyclopaedia of Unified Science, Vol. 2, No. 2, University of Chicago Press, 2nd edn., Chicago, USA.
- Khut, G., 2007, 'Interactive Art as Embodied Enquiry: Working with Audience Experience', *Engage: Interaction, Art and Audience Experience*, Nov. 26 - 28, Sydney, Australia, pp. 159 - 169.
- Klein, G., Orasanu, J., & Calderwood, R., 1993, *Decision Making in Action: Models and Methods*, Ablex Publishing, New York, USA.
- Klein, G., 1998, *Sources of Power - How People Make Decisions*, MIT Press, Cambridge Mass., USA.
- Klein, G. & Salas, E., (eds) 2001, *Linking Expertise and Naturalistic Decision-Making*, Lawrence Erlbaum Publishers, London, UK.
- Klein, G., Moon, B. & Hoffman, R., 2006, 'Making Sense of Sensemaking 1: Alternative Perspectives' *IEEE Intelligent Systems Magazine*, Vol. 21, No. 4, viewed 10 September 2011, <<http://www.computer.org/intelligent>>
- Klein, G., 2011, 'Insight: a conversation with Gary Klein', *Edge* 345, 7 July 2011, viewed 8 July 2011, <<http://www.edge.org>>
- Klein, S., 2002, "Libet's Timing of Mental Events: Commentary on the Commentaries", in *Consciousness and Cognition* 11, pp. 326 - 333.
- Kobow, B., 2011, 'Language as Embodiment', in *Phenomenology and Mind*, No.1, pp. 174 - 181.
- Kosinski R. J., 2010, 'A literature Review on Reaction Time', viewed 7 July 2011, <<http://biology.clemson.edu/bpc/bp/Lab/110/reaction.htm>>
- Kress, G., 2003, *Literacy in the New Media Age*, Routledge, London, UK.
- Kress, G., 2010, *Multimodality: A Social-Semiotic Approach to Contemporary Communication*, Routledge, New York, USA.
- Kurby, C. & Zacks, J., 2007, 'Segmentation in the Perception and Memory of Events', in *Trends in Cognitive Sciences* Vol. 12, No 2, pp. 72 - 80.
- Kurtz, C.F. & Snowden, D.J., 2003, 'The new dynamics of strategy: Sense-making in a complex and complicated world', *IBM Systems Journal* Vol. 42, pp. 70 - 75.
- Laerdal Medical Website, 2001 - 2013, viewed 19 August 2012, <<http://www.laerdal.com/au/>>
- Laughlin, R., 2005, 'The End of Reductionism', viewed 17 February 2012, <<http://musicofthequantum.rutgers.edu/>>
- Lakoff, G. & Johnson, M., 1980, *Metaphors We Live By*, University of Chicago Press Chicago, USA.
- Lakoff, G. & Johnson, M., 1999, *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*, Basic Books, New York, USA.
- Laurel, B., 1991, *Computers as Theatre*, Addison-Wesley, Mass., USA.
- La Pierre, A., 2006, 'From Felt Sense to Felt Self: Neuro-affective Touch and the Relational Matrix', in *Psychologist-Psychoanalyst*, Issue 16 - 17, pp. 43 - 45.
- Le Doux, J., 1988, *The Emotional Brain: the Mysterious Underpinnings of Emotional Life*, Weidenfeld & Nicholson Publishers, London, UK.
- Leedom, D., 2001, *Final Report - Sense Making Symposium*, 23-25 October, Command and Control Research Program (CCRP), Office of the Assistant Secretary for Command, Control, Communications and Intelligence, USA.
- Legrand, D., 2003, 'How Not to Find the Neural Signature of Self Consciousness', in *Consciousness and Cognition* 12, pp. 544 - 546.
- Legrand, D., 2005, 'Being a Body', in *Trends in Cognitive Sciences* Vol. 9, No. 9, pp. 413 - 414.
- Lehmann H., Thesis, 2006, *Post Dramatic Theatre*, trans. K. Jurs-Munby, Routledge Taylor and Taylor, London, UK.
- Lewis, M.D., 2005, 'Bridging Emotion Theory and Neurobiology through Dynamic Systems Modelling', in *Behavioural and Brain Sciences* 28, pp.169-245.
- Libet, B., 1999, 'Do we have free will?', in *Journal of Consciousness Studies* 6, pp. 47 - 58.
- Libet, B., 2003, 'Can conscious experience effect brain activity?', in *Journal of Consciousness Studies* 10, No. 12, pp. 24 - 28.

- Libet, B., 2004, *Mind Time – The Temporal factor in Consciousness*, MIT Harvard Press, Cambridge, USA.
- Libet, B., 2006, 'Reflections on the Interactions of the Mind and Brain', *Progress in Neurobiology* 78, pp. 322 – 326.
