Development and Evaluation of Participant-Centred Biofeedback Artworks

An exegesis submitted to the School of Communication Arts, University of Western Sydney in partial fulfilment of the requirements for the Doctorate of Creative Arts

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2006
Statement of Authentication

The work presented in this exegesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

George Poonkhin Khut, November 17, 2006

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Abstract

This exegesis details the development of four interactive artworks that enable audiences to observe and reflect on aspects of their own psychophysiology, using the technologies of biofeedback interaction as a way of situating the participant’s subjectivity and bodily experiences within each other as reciprocal phenomena.

The central theme addressed through these works concerns the representation and experience of subjectivity as a physiologically embodied phenomenon. Although contemporary theories of psychophysiology and phenomenology have overturned the idea of mind-body separation, many forms of cultural practice continue to represent subjectivity as a fundamentally disembodied phenomenon. In addition, bodily experience in contemporary culture is framed almost entirely in terms of narrowly defined and commodity driven notions of sexuality and desirability, or even pathology. Such representations and experiences perpetuate feelings of mistrust and hostility towards the body, in ways that inhibit our ability to fully engage with the world as fully humans. This problematic use and representation of the body in contemporary culture has attracted the attention of many artists and theorists over the past fifty years, generating a diverse body of works celebrating and sometimes questioning the embodied subject as a medium for enquiry and aesthetic enrichment.

The artworks documented in this exegesis extend this process of re-examination through the use of interactive bio-sensing technologies and audience participation. Interactive practices reframe subjectivity as a fundamentally active process, shifting our sense of involvement in the issues at hand from one of detached onlookers to active participants. Each of the works creates a space where participants and observers alike can become present to aspects of body-mind process. Audience responses to these works have been studied as a way of evaluating the extent to which these interests have been realised through interaction and this exegesis contributes to an emerging but growing body of research into the use of audience experience as a tool for designing and evaluating interactive artworks.
Dedication

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Chapter 1  Introduction

Today, we are in the situation of looking for a new paradigm for the mind-body relationship. In this regard, it is appropriate that we acknowledge the new movements in holistic and psychosomatic medicine, which undertake the research in depth-psychology (particularly biofeedback). These empirical scientific movements have a tendency to lean towards a new dualism presupposing the correlativity of mind and body, in place of the Cartesian dualism which separates them. It is encouraging for those of us who have been nurtured within the Eastern cultural tradition that Eastern medicine and traditional meditational methods have now come to be re-evaluated along side these aforementioned movements. Here we can sense a potential movement which will demand a thorough reflection upon Western attitudes, unchanged in philosophy and empirical science since Descartes.


Twentieth-century Western sciences have overturned traditional Enlightenment assumptions regarding the relationship between mind and body, demonstrating numerous ways in which cognitive and physiological processes can be seen as inseparable from one another (Damasio, 1994, Gallagher, 1995). This understanding of consciousness as a physiologically embodied phenomena is opening the way for a far reaching re-evaluation of the way we conceive mind and body in contemporary society (Yasuo, 1989). Despite the near universal rejection of Cartesian dualism as a theory of mind and body, subjectivity continues to be represented in contemporary media and popular culture as some form of mysteriously disembodied ethereal spirit, peering out onto the world from behind our eyes. This sense of disembodiment finds its most recent expression in the notion of a post-corporeal virtual consciousness proposed by such cyber-cultural theorists as Jaron Lanier (Richardson and Harper, 1996).

The central problem addressed in this exegesis is: how can contemporary fine arts practice evolve new ways of facilitating and representing experiences of subjectivity (and by inference, the self) as a physiologically embodied phenomena? While many artists and theorists have explored the idea of embodied subjectivity through representations, personal accounts and propositions (Hartoum, 1994, Lucier, 1976,
Hall, 1992, Bourgeois and Weiermair, 1995), my interest in this exegesis is in how audience experience itself can be developed as a medium and focus for aesthetic enquiry. If as Merleau-Ponty (1962) suggests, the body is our medium for having a world, then this exegesis explores the potential of this medium as both a subject and vehicle for aesthetic enquiry and enrichment, using the technologies of biofeedback training.

Biofeedback training is a process of electronically monitoring moment-to-moment changes in a subject’s internal behaviour and feeding these changes back to the subject (i.e. ‘feedback’) in such a way that the subject can learn to consciously influence the behaviour being observed. The artworks documented in this exegesis use biofeedback training to enable subjects to sense and then initiate subjectively mediated changes in their own breath and heart rate patterns, as revealed to them through a physiologically responsive audio-visual artwork.

The aesthetic developed through the four works documented in Chapter 5 is an aesthetic of self-sensing, self-moving and self-knowing. However, the works themselves are presented in the context of public exhibitions – a highly social setting – and it is this context that enables audiences to be with each other in ways seldom afforded in normal social life. The work provides a space where people can be present in a sustained and highly focused manner, not just to the quiet rhythms of their own interior, but also to the interiors of their companions and the interiors of total strangers. The function of the witness and the sharing of intimate experiences amongst friends and strangers is an important component of how people experience art in social settings, and is one of the factors that serves to distinguish these artworks from their related experiences in clinical biofeedback and body-mind training practices such as yoga, Feldenkrais Method or Alexander Technique. These works are not claimed as art simply because they are situated in art galleries. Rather, they are presented in art galleries because these settings can offer a supportive space for having and sharing experiences outside the usual body-focused contexts of pathology, crisis, sexual attraction and competitive sport. While these contexts can and often do provide us with valuable and transforming life-experiences and knowledge, the more subtle, intimate and quiet of these experiences usually takes place behind closed doors and outside of public forums. Art exhibitions are special in this respect, because they provide a safe space for testing out new, unfamiliar or difficult subjectivities in a setting that is both intimate and social at the same time.

Another related strand addressed by the works documented in this exegesis and their presentation in public places is the fact that we usually only ever become aware of our bodies when something breaks down – we become ill in some way, or fail to conform to social conceptions of what a desirable body should look like. Our experience of the body at a personal level is thus framed almost entirely by notions of pathology, alienation and function/dysfunction. The works documented in this exegesis
introduce the possibility of less pathologically-determined relationship to body experience, and a way of attending to the body as an instrument for pleasure, self-cultivation and insight. Focusing specifically on individual experiences of heart and breath functioning, the works facilitate an experience of the body as something we are, in contrast to the more prevailing notion of the body as something we have. HCI (Human-Computer-Interaction\(^1\)) and experience-centred design approaches are explored in Chapter 5.4 (*Cardiomorphologies v. 2*) as a way of examining the range of conditions afforded by the design of each of the works, and these methods have been used to develop a more detailed understanding of how the works help shape participants’ experience of themselves and the kinds of behaviours that they can and cannot afford.

1.1 Methodology: Art practice as research

The methods used in the development of this practice-based exegesis and its related body of works draw on a multiplicity of dialogues, methods, contexts and practices. In *Art Practice as Research*, Graeme Sullivan (2005) terms this approach as *Visual Arts Knowing* and uses it to differentiate creative arts research processes from those of both logical positivism and qualitative research:

> Visual Arts Knowing [sic] situates the imaginative and intellectual process that describes the way artists think as they make use of a cognitive coalition of ongoing dialogue between, within, and around the self, artworks, viewers, and settings, where each is used to help create new understandings. This dynamic and reflexive meaning making is described as ‘transcognition’, and it captures the movement and purposeful searching of the artistic mind. Seen within the context of research, the alignments and areas of emphasis that artists search out take in the perspectives of ‘others’, be they other artists, theorists, art writers, artworks, viewers, or contexts, and this ensemble provides a structure for referencing and reviewing.
> (Sullivan, 2005)

Rather than working through a predetermined proposition or design problem, this exegesis documents an iterative process in which the various strands of discourse, practice and critical enquiry surrounding our experience and representation of the body and human-computer interactions are unravelled and re-integrated within successive artworks and their associated critical evaluations. Sullivan describes this process as a braid-like structure in which a multiplicity of tightly bundled strands undergo a processes of unravelling, critical sorting/editing and re-braiding, by which

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\(^1\) HCI is a field of design research and information technology concerned with the study and development of interactions between humans and computational systems.
new ‘ropes’ of ‘visual arts knowing’ become woven from existing stands of discourse, practice, inquiry and critique.