- Live Art Development Agency, 2009, 'What is Live Art?', viewed 12 February 2010, <http://www.thisisliveart.co.uk/about_us/what_is_live_art.html>
- Lombard, M. & Ditton, T., 1997, 'At the Heart of It All: The Concept of Presence', in *Journal of Computer-Mediated Communication* 3: Issue 2, viewed 31 March 2012, <<http://www.jcmc.indiana.edu/vol3/issue2/lombard.html>>
- Lopez, J.C., 2003, 'Brain Imaging: Closer to the Source', in *Nature Reviews Neuroscience* 4, October, p. 778.
- Lutz, J., 1994, *Introduction to Learning and Memory*, Brooks Cole Publishing, CA, USA.
- McAdams, S. & Bigand E., (ed), 1993, *Thinking in Sound - The Cognitive Psychology of Human Audition*, Oxford University Press, London, UK.
- McBride, D. & Schmorow, D., (eds) 2005, *Quantifying Human Information Systems*, Potomac Institute for Policy Studies, Jason Aronson Inc., Virginia, USA.
- McCarthy, J. & Wright, P., 2004, *Technology as Experience*, MIT Press, Cambridge, USA.
- McClelland, J.L., 2000, 'Connectionist Models of Memory', viewed 9 May 2013, <http://psych.stanford.edu/~jlm/papers/PublicationFiles/2000_Pres_Articles_Add_to_OnlinePubs/McClelland00onnectionistModelsOfMemory.pdf>
- McCloud, S., 1999, *Understanding Comics*, Paradox Press, New York, USA.
- McCloud S., 2005, Ted Video Talks: 'The Visual Magic of Comics', viewed 30 January 2012, <http://www.ted.com/talks/scott_mccloud_on_comics.html>
- McGaugh, J., (ed), 1992, *Brain Organisation and Memory - Cells Systems and Circuits*, Oxford Press, London, UK.
- McGaugh, J., 2003, *Memory and Emotion*, Weidenfeld and Nicholson, London, UK.
- McKee, R., 1997, *Story: Substance, Structure, Style and Principles of Screenwriting*, Harper Collins, New York, USA.
- Makela, Mia, 2006, *Live Cinema*, MA Thesis, Helsinki University of Art and Design. Finland
- McMahan, A., 2003, 'Immersion, Engagement and Presence', in Wolf, M.J. P. & Perron, B. (eds), *The Video Games Theory Reader*, Routledge, New York, USA, pp. 67 - 87.
- Manovich, L., 1998, Database as Symbolic Form, viewed 10 August 2010, <<http://www.manovich.net>>
- Manovich, L., 2001, *The Language of New Media*, MIT Press, Cambridge, USA.
- Manovich, L., 2004, *Navigable Space*, viewed 26 January 2012, <www.manovich.net/DOCS/navigable_space.doc>
- Manovich, L., 2005, *Soft Cinema: Navigating the Database*, MIT Press, Cambridge USA.
- Manovich, L., 2006, 'The Poetics of Augmented Space: The Art of our Time', *Visual Communication*, June vol. 5, No. 2, pp. 219 - 240.
- Manovich L., 2013, *Software takes Command*, Bloomsbury, London, UK.
- Mantovani, F. & Castelnuovo, G., 2003, 'Sense of Presence In Virtual Training: Enhancing Skills acquisition and transfer of knowledge through learning experience in Virtual Environments', in Riva, Davide & IJesselstein (eds), *Being There: Concepts, effects and measurement of user presence in synthetic environments*, IOS Press, Amsterdam, Netherlands, pp. 168 – 178.
- Markram H., 2009, TED Video Talks, 'Henry Markram builds a Brain in a Super Computer', viewed 2 February 2009, <http://www.ted.com/talks/henry_markram_supercomputing_the_brain_s_secrets.html>
- Matteas, M., 2004, 'A preliminary Poetics for Interactive Drama and Games', in Harrigan, P. & Wardrip-Fruin, N.,(eds), *First Person as Story, Performance and Game*, MIT Press Cambridge, Mass., USA, pp. 19 - 33.
- Massumi, B., 2002, *Parables for the Virtual*, Duke University Press, Durham, NC, USA.

- Massumi, B., 2006, 'Transforming Digital Architecture from Virtual to Neuro', *Intelligent Agent* 5.2, viewed 26 January 2012, <http://www.intelligentagent.com/archive/Vol5_No2_massumi_markussen+birch.htm>
- Mayer R.E. (ed.) 2005, *The Cambridge Handbook of Multimedia Learning*, Cambridge University Press, Cambridge, USA.
- Meadows, M., 2003, *Pause and Effect - The Art of the Interactive Narrative*, New Riders, Pearson Education, London, UK.
- Merleau-Ponty, M., 1962, *Phenomenology of Perception*, trans. C. Smith, 2nd edn., Routledge Press, London, UK.
- Metzinger, T., 2009, *The Ego Tunnel*, Basic Books, New York, USA.
- Miller, K., 2008, 'The Accidental Carjack', *Game Studies* Vol. 8, Issue 1, viewed 12 December 2008, <<http://gamestudies.org/0801>>
- Mitchell, T., 1998, 'Maintaining Cultural Integrity: Teresa Crea, Italo-Australian Theatre Doppio Teatro and Critical Multiculturalism', in Kelly, V., *Our Australian Theatre in the Nineties*, Rodopi Editions, Amsterdam, Netherlands, pp. 132 - 151.
- Modelli, A., 2009, 'Metaphor – The Bridge between Feelings and Knowledge', in *Psychoanalytic Inquiry* 29, Issue 1, pp. 6 - 11.
- Moggridge, B., 2006, *Designing Interactions*, MIT Press, Cambridge Mass., USA.
- Montola, M., Stenros, J. & Waern, A., 2009, *Pervasive Games Theory and Design*, Morgan Kaufmann Publishers, Elsevier Press, Mass., USA.
- Moody, A.H., 2003, 'In The Time of Distance', *Lowdown Magazine*, Oct., p. 45.
- Morie, J. F., 2007, *Meaning and Emplacement in Expressive Immersive Virtual Environments*, PhD thesis, University of East London, UK.
- Morris, J., 2002, 'How do you Feel?' *Trends In Cognitive Science* Vol. 6, No. 8, pp. 317 – 319.
- Moustakas, C., 1994, *Phenomenological Research Methods*, Sage Publications, London, UK.
- Murray, J., 1997, *Hamlet on the Holodeck - The Future of Narrative in Cyberspace*, MIT Press, Cambridge, Mass., USA.
- Murray, J., 2006, 'Toward a Cultural Theory of Gaming Digital Culture and the Co-Evolution of Media Mind and Culture', in *Popular Communication* 4, No. 3, Georgia Institute of Technology, USA, pp. 185 – 202.
- Naikar, N., 2010, *A Comparison of the Decision Ladder Template and the Recognition-Primed Decision Making Model*, DSTO-TR-2397, Commonwealth of Australia, AR-014-738.
- Nair, B.R. (2003), *Narrative Gravity: Conversation, Cognition, Culture*, Routledge, New York, USA.
- Nalbantian, S., 2008, 'Neuro-aesthetics: Neuroscientific Theory and Illustration from the Arts' *Interdisciplinary Science Reviews* 33-4, pp. 357 – 368.
- NATO, 2008, 'Tactile Displays for Orientation, Navigation and Communication in Air, Sea and Land Environments', *RTA/NATO Report* August 2008, TR-HFM-122.
- Nash, C., (ed) 1994, *Narrative in Culture: The Uses of Storytelling in the Sciences, Philosophy and Literature*, Routledge, New York, USA.
- Nintendo Games, 2001- 2013, *Animal Crossing*, Video game for Nintendo, viewed 22 September 2013, <<http://gamesites.nintendo.com.au/animal-crossing-new-leaf/>>
- Nitsche, M., 2007, 'Mapping Time in Video Games', in *Situated Play: Proceedings of DiGRA Conference*, Tokyo, pp. 145 - 151.
- Noë, A., 2004, *Action In Perception*, MIT Press, Cambridge Mass., USA.
- Noë, A., 2005, 'Real Presence', in *Philosophical Topics* 33 (1), pp. 235 – 264.
- Noë, A., 2007, 'Understanding Action in Perception', in *Philosophical Psychology* Vol. 20, No. 4, pp. 531 - 538.
- Norfor, L., 2009, 'Susan Bonds: Why so Serious? 360 Alternate Reality Experience', *Screen Hub*, Dec. 2009, viewed 2 December 2009, <<http://www.screenhub.com.au/news/shownewsarticle.php?newsID=30478>>

- Norman, D., 1969, *Memory and Attention: An Introduction to Human Information Processing*, Wiley Publishing, New York, USA.
- Norman, D., 1982, *Learning and Memory*, W.H. Freeman Publishers, San Francisco, USA.
- Norman, D., 1988, *The Psychology of Everyday Things*, Basic Books, New York, USA.
- Norman, D., 2007, *The Design of Future Things*, Basic Books, New York, USA.
- Norman, D., 2010, 'The Way We See It: The Transmedia Design Challenge', in *Interactions Magazine* 17, Vol. 1, pp. 12 – 15.
- Northoff, G., 2004, *Philosophy of the Brain: The Brain Problem*, John Benjamins Publishing, Amsterdam, Netherlands.