Figure 1 Graeme Sullivan’s Framework for Visual Arts Research Projects (2005) describing the four primary bundles that constitute the larger “braid” from which creative arts research process create new knowledge and cultural practices: art practice; interpretive discourse; empiricist inquiry and critical processes.
1.2 Structural Overview

The multiple strands of action and enquiry described by Sullivan in his *Framework for Visual Arts Research* are established in chapters 2 and 3 of this exegesis. Chapter 2 introduces the methodological frameworks that have helped guide this exploration of biofeedback interaction as a vehicle for body-mind practice and representation. A number of the approaches described in this chapter are drawn from non-arts related disciplines, but all share an interest in human subjectivity and action as a richly embodied phenomena situated across multiple dimensions of physical, psychological, and environmental interaction.

Chapter 3 outlines key art practices that have informed the development of the works documented in this exegesis, focusing on issues surrounding audience experience, interaction, perception and body-mind processes. In addition to the precedents established by other artists working in areas of bodily interaction and electronic media, this chapter explores art practices that engage audiences through processes of direct inter-personal exchange and conviviality. The inclusion of these 'low tech' practices provides a context for analysing the important relational and dialogical aspects that have evolved though each of the artworks documented later in Chapter 5.

Chapter 4 introduces the core principals of human psychophysiology that form the basis of the human-computer interactions explored in this exegesis. Unconventional modes of interaction based on processes of differentiation and the voluntary entrainment of externally focused ‘fight-flight’ responses and internally focussed ‘rest-digest’ response patterns render subjectivity and the process of being as fundamentally active and organizing processes. Emotionally mediated changes in heart rate variability patterning are introduced as a safe and symbolically rich modality for the exploration of body-mind and environmental interactions explored in the two principal artworks documented in Chapter 5: *Cardiomorphologies v. 1* and *Cardiomorphologies v. 2*.

Chapter 5 details the development of the four interactive artworks that comprise the practical component of this exegesis, describing the development of the conceptual, aesthetic and technical structures that have informed each of these works along with a consideration of the audience experiences and behaviours these works afforded. In different ways, each work documented in this chapter draws together the various strands of discourse, practice, inquiry and critique introduced in Chapter 2 and 3, documenting the evolution of my own understanding of the issues surround the use of biofeedback interaction and physiological sensing.

Key understandings emerging from this evaluation form the basis of the concluding Chapter 6, followed by a consideration of future directions suggested by this exegesis in Chapter 7.
1.3 Background and Personal Motivations

The research process I have presented here began several years ago as a general yearning for a form of experience that would engage audiences at a more physically intense level than prevailing trigger-based interactions or the point-and-click interface of CD-ROMs. The increasing presence of computer mediated interactions in both work and recreational spheres has provoked a growing sense of frustration for many artists and designers with the overwhelmingly impoverished physicality of the standard (mouse and keyboard) computational interfaces provided to their users (Rokeby, 1998). At the same time, a growing interest in the role of the body and various forms of physically-intense interactions and experiences has been made possible with the wider accessibility of bio-sensing and interaction-design technologies. During the 1990’s, theories of ‘the body’ gained widespread interest in contemporary arts practice and criticism, with artists such as Kiki Smith, Helen Chadwick, Marina Abramovic, Stelarc and Orlan, developing works that invoked or represented the body and its processes as a site of contesting ideologies, contradictory desires and utopian/dystopian fantasies. Science fiction culture was (and continues to be) saturated with ‘cyborg’ imagery and fantasies of downloadable consciousness: the mind’s final emancipation from the vulnerabilities of flesh.

Up to 2001, my own practice as an artist had, for the most part, focussed on creating quiet, meditative installation environments, often using electronically manipulated sound recordings to invoke trance-like states of reverie and synaesthesia. In my installation Pillowsongs, presented in various configurations between 1997 and 2000, audiences rested on specially prepared beds in a darkened installation space, listening to shifting constellations of environmental recordings, droning audio textures and distant radio-transmissions. Resting horizontally on these bed structures for up to forty-five minutes at a time, audiences would drift towards a state of lucid-dreaming, listening to sounds reproduced through speakers implanted underneath the pillows on which they rested. I was fascinated by the response of audiences who engaged with the work and especially by the intensely personal nature of the ‘sounds and shapes inside my head’ experience they reported, due in no small part to the sleep-like physical re-orientation the work demanded. This process of actively engaging with the terms and conditions by which audiences themselves engage with the work, became the starting point for my investigations into the psychophysiological dimensions of aesthetic experience. This initially led to an investigation into so-called subliminal communication techniques (Nightshift installation with Wendy McPhee, 2001-2003), and then to brainwave entrainment and biofeedback explorations with psychologist Dana Adam in 2001.

What attracted me to these unusual forms of physical interaction (listening on beds, subliminal audio-visual cues, brainwave entrainment, etc) was the way they
transformed our experience of the world and our experience of being within it by altering the conditions of our being, both physically and subjectively. Biofeedback interactions enable participants to consciously influence aspects of their own physiology (i.e. brain wave patterns, heart rate, nervous system processes, etc), in ways that invite a profound re-assessment of the long-held Western ontology of mind and body separation. Instead of the distant observer acting upon a passive physical substance (their body and the ‘dead matter’ of the world), biofeedback and psychophysiology present us with an experience of conscious engagement of psychological and physiological processes: the self is not separate from the physiological behaviours it seeks to influence, but rather is continuous with it. Indeed, as anyone who has experienced biofeedback interaction for themselves can attest, conventional habits of exerting coercive mental effort as a means of affecting change actually impede one’s ability to influence many physiological processes i.e. alpha, theta and SMR brain-waves; along with heart rate, sweat gland activity, etc. In this sense the research undertaken here inevitably involved the negotiation of various theories of ontology, of how we are in the world, and the nature and extent of our being. A detailed philosophical and sociological investigation into the transformation of Western ontologies is obviously beyond the scope of this essentially practice-based creative arts research exegesis. However, this issue of ontology introduces three theoretical perspectives that have come to form the conceptual and critical framework used in the ongoing development and evaluation of the works presented in this exegesis:

• The somatic body-work methodologies embodied in the work of such writers and practitioners as Dan Hanlon Johnson, Moshe Feldenkrais, Thomas Hanna and Dean Juhan (Hanlon-Johnson, 1995a) and Richard Shusterman, exploring the body as a subjectivity;

• John Dewey’s Pragmatist Aesthetics, (1958) with its instrumental notion of the work that art does, and the important role of the audience in the development of cultural practices, understandings, and values; and,

• Interactive art practices, as defined by David Rokeby’s notion of the interactive artwork as a Transforming Mirror (Rokeby, 1995) and as a model for understanding and evaluating interactive art works that engage participants in mirror-like processes of self-reflection, observation, and correlation.

All three approaches emphasize the instrumental role of first-person audience/subject and use systems-oriented methodologies to describe and develop relationships between the self and the world/other. My relationship to the theories and practices contained
within this framework have evolved over the course of my research: from a series of vague, enthusiasms towards a more detailed appreciation of each of the fields involved. The following chapter provides an overview of these key research influences; delineating the scope of my interests and aims, and providing a framework from which to critically evaluate the works developed in this exegesis.
Chapter 2  Conceptual Framework

This chapter provides an overview of six key areas of enquiry that have emerged as a framework for the development and evaluation of the interactive artworks documented in Chapter 5. The diagram in Figure 2 outlines the three principal theoretical perspectives informing the conceptual and critical framework of this exegesis, and their relationship to one another via Richard Shusterman’s notion of somaesthetics (1999), Jodi Forlizzi’s Experience-centred design (Forlizzi and Battarbee, 2004), and clinical biofeedback methodology. The process contained within this framework is that of the self and its inherence in the world, focusing specifically on the body as a subjectivity, and aesthetic experience as a means by which this inherence can become sensible to us (Crowther, 1993).