- Northoff, G., Heinzel, A., deGreck, M., Bermpohl, F., Dodrowolny, H. & Panksepp, J., 2006, 'Self Referential Processing in our Brain – a Meta Analysis of Imaging Studies on the Self', *NeuroImage* 31, pp. 440 - 457.
- O'Brien, D., 2000, 'The Last Child', *DB Magazine*, Issue 29, 15 - 21 March, p. 19.
- Ochs, E. & Capps, L., 1996, 'Narrating the Self', *Annual Review of Anthropology* 25, pp. 19 - 43.
- Oddey, A. & White, C., 2009, *Modes of Spectating*, University of Chicago Press, Chicago, USA.
- Oon, C., 2000, 'Clifford Pier in The Act', *Singapore Straits Times*, Friday June 9, p. 7.
- Pally, R., 2000, *Mind – Brain Relationship*, Karnac Books, London, UK.
- Paul, C., 2007, 'The Database as System and Cultural Form: Anatomies of Cultural Narratives', in Vesna, V., *Database Aesthetics*, Minnesota Press, Minnesota, USA.
- Pasquinelli, E., 2006, 'Varela and Embodiment', *The Journal of Aesthetic Education* Vol. 40, No. 1 Spring, pp. 33 - 35.
- PC World Staff, 2001, 'Majestic: You Don't Just Play This Game, You Live It', PC WORLD, viewed 12 October 2012, <<http://www.pcworld.com/article/48191/article.html>>
- Pearce, C., 2001, 'Emergent Authorship: the Next Interactive Revolution', in *Computers and Graphics – Journal of Systems and Applications* (0), pp.1-9.
- Pearce, C., 2004, 'Towards a Game Theory of Game' in Harrigan, P., Wardrip-Fruin, N., (eds), *First Person: New Media as Performance, Story and Narrative*, MIT Press, Cambridge, Mass., USA, pp. 143 - 153.
- Pearce, C., 2005, 'Theory Wars: An Argument against the Arguments in the so-called Ludology/ Narratology debate', *Proceedings of DiGRA Conference: Changing Views- Worlds In Play*, pp. 664 - 672.
- Pena, A., 2010, 'The Dreyfus Model of Clinical Problem Solving Skills Acquisition: A Critical Perspective', in *Medical Education Online* v. 15, viewed 19 September 2011, <<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2887319/>>
- Perlovsky, L. & Kozma, R., (eds), 2007, *Neurodynamics of Cognition and Consciousness*, Springer-Verlag, Berlin/Heidelberg, DE.
- Perlovsky, L., 2007, 'Neural Dynamic Logic of Consciousness: The Knowledge Instinct', in Perlovsky, L. & Kozma, R., in *Neurodynamics of Cognition and Consciousness*, Springer-Verlag Berlin/Heidelberg, DE, pp. 73 - 108.
- Perron, B. & Wolf, M.J.P., (eds), 2009, *Video Games Theory 2*, Routledge, New York, USA.
- Petitmengin, C., 2006, "Describing one's Subjective Experience in Second Person: An Interview Method for the Science of Consciousness", in *Phenomenology and Cognitive Sciences* Vol. 5, pp. 229 - 269.
- Petitmengin, C. 2009, 'The View from Within', in *Journal of Consciousness Studies* 16, Nos. 10 -12, pp. 7 - 19.
- Phelps, E., 2004, 'The Interaction of Emotion and Cognition: The Relation between the Human Amygdala and Cognitive Awareness', in Hassin et al., *The New Unconscious*, Oxford University Press, London, UK, pp. 61 – 67.
- Prince, S., 1996, 'True Lies: Perceptual Realism, Digital Images and Film Theory', in *Film Quarterly* Vol. 49, No. 3, pp. 27 - 37
- Prinz, J., 2004, *Gut Reactions – A Perceptual Theory of Emotions*, Oxford University Press, New York, USA.

- Prinz, J., 2006, 'Putting the brakes on Enactive Perception', *Psyche* Vol. 12, Issue 1, viewed 10 September 2010, <http://www.theassc.org/vol_12_2006>
- Poerksen, B., 2004, 'Interview with Varela', in *The Certainty of Uncertainty: Dialogues Introducing Constructivism*, trans. A. Koek & W. Loek, Imprint Academic, Exeter, UK, pp. 85 – 107.
- Ramachandran, V.S., Blakeslee, S. & Sacks, O., 1999, *Phantoms in the Brain: Probing the Mysteries of the Human Mind*, William Morrow, Harper Collins Publishers, New York, USA.
- Ramachandran, V.S., 2004, *A Brief Tour of Human Consciousness*, Pearson Education, New York, USA.