Figure 2 Diagram showing the relationships between the six research areas used to develop and evaluate the artworks documented in this exegesis.
The somatic bodywork methodologies developed by such practitioner-researchers as Thomas Hanna (1988, 1986, 1970) and Moshe Feldenkrais (Rywerant, 2003a, Feldenkrais, 1990, 2002) provide a primary inspiration and challenge to my work with bodily experience. The depth and intensity of insight, sensuality and perceptual awakening afforded by these perceptually focused methods open the way for a radical reconsideration of what aesthetic experience can be, the nature and extent of our engagement with audiences and the contextual and relational limits we place on this relationship (Hanlon-Johnson, 1995b, Shusterman, 1999).

John Dewey’s pragmatist aesthetics (Dewey, 1958, Shusterman, 2001) provide a framework for re-examining the social and evolutionary function of art and aesthetic experiences in human societies, with important implications for how we define, support and evaluate art practices.

Experience-centred design theories adapted from the fields of interaction design and Human-Computer Interaction (HCI) have been used as a practical framework for understanding how audiences engage with designed objects in ways that become meaningful and/or enjoyable, and how an understanding of this process can be used to inform the design of interactive experiences (Forlizzi and Battarbee, 2004, 2000, Press and Cooper, 2003).
Chapter 2 Conceptual Framework

2.1 The Somatic Perspective

The term somatics was first coined by philosopher and bodywork practitioner Thomas Hanna in 1977 in the journal Somatics, which Hanna established as a forum for research and discussions between exponents of the various 20th century bodywork methodologies (Hanlon-Johnson, 1995c). The term somatic is conventionally used to denote the corporeal body as distinct from the mind or soul of a person and in physiology is used to distinguish the musculoskeletal system from the autonomic-nervous and visceral systems of the body. Hanna distinguished his notion of somatics from these conventional meanings through the addition of the final ‘s’ denoting it as separate field of study, focused around an understanding of the body-mind as an indivisible, intelligent and directed whole:

...When one looks at another human being, one sees a body with a certain external shape and size. It’s just the same as an observed statue or wax dummy that also has a ‘bodily’ shape and size. But when the human being looks at himself from the inside, he or she is aware of feelings and movements and intentions—a quite different, fuller being. To view the body from the outside is a third-person view: one sees a ‘he’, ‘she’ or an ‘it’. But when the human views himself or herself from the inside, it is a first-person view—a privileged view of ‘Me’, which means being aware of ‘I, myself’. What physiologists see from their externalised, third-person view is always a ‘body’. What the individual sees from his or her internalised, first-person view is always a ‘soma’. Soma is a Greek word that, from Hesiod onward, has meant the ‘living body’.

...Any viewpoint of the human being that fails to include both the first-person, somatic view and the third-person, physiological view is deceptive. To view a human only as a third-person, externalised body is to see only a physical puppet or dummy that can be changed by external methods of chemical and surgical engineering. This is prima facie, a false view of the human being: It is one sided and incomplete. (Hanna, 1986)

This chapter provides an introduction to the somatic bodywork methodologies that constitute a key strand of my inquiry into issues and possibilities surrounding body-mind experience and self-representation in interactive art. Similarities between somatic bodywork methodologies and Merleau-Ponty’s phenomenology of aesthetic experience (Crowther, 1993) are explored, with both approaches containing important implications for artists working critically with issues of body-mind and the aesthetics of

* Throughout this exegesis the terms soma and somatic should be understood in the sense developed by Hanna and as presently used within the international community of bodywork practitioner-researchers.
self-representation. The body forms the basis of our being in the world, its structures and habits develop reciprocally with those of its immediate environment. Somatic bodywork methodologies reframe the body as an intelligent and highly directed subjectivity, and the experience of bodywork as a form of ontological enquiry grounded in the immediacy of our moment-to-moment being in the world. Artworks utilizing these methodologies of touch, sensation, perception and differentiation can help focus our exploration of these issues in a way that remains relevant to the details of our lived (as distinct from imagined) individual experiences and patterns of worldly interaction.

2.1.1 Somatic Bodywork Methodology

Don Hanlon Johnson's *Bone, Breath and Gesture: Practices of embodiment* (1995a) is an anthology of somatic practices developed from the early 1900's to the present day, including texts by F.M. Alexander, Ilse Middendorf, Moshe Feldenkrais, Thomas Hanna, Bonnie Bainbridge Cohen and Dean Juhan. While each method has its own points of emphasis and specific terminologies, they all share the basic concept of the human being as a physiologically embodied, learning organism; the importance of the first-person perspective (an individual's experiences and responses to their immediate experience of themselves); and an appreciation of the fundamental role of touch and movement sensation in the ongoing development of the whole person. Dean Juhan distils the defining principles and understandings shared by these somatic bodywork methodologies in the following paragraphs, describing the relationship between consciousness, perception, movement and touch in human development:

> It is the touching of the body's surfaces against external objects and the rubbing of its own parts together which produce the vast majority of sensory information used by the mind to assemble an accurate image of the body and to regulate its activities... We do not feel our body so much when it is at rest; but we get a clearer perception of it when it moves and when new sensations are obtained in contact with reality, that is to say, with objects. Not only is it true that the nervous system stimulates the body to move in specific ways as a result of specific sensations; it is also the case that all movements flood the nervous system with sensations regarding the structures and functions of the body, and sensations are the substance of that bond.
> (Juhan, 1995)

The perception of touch and movement (as revealed through our various senses) is fundamental to our operation within the world, and the judicious use of touch, movement and observation are the cornerstones of all somatic bodywork traditions.
New sensations require the formation of new perceptions and response patterns. The relationship between sensation and action is circular:

...[j]ust as the mind organizes the rest of the body's tissues into a life process, sensations to a large degree organize the mind. They do not simply give the mind material to organise; they are themselves a major organizing principle. (Juhan, 1995)

The specific qualities of our habitual movements and response patterns reinforce a specific repertoire of sensations and perceptions, creating over time a relatively stable but largely unconscious pattern of being and responding: our particular way of moving and responding. This stability enables us to go about our daily tasks with a minimum of difficulty, but can become problematic if it prevents us from adapting to changes in our internal and/or external environments. This is easily observed in sports training where for beginners especially, considerable time is invested in processes of un-learning ineffective movement habits through a re-examination of sensations obscured by deeply ingrained sensori-motor response patterns. Somatic bodywork methods involve a momentary surrender of these response patterns, during which time the bodyworker introduces a flood of unfamiliar sensations and movements to stimulate new or long forgotten sensori-motor experiences designed to provide the client with a more up-to-date sense of themselves and how they can be in a given situation (i.e. work, sport, home, dance, etc.). Differentiation is crucial to this process: as Feldenkrais states in Awareness Through Movement:

If a man [sic] does not feel he cannot sense differences, and of course he will not be able to distinguish between one action and another. Without this ability to differentiate there can be no learning, and certainly no increase in the ability to learn. (Feldenkrais, 1990)

The unfamiliar sensations and patterns of movements across the client’s body invite a process of sensori-motor differentiation i.e. what differentiates these unusual new sensations and movement patterns from each other from my normal experience of being? The qualitative differentiation of new sensations of movement draws previously unconscious sensations and habits into the realm of conscious choice, providing a basis upon which the client can begin to choose between old or new response patterns according to that which feels best suited to the present situation.
2.1.2 Somatics, Phenomenology and Aesthetic Experience

Somatic methodologies developed by such practitioner-researchers as Alexander (1923), Hanna (1988) and Feldenkrais (1990) share much in common with phenomenological theories of embodiment, especially as developed by the philosopher Maurice Merleau-Ponty. Considered together, these approaches (Somatic bodywork and Phenomenological philosophy) can help articulate the role and value of art and sensual experience as forms of embodied inquiry combining theoretical discourse and sensual interaction (Crowther, 1993). Notions of embodiment and the significance of sense, perception, and movement are fundamental to both disciplines’ conception of human development and ontology, and connect with many of the concerns explored by the artists engaging with interactive and perceptually focussed works examined in Chapter 3.

Phenomenological theories of experience and meaning describe experience as a fundamentally active phenomena, constituted according to our availability and situation within the world. As Crowther notes in his introduction to Art and Embodiment:

> Our relation to Otherness is determined fundamentally not simply by ‘mental’ acts of cognitive discrimination, but by our sensori-motor capacities (of which language is the highest function) in operation as a unified field. The unity of this field, and the consciousness of self emergent from it, is both stimulated by, and enables us to organize, the spatio-temporal diversity of Otherness. We give it contour, direction, and meaning; thus constituting it as a world. On these terms the structure of embodied subjectivity and of the world are directly correlated. Each brings forth and defines the essential characteristics of the other. Their reciprocity is ontological as well as causal.
> (Crowther, 1993)

This reciprocity with the world is largely pre-reflective, in the sense that we do not consciously separate out of the various social, physical, cultural factors that contribute to a given experience, but experience them as an inseparable unity (gestalt): removing or altering any single aspect of an experience alters the experience as a whole. Conventional verbal or written accounts of experience are limited to the extent that they inevitably fragment the unity of lived experience into a series of abstract mental concepts. Art is special in this respect because it allows us to reflect on the conditions of being in a way that preserves the fundamental unity of pre-reflective experience as physically and culturally embodied phenomena. Focusing on the paintings of Cézane, Merleau-Ponty suggests that the painter ‘makes visible how the world touches us’ (Merleau-Ponty cited in Crowther, 1993, p. 107).
Aesthetic experiences such as those provided by art, refocus our experience of being in the world, reaffirming existing patterns of engagement or stimulating new ones in much the same way as the somatic bodyworker facilitates the development of new response patterns through touch and movement, thereby rearticulating our sense of ourselves and the world’s availability to us.

2.1.3 Implications

Having introduced a basic theory of aesthetic experience and its relationship to somatic bodywork as a mode of self-representation and self-cultivation, I shall now examine how these principles can be brought to bear on the development of interactive artworks using the technologies of biofeedback training. Works such as those described in Chapters 3.4 and 5, engage their audiences in processes of self-sensing, self-identification and differentiation in ways that relate closely to the basic principals of somatic bodywork methodology. These (somatic) practices can provide clients/pupils with startling and highly personal insights regarding the quality of their being in the world and their sense of availability to the people and environments that surround them.

Important differences between somatic bodywork and biofeedback art experiences lie in the nature of the relationship between participant/artwork-bodyworker/client, and in the degree of intensity, proximity, and intelligence that is brought to bear on the individual in each context. In somatic bodywork practices such as Feldenkrais Functional Integration, each interaction is based on the process of enquiry and dialogue with the peculiarities of the client’s somatic organization. The practitioner’s own somatic organization is also crucial to the quality of the client’s learning experience: general discomfort or a loss of balance in posture on the part of the practitioner translates easily into a feeling of instability and danger for the recipient of their contact (Rywerant, 2003a).

The complex gestalt of human sensori-motor abilities utilised in somatic bodywork far surpasses existing bio-sensing, analysis and display technologies. Rather than replacing human sensory abilities with crude and inflexible interactive technologies, biofeedback artworks can be developed as a way of augmenting and refocusing our existing perceptual abilities. The role of touch and the perception of movement (including self-touch as in the case of practices such as yoga and Feldenkrais Awareness Through Movement) requires special attention in this regard, given the predominantly audio-visual bias of most art practices and its primacy in somatic

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3 Functional Integration is the term given to the process of individualised manipulation and instruction provided by a Feldenkrais instructor to an individual client.
4 Awareness Through Movement is term used to describe group lessons in body awareness and coordination as developed by Moshe Feldenkrais and certified the Feldenkrais practitioners.
bodywork. If the bodyworker's own physical organization is a crucial part of communicating the right message to the client, how might we consider the artwork's organization in relation to the participant’s experience? What does the physical structure of the work itself as an interface evoke within the participant’s experience? These questions are considered in Chapter 2.5 (Experience-Centred Design), throughout Chapter 5 (The Installations) and at length in Chapter 6 (Conclusions).
2.2 Biofeedback

This chapter outlines the field of biofeedback and the practical and conceptual implications for the works developed in this exegesis. It introduces a brief history of biofeedback and its influence on Western medicine and body imaging, followed by an account of the key principles that have defined clinical biofeedback, and the implications they hold for the development and evaluation of the works examined in this exegesis.

The term biofeedback was first used in 1969 at the inaugural meeting of the Biofeedback Research Society, Santa Monica, California, USA (Schwartz and Olsen, 1995), and is used as shorthand for processes involving external psychophysiological feedback, physiological feedback, and in some cases augmented proprioception – a phrase that has special significance for my own research in physiological sensing and somatic bodywork methodologies. Schwartz and Olsen (1995) suggest that clinical biofeedback’s emergence as a field is best understood as a convergence of several traditionally separate research areas:

- Instrumental (operant) conditioning of autonomic nervous functioning;
- Psychophysiology;
- Behaviour Therapy and Behavioural Medicine;
- Stress research and stress-management methods;
- Biomedical engineering;
- Consciousness, altered states of consciousness and electroencephalographic (EEG) feedback;
- Cybernetics; and
- Broader cultural factors including the popularisation of Eastern body-mind practices and the emergence of ‘preventative health’ and ‘wellness’ as public health and education issues.

The cultural climate that biofeedback emerged from should not be underestimated. Prior to the development of biofeedback and applied psychophysiology, Western medicine emphatically denied the possibility of any form of voluntary control over autonomically regulated homeostatic body functions such as circulation, heart rate, digestion or body temperature. While some of the basic principles of biofeedback training had been present since the late 1930’s (Jackobson, 1938), most of the key
findings supporting the validity of the biofeedback training model were developed in
the late 1960’s and early 1970’s, with Neal Miller’s pioneering research into operant
(learnt) control of visceral responses in laboratory animals (1969), John Basmajian’s
demonstration that, given proper biofeedback, almost anyone could gain control of a
single motor unit of a muscle within a brief period of time (1967), and Joe Kamiya’s
demonstration that humans could learn to switch alpha brainwave rhythms on and off
at will, based on continuous information about the state of their brainwave activity
(1969). The first university course in psychophysiology was offered in 1965 at Harvard
University by David Shapiro and since then there has been an increasing
acknowledgement of the validity of biofeedback training and research, and its
implications for our conception of the mind-body relationship in Western science and
culture and philosophy (Yasuo, 1989).

2.2.1 Definition and Implications for Interactive Art

In Definitions of Biofeedback and Applied Psychophysiology, Schwartz and Paul Olson
(1995) propose the following ten-part definition of biofeedback based on his survey of
existing definitions within the field, synthesizing various operational, teleological and
theoretical approaches:

As a process, applied biofeedback is a group of therapeutic procedures that
utilizes electronic or electromechanical instruments to accurately measure,
process and ‘feed back’ to persons information with reinforcing properties
about their neuro-muscular and autonomic activity, both normal and
abnormal, in the form of analogue or binary, auditory and/or visual feedback
signals. Best achieved with a competent biofeedback professional, the
objectives are to help persons develop greater awareness and voluntary
control over their physiological processes that are otherwise outside
awareness and/or under less voluntary control, by first controlling the
external signal, and then with internal psychophysiological cues. (Schwartz
and Olsen, 1995).

They then unpack each of these ten components, revealing the implications they
present for clinical practitioners and researchers. I will now consider five key
implications arising from their definitions, which have influenced the development of
the interactive artworks documented in Chapter 5.

To accurately measure, process and feed back to persons...

One unique feature of biofeedback is to provide accurate and meaningful
physiological information directly to the patient. Regardless of the theoretical
model, accuracy of measurement is important. ...'The patient is no longer an object of treatment, he is the treatment' (citing Brown, 1977, p13). There is a shift in the role of the therapist who sometimes also becomes a coach or instructor as well as therapist. (Schwartz and Olsen, 1995)

For an actual feedback loop to take place in the behaviour of the participant, the data presented must provide an accurate and intelligible reflection of the specific behaviour being observed (heart rate, brainwave rhythms, etc). Biosensors can be used as novel control sources for interactive art compositions without creating a feedback loop, in which case they would be best described as physiologically responsive or simply biosensing artworks. Artworks seeking to facilitate the differentiation of physiological behaviours and their correlation to specific psychophysiological response patterns will be dependant on accurate measurements and intelligible feedback signals and thus to enable their function, are reliant on the achievement of a genuine feedback loop.