- Ramachandran, V.S., 2009, 'Self-awareness: the Last Frontier', *Edge* 270, viewed 7 February 2009, <<http://edge.org/conversation/self-awareness-the-last-frontier>>
- Ramachandran, V.S., 2012, 'Adventures in Behavioural Neurology or What Neurology Can Tell Us about Human Nature', *Edge Conversations*, February 2012, viewed 1 March 2012, <http://edge.org/conversation/adventures_behavioral_neurology>
- Raffone, A., & Srinivasan, N., 2010, 'The exploration of Meditation in the Neuroscience of attention and Consciousness', in *Cognitive Processing* Vol. 11, No. 1, pp. 1 - 7.
- Raffone, A., Srinivasan (eds) 2010, 'Special Issue: Neuroscience of Meditation and Consciousness', *Cognitive Processing* Vol. 11. No. 1.
- Retaux, X., 2002, "A Subjective Measure of Presence Feeling: The 'Auto-confrontation Method'", in *Presence 2002 Conference Proceedings*, Portugal, Oct. 9 – 11, viewed 19 August 2011, <http://www.temple.edu/ispr/prev_conferences/proceedings/2002/Final%20papers/Retaux.pdf>
- Revonsuo, A. & Newman, J., 1999, 'Binding and Consciousness', *Consciousness and Cognition*, No. 8, pp. 123 - 127.
- Revonsuo, A., 1999, 'Binding and the Phenomenal Unity of Consciousness', in *Consciousness and Cognition*, No. 8, pp. 173 - 185.
- Ricoeur, P., 1983, *Time and Narrative* Vol. 1, University of Chicago Press, Chicago, USA.
- Ricoeur, P., 1985, *Time and Narrative* Vol. 2, University. of Chicago Press, Chicago, USA.
- Riva, G., Davide, F. & IJsselstein, W., (eds), 2003, *Being There: Concepts, Effects and Measurement of User Presence in Synthetic Environments*, los Press, Amsterdam, Netherlands.
- Rizzolatti, G., Fogassi, L. & Gallese, V., 2001, 'Neurophysiological Mechanisms Underlying the Understanding and Imitation of Action', in *Nature Reviews Neuroscience* Vol 2, No. 9, pp. 661 - 670.
- Rizzolatti, G. & Arbib, M.A., 1998, 'Language within our Grasp', in *Trends in Cognitive Science*, No. 21, pp. 188 - 194.
- Reisenzein, R., 1983, 'The Schachter Theory of Emotion: Two Decades Later', in *Psychological Bulletin*, Vol. 94, No. 2, pp. 239 - 264.
- Rokeby, D., 1995, 'Transforming Mirrors: Subjectivity and Control in Interactive Media', in Simon, P., (ed.) *Critical Issues in Electronic Media*, Albany Press, New York, USA.
- Romano, D.M., & Brna P., 2001, 'Presence and Reflection in Training: Support for Learning to Improve Quality Decision-Making Skills under time Limitations', in *Cyber Psychology and Behavior* 4, No. 2, pp. 265 - 77.
- Rovner, A., 2009, 'A Fable: Or How to Recognise a Narrative When you Play One', in *Journal of Gaming and Virtual Worlds* 1, No. 2, pp. 97 - 115.
- Ruddauff, D., Lutz, A., Cosmelli, D., Lauchaux, J.P. & Van Quyen, M., 2003, "From Autopoiesis to Neurophenomenology: Francisco Varela's Exploration of the Biophysics of Being", in *Biological Research* 36, pp. 21 - 59.
- Rush, M., 1999, *New Media in Late 20th Century Art*, Thames and Hudson, London, UK.
- Ryan, M. L., 2001, *Narrative as Virtual Reality*, John Hopkins University Press, Baltimore, Maryland, USA.
- Salen, K. & Zimmerman, E., 2004, *Rules of Play: Game Design Fundamentals*, MIT Press, Cambridge, Mass., USA.
- San Francisco Museum of Modern Art, 2008, *The Art of Participation 1950 to Now*, Thames and Hudson, San Francisco, USA.
- Sanchez-Vives, M. & Slater, M., 2004, 'From Presence towards Consciousness Studies', *7th International Conference on Presence: Proceedings of Presence*, Valencia, Spain, pp. 141 - 147.

- Saxa B., 2006, 'Storytelling and the Information Overload', in *On the Horizon* Vol. 14, No. 4, pp. 165 – 170.
- Schmidt, E., 2010, 'The Future of Search is Mobile, Autonomous & Serendipitous', viewed 22 October 2010, <http://www.readwriteweb.com/archives/the_future_of_search_is_mobile_autonomous_serendipitous_says_google_ceo_eric_schmidt.php>
- Schmorrow, D. & Kruse, A., 2004, 'Augmented Cognition', in Bainbridge, W. S. (ed) *Berkshire Encyclopaedia of Human Computer Interaction*, Berkshire Publishing Group, Great Barrington, Mass., USA, pp. 54 - 59.
- Schmorrow, D. (ed), 2005, *The Foundations of Augmented Cognition*, CRC Press, FL, USA, viewed 12 April 2012, <<http://www.augmentedcognition.org/>>
- Schooler, J.W., 2002, 'Re-Representing Consciousness: Dissociations between Consciousness and Meta-Consciousness', *Trends in Cognitive Science* 6, pp. 339 - 344.
- Schön, D., 1983, *The Reflective Practitioner*, Basic Books, New York, USA.
- Seaman, B., 2010, *Recombinant Poetics; Emergent Meaning as Examined and Explored within a Specific Generative Virtual Environment*, VDM Publishing, Saarbrücken, Germany.
- Seamster, T., Redding, R. & Kaempfe, G., 1997, *Applied Cognitive Task Analysis in Aviation*, Ashgate, Aldershot, Hampshire, UK.
- Searle, J., 1992, *The Rediscovery of the Mind*, MIT Press, Cambridge Mass, USA.
- Searle, J., Dennett, D. & Chalmers, D., 1997, *The Mystery of Consciousness*, 2nd edn., New York Review of Books, New York, USA.
- Sedroff, N., 2005, *Experience Design*, viewed 2 June 2012, <<http://www.nathan.com/ed/index.html> >
- Seegert, A., 2009, "'Doing there' vs 'Being there' – Performing Presence in Interactive Fiction", in *Journal of Gaming and Virtual Worlds* 1:1, pp. 23 - 37.
- Sekuler, R. & Blake, R., 1994, *Perception*, 3rd edn., McGraw Hill, New York, USA.
- Self, B., Van Erp, J.B.F., Eriksson, L. & Elliot L.R., 2000, 'Human Factors Issues of Tactile Displays for Military Environments', *National Research Organisation Scientific Papers - Technical Report – Human Factors & Medicine* – No. 122, NATO.
- Seow, S., 2008, *Designing and Engineering Time: The Psychology of Time Perception in Software*, Pearson Education, Boston, USA.
- Shaw, J. & Weibel, P., (eds), 2003, *Future Cinema - The Cinematic Imaginary after Film*, Catalogue Published for the exhibition 'Future Cinema - The Cinematic Imagery After Film', ZKM, MIT Press, Cambridge Mass., USA.
- Shedroff, N., 2001, *Experience Design*, New Riders, University of Michigan, USA.
- Sheridan, T.B., 1992, 'Musings on Telepresence and Virtual Presence', in *Presence: Tele-operators and Virtual Environments* No. 1, pp. 120 - 126.
- Siegal, D., 2007, *The Mindful Brain*, W.W. Norton, New York, USA.
- Singer, W., 1999, 'Time as Coding', in *Current Opinion in Neurobiology* Vol. 9, pp. 189 – 194.
- Simmons, J., 2007, 'Narrative, Games, and Theory,' *Games Studies* Vol. 7, Issue 1, viewed 24 November 2012, <<http://gamestudies.org/0701/articles/simons>>
- Simulation Australia 2008 - 2009, SimTect 2009 Conference Website, viewed 29 June 2010, <<http://www.simulationaustralia.org.au/archive/simtect/2009/2009.htm>>
- Sperry, R .W., 1998, 'A Powerful Paradigm made Stronger', *Neuropsychologia* 36, pp. 1063 - 1068.
- Staff, C., 2009, 'Embodiment, Ambulation and Duration', in Oddey, A. & White, C., *Modes of Spectating*, University of Chicago Press, Chicago, USA, pp. 207 - 218.
- Stokes, J., 2008, 'Understanding Moore's Law', *ARSTechnica*, viewed 19 August, 2012, <<http://arstechnica.com/gadgets/2008/09/moore/>>
- Stone, R. J., 2008, *Human Factors Guidelines for Interactive 3D and Game-Based Training Systems Design*, 1st edn., version 6, Human Factors Integration Defence Technology Centre, University of Birmingham, UK.

- Stuer, J., 1992, 'Defining Virtual Reality: Dimensions Determining Telepresence', in *Journal of Communication* 42, No. 4, pp. 73 - 93.
- Styan, J.L., 1981, *Modern Drama in Theory: Expressionism and Epic Theory* Vol. 3, Cambridge University Press, New York, USA.
- Styan, J.L., 1988, *Modern Drama in Theory: Symbolism, Surrealism and the Absurd* Vol. 2, Cambridge University Press, New York, USA
- Subhash, K., 2007, *The Prajna-Sutras: Aphorisms of Intuition*, D.K. Printworld, New Delhi, India.