The concept that nothing is being done to the participant — that it is the participant themselves who is influencing the behaviours in question via the quality of their engagement/being — can be especially challenging to audiences accustomed to traditional Western notions of the body as a passive receiver of energy and information. ...

...Information with reinforcing properties

This phrase integrates the perspectives of both cybernetics and learning theory. The biofeedback signals fed back to a person convey information, and this information often contains reinforcing properties. ...Admittedly the therapist often needs to explain to the patient the meaning of the information. ...

...From a behavioural perspective, the person learns to regulate his or her physiological process with the help of feedback information. Feedback information reinforces, facilitates, augments, and encourages physiological and cognitive learning. (Schwartz and Olsen, 1995)

If actual feedback is a goal, how can the design of the experience as a whole enable its participants to enter into the aforementioned processes of engagement and differentiation? To what extent can or should the design of the experience prescribe and guide the participant towards the attainment of efficacy in the coordination of specific psychophysiological responses, as would be the case in the clinical context? Given the unfamiliarity of the interface and the abilities/behaviours being observed, it cannot be assumed that participants will automatically know what to do. This is often one of the first questions that participants will ask, if not told prior to their engagement with the work.
...In the form of analogue or binary, auditory and/or visual feedback signals.

Analogue feedback is continuous feedback. For example a continuous tone of varying pitch may indicate rising or falling muscle activity or skin temperature. Binary feedback is discontinuous, either on or off. For example, one may set a signal to go on or off when the patient lowers his or her respiration rate from sixteen cycles per minute to twelve cycles per minute or lower ...in this example the threshold is twelve cycles. (Schwartz and Olsen, 1995)

Analogue and binary feedback are two categorically different forms of feedback from an interaction design perspective. Each has its own strengths and suitability for particular experiential/interactional goals. Binary (threshold-based) feedback can be used to provide clearly discernable reference points or signposts that can help facilitate processes of differentiation and correlation. Analogue (continuous) feedback provides participants with a moment-by-moment account of their movement within the system, conveying sensations of fluidity, viscosity and immersion that play an important role in the overall vision for the artworks and the experiences documented in Chapter 5.

By first controlling the external signal...

Finite sensory feedback and control systems of humans limit the development of physiological self-regulation. For example most persons are unaware of changes in muscle activity corresponding to a few or several microvolts. Most are unaware of blood pressure changes of a few to several millimetres of mercury (mm Hg) and in the electrical activity of the brain. ...Biofeedback instruments detect minute changes in bioelectrical activity that human sensory systems cannot detect or are not detecting. Theoretically, the person first learns to control the external signal and then develops more control over his or her physiological processes. (Schwartz and Olsen, 1995)

Considered in relation to somatic bodywork methodologies, biofeedback can be understood as a sensorial bridging device between the sensible and that which cannot yet be sensed. Biofeedback training builds incrementally on otherwise imperceptibly weak sensori-motor abilities. Many people lack the ability to concentrate for any extended period of time on the nuances of their own physicality, thus audio-visual biofeedback provides a means by which they can enter into sustained engagement with these behaviours and sensations. There is a tension at play between existing sensorial abilities and inabilities – that which can be externally seen and heard, and that which is internally felt through sustained attention. To what extent is the prevailing privilege of
sight and sound in the fine arts unavoidable? How might this conventional hierarchy of perceptual modalities be altered through skilled experience-centred design methods?

...and then with internal psychophysiological cues.

The final goal is for persons to maintain physiological self-regulation without feedback from external instruments. People learn to apply self-regulation in their daily lives by learning to identify undesirable internal cues and reproducing desired cues associated with physiological changes learned and reinforced with external feedback. An effective biofeedback program includes methods to help people transfer and generalize the acquired self-regulation responses. (Schwartz and Olsen, 1995)

Given the centrality of the learning as a concept in my exploration of biofeedback as a vehicle for interactive art experiences, and the politics of body-mind representation at the heart of this work, this notion of transferability and generalization raises some interesting questions regarding the framing of the participant’s agency within the interactive experience: how does an art experience communicate this transferability? To what extent can or do technologies diminish our innate abilities in order to render us dependent on the institutions that maintain and develop these technologies? These issues of agency and interaction as a form of enquiry are addressed in Chapter 6.

2.2.2 Summary: Biofeedback

The potency of biofeedback as a vehicle for exploring the embodied nature of human subjectivity in interactive art works is not easily separated from the clinical/scientific frameworks from which it has been developed. As we have seen from the clinical perspective described by Olsen, successful biofeedback therapy is highly contingent on the relational and pedagogical skills of the biofeedback clinician. Problems of translation from clinic to gallery become especially apparent in this respect. Where clinical biofeedback involves a careful process of induction, explanation and differentiation using a clear goal-oriented approach, interactive art experiences are often open-ended and non-goal oriented; for most audiences visiting a gallery, it is usually enough just to be with the work. Artworks exploring biofeedback as a process of embodied enquiry need to take into account the importance of differentiation as a component of the biofeedback learning process if they are to realise the radical potential of biofeedback as a tool for transforming individual understandings and experiences of body-mind.
2.3 Pragmatist Aesthetics

In *Art as Experience* (first published in 1938), philosopher John Dewey introduced his theory of *pragmatist aesthetics* (1958), radically redefining art and aesthetic experiences as fundamentally experiential and relational activities, *directed towards* the enhancing of human experience and the meanings and values derived from this experience. Dewey’s pragmatist aesthetics is introduced here as a framework for understanding the role of experience in the work of art in the broadest sense of the word, as a set of social behaviours and needs fundamental to the human organism. The work of art (being the work that art does) for Dewey is an ongoing process through which human experience becomes imbued with meaning, value and a *sense of enjoyment and vitality*.

This *instrumental* approach to the production and consummation of art experiences, although at odds with conventional (Kantian) analytical aesthetics (Shusterman, 2001, Grau, 2003b) resonates strongly with the instrumental and experience-centred approaches of clinical biofeedback training, somatic bodywork practices, interactive design and the phenomenology of Merleau-Ponty, providing a shared evaluative framework for the interactive art works presented in this exegesis.

This chapter provides a brief introduction to key aspects of Deweyan pragmatist aesthetics as identified by philosopher Richard Shusterman (Shusterman, 2001), Dewey’s *naturalistic* concept of art as a social activity fundamental to human behaviour, his *instrumental* concept of aesthetic experience, the continuity of aesthetic experience between ‘Art’ and everyday life, the dismantling of traditional Western dualisms that this entails, and the inclusive vision of a lived aesthetic that unfolds from this continuity.

2.3.1 Deweyan Naturalism

Naturalism is a defining feature of Dewey’s philosophy of aesthetics as presented in *Art as Experience*, and he uses naturalism as a way of grounding aesthetics within the structure of the human organism. Charles Darwin provided the early seeds for these theories when he first considered the similarities between courtship rituals and adornment in animals and human beings, noting the ‘...widespread pleasure which the men of all races take in dancing, rude music, acting, painting, tattooing and otherwise decorating themselves’ (Dengerink-Chaplin, 2005). For Darwin the pleasures produced through bodily display developed hand-in-hand with the sense of beauty, not only as seen in humans, but throughout the wider animal world. Male displays of bodily beauty through movement, colour, sound and the construction of temporary artefacts (as seen for example in lyre birds) function to charm and attract female partners required for reproduction and genetic continuity (Dengerink-Chaplin, 2005). Significantly, displays
that may have originally provided advantages in natural selection (for example a deer's antlers in combat) evolve into displays directed exclusively towards the enchantment of securing females for mating, as dramatically demonstrated in the peacock's beautiful but otherwise highly impractical tail plumage.