- Swartz, A., 2012, 'Embodied Learning and Patient Education: From Nurses' Self Awareness to Patient Self Caring', in *New Directions for Adult and Continuing Education*, No. 134, pp. 15 - 24.
- Sweller, J., 2009, 'Cognitive Load during Problem Solving: Effects on Learning' in *Cognitive Science: A Multidisciplinary Journal* 12, No. 2, pp. 257 - 285.
- Tagini, A. & Raffone, A., 2010, "The 'I' and the 'ME' in self-referential awareness; a neurocognitive Hypothesis", in *Cognitive Processing* 11, pp. 9 - 20.
- Tan E.S., 1996, *Emotion and the Narrative Structure of Film - Film as Emotion Machine*, Erlbaum Associates, New Jersey, USA.
- Tan, E.S., 2001, 'Keeping Track of Cultural Functions and Practices in the Digital World: How Old is the New?', in *Crossings Electronic Journal of Art and Technology* Vol. 1, Issue 1, Trinity College, Dublin, Ireland, viewed 9 March 2012, <<http://crossings.tcd.ie/issues/1.1/Tan/>>
- Tan, E.S. & Jansz, J., 2008, 'The Game Experience', in R. Schifferstein & P.P. Hekkert (eds.), *Product Experience*, Elsevier Publications, Amsterdam Netherlands, pp. 531 - 556.
- Terranova, T., 2004, *Network Culture: Politics for the Information Age*, Pluto Press, London, UK.
- Tijs, T., Brokken, D. & IJsselsteijn, W., 2009, 'Creating an Emotionally Adaptive Game', in *Entertainment Computing, ICEC - 7th International Conference Proceedings*, Sept 25- 27, Pittsburgh, Springer, Berlin/ Heidelberg, Germany, pp.122 - 133.
- Tilley C., 1994, *A phenomenology of Landscape – Places, Paths and Monuments*, Berg Publishers, Oxford, UK.
- Torrance, S., 2006, 'In Search of the Enactive: Introduction to Special Issue on Enactive Experience', *Phenomenology and the Cognitive Sciences* 4, pp. 357 - 368.
- Tomasello, M., 2000, *The Cultural Origins of Human Cognition*, Harvard University Press, Cambridge, MA, USA.
- Thompson, E. & Varela, F., 2001, 'Radical Embodiment: Neural dynamics and Consciousness', in *Trends in Cognitive Science* Vol. 5, No. 10, pp. 418 – 425.
- Thompson, E., 2001, 'Tribute to Varela', *Journal Of Consciousness Studies* 8, No. 8, pp. 66 – 69.
- Thompson, E., 2004, 'Life and Mind: From Autopoiesis to Neurophenomenology - A tribute to Francisco Varela' in *Phenomenology and the Cognitive Sciences* 3, pp. 381 - 398.
- Turner, C., & Behrndt, S., 2008, *Dramaturgy and Performance*, Palgrave MacMillan, Hampshire, UK.
- Turner, M., 1996, *The Literary Mind: The Origins of Mind and Thought*, Oxford University Press, Oxford, UK.
- Turner, M., (ed.) 2006, *The Artful Mind: Cognitive Science and the Riddle of Human Creativity*, Oxford University Press, New York, USA.
- Turkle, S., 1996, *Life on the Screen – Identity in the Age of the Internet*, Orion Publishing, London, UK.
- Turkle, S., 2012, 'Connected but alone?', TED TALK Posted April 2012, viewed 28 April 2013, <http://www.ted.com/talks/sherry_turkle_alone_together.html>
- Travis, F., Haaga, F., Hagelin, J., Tanner, M., Arenander, A., Nidch, S., Gaylore-King, C., Grossworld, S., Rainfroth, M. & Schneider, R., 2010, 'Self referential default brain state: patterns of coherence and e-Loreta sources during eyes closed rest and Transcendental Meditation Practice', in *Cognitive Processing* 11, pp. 21 - 30.
- Uleman, J., 2004, 'Becoming Aware of the New Unconscious', in Hassin, R., Uleman, J. & Bargh, J., *The New Unconscious*, Oxford University Press, Oxford, UK, pp. 3 – 19.
- Varela, F.J., Thompson, E. & Rosch, E., 1991, *The Embodied Mind: Cognitive Science and Human Experience*, MIT Press, Cambridge, Mass., USA.

- Varela, F.J., 1996, 'Neurophenomenology: A Methodological Remedy for the Hard Problem', in *Journal of Consciousness Studies* Vol. 3, No. 4, pp. 330 - 349.
- Varela, F.J. & Shear, J., 1999, 'The View from Within: First Person Methodologies: Why, When and How', in *Journal of Consciousness Studies* 6, (2-3), pp. 1 - 14.