In *What is Art For?* human ethologist Ellen Dissanayake (1988) explores the evolution of art-like behaviours in human societies to analyse the development of ritual and play and their shared use of ornamentation and beauty as precursors to our present day construction of art and aesthetics as a highly specialised field of cultural activity. Dissanayake defines art as a process of ‘making [something] special – or more precisely the marking of something as special’ – a feature she argues that is unique to humans. For Dissanayake ‘special-ness’ becomes a means by which meanings and values are evolved and transmitted via sensually and symbolically engaging cultural practices (Dissanayake, 1988).

Dewey’s own naturalism as described in *Art as Experience* predates Dissanayake's more extended developments by some fifty years, but his concept of art’s instrumentality and fundamental continuity with organic human needs is closely matched by Dissanayake’s ethological notion of art as ‘making special’. Art is not something separate from our everyday experience, but rather a sensually mediated intensification of everyday experience and the relations entailed by it, with this process of intensification becoming a means through which personal experiences assume significance and value in a social context.

### 2.3.2 The Work of Art: The work that art does

For Dewey, the aim of art is ‘...to serve the whole creature in his unified vitality’ (Dewey, 1958). Shusterman notes how this instrumental concept of art stands in marked contrast to Anglo-American analytical aesthetics' extreme emphasis on disinterestedness and non-instrumentality, a position he traces back to Kantian aesthetics. This stance still holds considerable influence in contemporary art criticism, despite the recent popularity of theorists such as Nietzsche, Bataille and Foucault with their emphasis on bodily factors and desires, and Marxian theories examining art's socio-economic, historico-political determinants and instrumentality. Within the context of interactive art, this resistance to the concept of instrumentality is evidenced in the widespread resistance and discrediting of HCI methodologies as deeply inappropriate to what many artists and critics hold to be art's intrinsically gratuitous nature (Penny, 2004, Sengers and Csikszentmihályi, 2003).

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5 Other books by Dissanayake addressing the evolution of art-like behaviours in ritual and play include *Homo Aestheticus: Where Art Comes From and Why* and *Art and Intimacy: How the Arts Began*. 
In defence of Dewey's instrumentalism, Shusterman argues that the mistake of this Kantian tradition is the assumption that ‘...since art has no specific, identifiable function which it could perform better than anything else, it could only be defended as being beyond use and function’ (Shusterman, 2001). According to this perspective, the work of art becomes significant to the extent that it resists any possibility of use or function. For Dewey and pragmatists like Shusterman, such concepts only contribute to the increasing devaluation of fine art in contemporary society, rendering aesthetic experience in general as ‘...eviscerate and socially irrelevant’ (Shusterman, 2001). Dewey's instrumentalism is based not on art's ability to serve any specialised or particular end, but in its ability to satisfy the living human through enhancing our immediate lived experience, invigorating and vitalising our lives and the various ends we put it to. Aesthetic values in this sense cannot be permanently fixed by any particular theory, but require an ongoing process of evaluation according the changing circumstances of our situation and lived experience (Shusterman, 2001).

2.3.3 Art and Everyday Life: A non-dualistic continuity

An important consequence of Dewey's instrumentalist approach is that aesthetic concepts and values need to be challenged and revised when they fail to provide the best experience, implying an ongoing process of socio-cultural negotiation and transformation. Art and aesthetic experience in general become better for Dewey, to the extent that they are integrated into the fabric of people's lives and more closely aligned to their most 'vital interests' (Dewey, 1958). Pragmatist aesthetics are in this sense fundamentally meliorative, but this does not imply a universal trans-cultural utopian vision based on man's common biological heritage. Dewey acknowledges that how a given society or sub-culture construes what is 'better' or in their own 'vital' interests is negotiated along their own terms in relation to their specific historico-political and socio-cultural circumstances and the opportunities afforded by them.

Rejecting the notion of the artist as active creator and audience as passive receiver, Dewey presents the audience as an active and fundamental component of the consummation of the work of art, distinct from the mere production and distribution of art products. This notion of the audience's role in the consummation of the work of art predates Duchamp's concept of the artist-artwork-audience relationship, and the cybernetic aesthetics of such artist-researchers as Cornock and Edmonds (1973) and Rosenboom (1976a) that marked the emergence of interactive art and aesthetics during the late 1960's and 1970's.

Dewey's naturalism, and the continuity it implies between aesthetic experience and the experience of everyday living, extends to many other traditionally binary Western concepts such as fine art/practical art, high/popular culture, and
artist/audience. In this way it also resonates strongly with many other 20th century systems-oriented approaches to the philosophy of perception, behaviour and design as exemplified by von Bertalanffy’s *General Systems Theory* (1968), James Gibson’s *Ecological Psychology* (1966), and Murray Bookchin’s *Social Ecology* (1982). What is at stake is no longer the preservation of established cultural hierarchies, but the overall vigour and potency of the specific system considered as whole (i.e. artist, art work, audience, community and region), and its capacity to add meaning, value and enjoyment to the lives of those involved.

### 2.3.4 Implications

Dewey’s instrumental concept of art provides a base from which to explore and negotiate the creation and evolution of meanings, values and pleasures from our contemporary experience. It grounds the process of artistic creation, presentation and consummation within a wide ranging and socially engaged relational framework that is particularly relevant to artists working with interactive and participatory practices in which the audiences themselves are implicated within the structure of the work and the issues of phenomenon explored. While this collaborative approach to the development of art experiences is most readily associated with the genres of community art or community cultural development (CCD), this development of audience experience has also been explored by a number of artists whose practices fall outside or along the borders of these still marginalised genres. Susan Hiller’s *Witness* (Milne, 2004), Lee Ming-Wei’s *Letter Writing Project* (Hoos-Fox, 2000, Lee, 2005), Mark Hansen and Ben Rubin’s *Listening Post* (Hansen and Rubin, 2001) and Ian Mott’s *Zhong Shuo* (2006) project all draw on audience experiences and life stories as means to focus, intensify and reflect on the various relationships, phenomena and historical events examined in their works. The work of the art object/process in such projects is to facilitate a process of enquiry and to generate responses and reflections in relation to the issues or phenomena in question. This notion of enquiry through interaction is central to the works documented in this exegesis. The challenge that such an approaches faces however, is to transform these raw ethnomethodological materials from an anonymous and overwhelming litany of historical facts and personal disclosures, into a compelling and personally empowering aesthetic experience.
2.4 Somaesthetics

In *Pragmatist Aesthetics: Living beauty, rethinking art*, Deweyan scholar, philosopher, and Feldenkrais practitioner Richard Shusterman (1992) introduces his concept of *somaesthetics* as a new philosophical and aesthetic framework for examining and developing the body as the site of our engagement with the world. Shusterman’s somaesthetics provides an important practical and theoretical link between somatic bodywork, Deweyan pragmatism and Merleau-Ponty’s phenomenology, reintroducing the practical cultivation of body-mind as a vital component in the realisation of philosophy as an art and ethics of living.

Shusterman defines somaesthetics as ‘...the critical, meliorative study of the experience and use of the body as a locus of sensory-aesthetic appreciation (aesthesis) and creative self-fashioning (Shusterman, 1999). Recalling Baumgarten’s original eighteenth-century conception of aesthetics as a science of sensory cognition and a life-improving cognitive discipline, Shusterman recovers the body from its historically degraded position in Western philosophy and aesthetics. The body is introduced not as something to be overcome through rigorously disembodied intellectualism and asceticism, but as the primary ‘instrument of our grasp upon the world’, a phrase he borrows from Simone de Beauvoir in his article *Somaesthetics and The Second Sex* (2003). In the following passage from this article, Shusterman outlines the historical context from which somaesthetics has emerged, the important claims it makes for the role of bodily experience and self-cultivation and the significant contributions it presents to contemporary philosophy:

...Still largely dominated by Kantian and Hegelian idealisms that tend to privilege pure form and spiritual truth, contemporary philosophical aesthetics have not yet given the body the systematic attention it needs. Thus, despite today’s heightened interest in the body, our culture’s aesthetic ideals of the body remain enslaved by shallow and oppressive stereotypes that serve more to increase profits for the cosmetics industry than to enrich our experience of the varieties of bodily charms. Somaesthetics claims that the body deserves more careful aesthetic attention not only as an object that externally displays beauty, sublimity, grace, and other aesthetic qualities, but also as a subjectivity that experiences aesthetic pleasures through somatic sensations. The notion of aesthesis (perception) that is incorporated into the very name of the discipline indicates that somaesthetics is concerned with the living, sentient ‘body-mind’ rather than with the body as a mere physical object or mechanism. Somaesthetics further argues that philosophical attention to the body should not remain merely theoretical; it should be aimed at improving our bodily functioning, not only by criticizing those practices and ideologies
that result in somatic misery and misuse but also by directing our attention to methods that foster better somatic experience.

In proposing ‘somaesthetics’ as a field of theory and practice, I could appeal to ancient and non-Western traditions that cultivate the body as means of improving one’s cognitive and ethical virtues as well as one’s aesthetic dimension. While modernity’s dominant ideology compartmentalizes and trivializes the aesthetic by sharply distinguishing it from more serious realms of knowledge and praxis (by identifying the aesthetic with mere prettiness, appearance, surface, form, play, fantasy, etc.), somaesthetics blends aesthetic, cognition, and praxis to address some of philosophy’s most central aims: knowledge, self-knowledge, right action, happiness, and justice. (Shusterman, 2003)

Shusterman (2003) outlines three overlapping branches of somaesthetics, a field he ultimately situates as a sub-branch within an enlarged definition of the discipline of aesthetics. The first of these three somaesthetic branches, analytic somaesthetics is an essentially descriptive and theoretical undertaking and the most easily recognisable branch in relation to existing aesthetic discourse. Pragmatic somaesthetics forms the second branch, and is distinguished from the first by its normative and often prescriptive characteristics, involving the development of specific methods of somatic improvement, and includes the explication, comparison and critique of these methods. The third and perhaps most challenging and vital branch of Shusterman’s somaesthetic proposal is that of ‘practical somaesthetics’ being the actual processes of somatic cultivation through ‘…disciplined, reflective corporeal practices aimed at somatic self-improvement’ (Shusterman, 2003).

Considered together, these branches provide a comprehensive framework for examining and cultivating the use and experience of the body in contemporary culture, redefining the scope of aesthetic research and development to include varieties of body practice and sensation traditionally marginalized in contemporary aesthetics (body modification and adornment, practical self-cultivation etc.). Within the context the research documented in this exegesis somaesthetics provides a useful framework for re-conceiving the scope and direction of biofeedback-based art experiences as tools for aesthetic enquiry and enjoyment. A space is created in which the ameliorative and instrumental characteristics so fundamental to effective clinical biofeedback and

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* Such an enlarged aesthetics would give more systematic attention to the body’s crucial roles in aesthetic perception and experience, including the aesthetic dimensions of body therapies, sports, martial arts, cosmetics, etc., that remain marginalized in academic aesthetic theory. However, to incorporate somaesthetics’ practical dimension the field of aesthetics must also expand its notion of disciplinary attention to actual, hands-on training in specific body practices that aim at somaesthetic improvement. Inclusion of such body work may make aesthetics more difficult to teach or practice in the standard university classroom, but could certainly make the field more exciting and absorbing as it comes to engage more of our embodied selves. – Richard Shusterman (1999)
somatic bodywork, but so problematic from the perspective of traditional analytical aesthetics, can be presented as a form of embodied and publicly engaging (som)aesthetic research.

2.4.1 Analytical Somaesthetics

Shusterman's concept of analytical somaesthetics is the field of somaesthetic enquiry most easily identifiable within the context of contemporary aesthetic and philosophical discourses. In addition to traditional philosophies of mind, ontology and epistemology as they relate to questions of embodiment and cognition, analytical somaesthetics also includes the genealogical, sociological and cultural analyses of the body as advanced by writers such as Michael Foucault, Simone de Beauvoir, Pierre Bourdieu, and American feminists such as Sandra Bartky, Susan Bordo and Judith Butler. These approaches reveal how the body is both shaped by power and coopted into its preservation, and how bodily norms of health, skill, beauty, sexuality and gender are constructed to reflect and sustain particular social forces (Shusterman, 2003). Analytical approaches articulate the body’s situation within complex historico-political and socio-economic practices and institutions, grounding our understanding of the highly personal practices of ‘pragmatic’ and ‘practical’ somaesthetics within the often stark and problematic reality of everyday social practices and the mixed agendas they conceal.

2.4.2 Pragmatic Somaesthetics

Pragmatic somaesthetics involves the development and comparative evaluation of specific bodywork methodologies and is, in this sense, a fundamentally normative and often prescriptive approach. It encompasses the multitude of disciplines designed to improve our experience and use of ourselves, through various diets, body modification and decoration practices, participation in performing arts, martial arts, biofeedback self-regulation, erotic ritual and various modern somatic disciplines like the Feldenkrais Method and the Alexander Technique (Shusterman, 2003). Shusterman has proposed a number of ways that this myriad of pragmatic methodologies might be classified, distinguishing between practices that are holistic and atomistic in their approach. Atomist approaches focus on specific body parts, functions or surfaces as exemplified in various forms of body decoration, body-building and erotic fetishism, while holistic approaches emphasise the body/mind as an integrated whole. Examples of such holistic approaches include the various somatic bodywork methodologies already discussed, as well as traditional practices like yoga and tai-chi. These holistic practices are characterised by their insistence on the inseparability of body and mind – improved somatic awareness both contributes to and is a product of heightened mental
awareness and psychological balance, and brings to mind the phenomenological concept of *ontological reciprocity* and embodied subjectivity discussed previously in Chapter 2.1.2.

### 2.4.3 Practical Somaesthetics

Regardless of how these various ‘pragmatic’ methodologies are classified and elaborated upon, Shusterman is emphatic that they be distinguished from the vital dimension of *actual* practice, a dimension he calls ‘practical somaesthetics’:

> It is not a matter of producing theories or texts, not even texts that offer pragmatic methods of somatic care. It is instead all about actually practising such care through intelligently disciplined bodywork aimed at somatic self-improvement (whether in a representational, experiential, or performative mode). Concerned not with saying but with doing, this practical dimension is the most neglected by academic body philosophers, whose commitment to the discursive logos typically ends in textualizing the body. For practical somaesthetics, the less said the better, if this means the more work actually done. But, unfortunately, it usually means that actual body work simply gets left altogether out of philosophical practice. Unfortunately, in philosophy, what goes without saying typically goes without doing, so the concrete activity of bodywork must be emphatically named as the crucial practical dimension of somaesthetics conceived as a comprehensive philosophical discipline concerned with self-knowledge and self-care.

(Shusterman, 1999)

Shusterman locates the importance of actual somaesthetic practice within the context of philosophy's concern for right action or virtue citing Japanese philosopher Yuasa Yusuo’s assertion that from an Eastern philosophical perspective true knowledge can only be obtained through *bodily recognition or realization* (*tainin ot taioku*) — theoretical thinking by itself is never enough (Shusterman, 1999).

Grounding the development and evaluation of interactive artworks in the lived experience of interaction shifts emphasis away from critical interpretations regarding the possible meanings and significances of the work as form of conceptual proposition, orientating it instead towards a consideration of the range of *actual experiences* unfolded from the work by its numerous participants. It is not just the *idea* of embodied subjectivity that is being communicated in these works, but more importantly the development of this idea *through* the lived experience of biofeedback interaction.
2.4.4 Implications

Somaesthetics implies the development of somatically articulate participating subjects as a crucial component in the recovery of the body in contemporary philosophy, aesthetics and arts practice. In line with pragmatist aesthetics recovery of philosophy as an art of living, somaesthetic art could therefore be conceived as a framework for intensely situated forms of sensual self-enquiry i.e. where am I? ...how am I here? ...how else could I be here? ...how can we become more available and present to our inherence in this scheme of things? ...What pleasures and joys might this inherence afford us?