- Varela, F.J. & Thompson, E., 2003, 'Neural Synchrony and the Unity of Mind: A Neuro-phenomenological Perspective', in Cleeremans, A. & Frith, C., (eds.), *The Unity of Consciousness: Binding, Integration and Dissociation*, Oxford University Press, New York, USA, viewed 16 July 2012, <https://unstable.nl/andreas/ai/langcog/part3/FV_ETNeuralSynchrony.pdf>
- Varela F.J. & Poerksen B (2006), 'Truth is What Works - Francisco J Varela on Cognitive Science, Buddhism, the Inseparability of Subject and Object, and the Exaggerations of Constructivism – A Conversation', in *Journal of Aesthetic Education* Vol. 40, No. 1, pp. 35 - 53.
- Veel, K., 2005, 'Once upon a time there was a database: Database and Narrative from a cognitive point of view', in *REFRESH ! First International Conference on Media Arts, Sciences and Technologies* BANFF Sept. 29 – Oct. 4, pp. 1-11, viewed 20 September 2010, <http://www.banffcentre.ca/bnmi/programs/archives/2005/refresh/docs/conferences/Kristen_Veel.pdf>
- Vesna, V., 2007, *Database Aesthetics – Art in the Age of Information Overflow*, University of Minnesota Press, MN, USA.
- Vimal, R.L.P., 2009, 'Meanings Attributed to the Term Consciousness: An Overview', in *Journal of Consciousness Studies* 16, No. 5, pp. 9 - 27.
- Vimal, R.L.P., 2010, 'Consciousness, Non-conscious Experiences and Functions, Proto-experiences and Proto functions, and Subjective Experiences', in *Journal Of Consciousness Exploration and Research* Vol. 1, Issue 3, pp. 383 - 389.
- Waterworth, E.L & Waterworth, J.A, 2001, 'Focus, Locus, and Sensus: The Three Dimensions of Virtual Experience', in *Cyberpsychology and Behavior* 4, No. 2, pp. 203 - 13.
- Weick, K., 1988, 'Enacted Sensemaking in Crisis Situations', *Journal of Management Studies* 25, pp. 305 - 317.
- Weick K., 1995, *Sense Making in Organisations*, Sage Publications, California, USA.
- Weick, K., Sutcliffe, K. & Obstfeld, D., 2005, 'Organizing and The Process of Sense Making', in *Organisation Science* Vol.16, No. 4, pp. 409 – 412.
- Weinbren, G., 1995, 'In the Ocean Streams of Story', *Millennium Film Journal*, No. 28, pp. 15 - 30.
- Xiong, J., Fox, P. & Gao J., 2003, 'Directly Mapping Magnetic Field Effects of Neuronal Activity by Magnetic Resonance Imaging', *Human Brain Mapping* Vol. 20, Issue 1, pp. 41 - 49.
- Youngblood, G. 2003, 'Cinema and the Code' in Shaw J. & Weibel P (eds) *Future Cinema*, MIT Press. Cambridge, Mass., USA, pp 156- 161.
- Ynnerman A., 2011, 'Visualising the Data Explosion', *You Tube* video recording, viewed 30 July 2012, <<http://www.youtube.com/watch?v=pqTkuaAykBw>>
- Zacks, J., Speer, N., Swallow, K. & Maley, C., 2010, 'The Brain's Cutting Room Floor: Segmentation of Narrative Cinema', in *Frontiers in Human Science* Vol. 4:168, viewed 13 November 2010, <http://www.frontiersin.org/Human_Neuroscience/10.3389/fnhum.2010.00168/abstract>
- Zahavi, D., 2008, 'Simulation, Projection and Empathy', in *Consciousness and Cognition* 17, pp. 514 – 522.
- Zeki, S., 2003, 'The Disunity of Consciousness', in *Trends in Cognitive Science* Vol. 7, No. 5, pp. 214 - 218.
- Zeki, S., 2003, *Inner Vision. An Exploration of Art and the Brain*, 2nd edn., Oxford University Press, Oxford, UK.
- Zhao, S., 2002, 'Reconceptualising Presence: Differentiating between mode of Presence and Sense of Presence', *Presence 2002 - Proceedings of 5th Presence Conference*, Oct. 9 - 11, Portugal, Viewed 17 March 2010, <http://www.temple.edu/ispr/prev_conferences/proceedings/2002/Final%20papers/Zhao.pdf>
- Zhao, S., 2003, "'Being There' and the Role of Presence Technology", in Riva, G., Davide, F., IJsselstein, W.A. (eds), *Being There : Concepts, Effects and Measurements of user Presence in Synthetic Environments*, IOS Press, Amsterdam, Netherlands, pp. 138 – 145.