An important distinction needs to be made between the development of art as a form of enquiry and practice, and the use of art as a therapeutic method. Especially in relation to health care, the lines between science, pseudo-science and occultist spectacle can become dangerously blurred without a clear professional accountability and affiliation. The role of the artwork in relation to therapeutic applications should be understood as primarily inspirational or reflective, whereby interaction becomes a way of doing critical somaesthetics. Contemporary dance/movement practices, such as Bonnie Bainbridge-Cohen’s work with Contact Improvisation and Mary Whitehouse’s Authentic Movement provide interesting precedents in this respect, being widely practised frameworks for embodied expression and playful exploration that relate closely to their respective founders’ own therapeutic bodywork methodologies (Bainbridge-Cohen, 1995, Hanlon-Johnson, 1995d).
2.5 Experience-centered Design

Thus far we have considered the central role of proprioceptive, interpersonal and aesthetic experiences in the development of the self and the social practices that surround it, through the conceptual and methodological frameworks of somatic bodywork, Deweyan pragmatist aesthetics and Shusterman’s somaesthetics. While these approaches can help us to understand the nature of aesthetic and somatic experience and the meanings that emerge from it, they do not tell us much about how these experiences can be developed through individual artworks. To learn more about how these experiences are facilitated through the design of interactive systems, we will now consider some approaches developed by researchers working in the fields of human-computer interaction (HCI) and experience-centred design research, and their relevance to the artworks documented in this exegesis. Although some artists and writers resist the application of these design-based methodologies to interactive artworks on the basis of the allegedly non-instrumental nature of creative arts practice, others have embraced these methods as a way of thinking through the changing role of computational technologies in contemporary culture and the new identities and practices they afford. This chapter will focus on the experience-centred theories of interaction developed by design researcher Jodi Forlizzi as a way of understanding user (participant) experience and how this is developed through interaction.

2.5.1 Developing a Model of Experience in Interaction

In The Building Blocks of Experience: An early framework for designers (2000) design researcher Jodi Forlizzi proposes an interaction-centred framework for collaborative multi-disciplinary design teams, focused on the notion of the ‘product’ and the range of experiences that arise from a user’s interaction with it. She discusses two aspects of experience that help us to understand user-product interactions and the meanings that emerge through them; influences on experience, and qualities of experience. Experience is considered according to three basic categories: experience being the constant flow of sensations and self-talk that happens during normal waking-consciousness; an experience as what we refer to when we feel we are having an experience such as a roller-coaster ride or enjoying the view of a sunset; and co-experience as concerning user experience in social contexts. In Understanding Experience in Interactive Systems Forlizzi and Battarbee describe co-experience as arising from experiences that are created together, or shared with others;

.... People find certain experiences worth sharing and lift them up to shared attention. Shared experiences allow a range of interpretations by others, from the expected and agreeable to the unusual or even deviant. For example, one
may reciprocate, reject or ignore an experience. Therefore, expressing meaning is invited by, and the meanings are elaborated in, co-experience through social interaction. (Forlizzi and Battarbee, 2004)

2.5.1.1 Influences on Experience

Experience can be examined in terms of the various influences that are brought to bear on a particular user-product interaction. The diagram shown in Figure 3 illustrates the components of an interactive experience and the factors that surround it. The ‘user’ brings the products of all their prior experiences to their interaction, all their emotional predispositions, values and perceptual and cognitive modalities (i.e. primarily visual, kinaesthetic, learns by doing, etc). Products influence experience by the kinds of interactions they afford by virtue of their features, aesthetic qualities and accessibility. All interactions take place in a context of use, which is shaped by broader social, cultural and organizational behaviour factors. How a product is experienced is then influenced by its context of use. Forlizzi notes that ‘as designers trying to craft an experience, we can only design situations, or levers that people can interact with, rather than neatly predicted outcomes ...a product offers a story of use that invites engagement’ (Forlizzi and Ford, 2000).

Figure 3 Diagram after Forlizzi and Ford (2000, p. 420), showing influences on experience, as they relate to product-user interactions, all of which work together to create a specific ‘story of use’.
This concept of *stories of use* relates closely to J.J. Gibson's widely acknowledged notion of *affordances* as used in his theory of direct perception (Overbeeke and Wensveen, 2003). Gibson contends that the world affords actions to organisms on the scale of that organism, unfolding itself to the organism as a set of possible interactions or *action possibilities*. The world appears to us as meaningful because we perceive action possibilities — what Gibson termed *affordances*. In this view, meaning is not something inferred through reasoning by an inner subject gazing out onto an external reality. Instead, meaning exists in the process of our being in and relating with the world (Overbeeke and Wensveen, 2003), a concept that was developed in Western philosophy by the phenomenologist Alfred Schutz (Dourish, 2001).

The term *affordance* in an experience-centred design context refers not only to the physical availability of a given product (i.e. the door knob supports manipulation by its size and shape in relation to the average human hand) but also to the user's abilities and inclinations, and to the *context of use*. The concept of affordances is in this sense far-reaching; embracing emotional, cognitive and social-contextual factors as well as physical sensori-motor abilities. Forlizzi's notion of *story-of-use* refers to the way in which a designed product invites certain possibilities of user engagement but, importantly, also acknowledges that users create their own *stories-of-use* according to their personal experiences and the context of use, which can be subject to variables beyond the designer's control.

### 2.5.1.2 Qualities of User Experience in Interaction

Forlizzi and Battarbee's (2004) framework identifies three forms of interaction taking place between users and interactive products:

- *Fluent* describes interactions that are performed without needing to consciously think about them, such as riding a bicycle or taking a shower. These types of interaction do not compete for our attention, but instead allow us to focus on the consequences of our activities or other matters altogether;

- *Cognitive* refers to interactions that require us to consciously think-through a problem, such as understanding how to use a remote control device for a piece of electronic equipment; and

- *Expressive* interactions involve the personalization of an experience into a subjective *story-of-use*. One person can relay the salient aspects of a story to another, turning the experience into a personal story of use. *Expressive* interactions enable the user to develop a more personal relationship with the product, and may involve personalizing the product to create a better fit
between product and person. In a biofeedback interaction, this can encompass
the process of identification i.e. that’s my breathing making the shapes move
and could also be extended to enable the user to select how certain goal states
and behavioural axis are represented, i.e. warm or cool colours for calm
feelings, etc.

2.5.1.3 The Dynamics of user experience in interaction

The diagram presented in Figure 4 shows Forlizzi and Batarbee’s (2004) model of
experience in interaction, illustrating the various pathways between different
dimensions of experience in interaction. This model provides researchers with an
understanding of the different kinds of experience at work in particular aspects of the
interactions they are facilitating, how they can be developed further, and areas that
may require special attention:

- Interactions can migrate from being cognitive to fluent experiences, as is
  usually the case with highly repetitive technical operations like tying
  shoelaces, making a bed or reading – becoming more automatic the more they
  are practised. A cognitive to sub-conscious shift usually indicates that the
  interactive interface is easily learnt and effortlessly used.

- Experiences that move from fluent to cognitive usually indicate that the user
  has encountered something unexpected and has been forced to re-think their
  interactions with the product. There may be an aspect of the experience that
doesn’t match the user’s mental state or expectations. A shift from sub-
conscious to cognitive can also indicate the development of new knowledge,
and a shift in the way a user habitually responds to some aspect of their
interaction. A fluent to cognitive shift can arise when a user is forced to
reconsider certain perceptions, beliefs or attitudes as a result of their
experience. A product can provoke users to reconsider their preconceptions
about what certain technologies can or should do, or their attitude to wider
social relationships.

- A fluent experience can migrate to an expressive state, as the user reflects on
  their experience, it becomes schematised and layered with other associations
  and levels of meaning, and is then communicated to someone else or used to
  inform the user’s customizing of the product’s appearance or performance.

- A narrative experience can shift to an expressive experience, as a formalized
  experience becomes personalized through the process of describing that
experience to someone else: what the user discovered, how it felt, the context of use, and the people they experienced it with.

2.5.2 Applications for Biofeedback Artworks

The following examples demonstrate how Forlizzi's framework can help us understand the interactive experiences involved in a biofeedback-based art experience, grounded in the experience of the participant (user). Each component of the framework enables the designer to focus on certain details of the experience:

- **Fluent** interactions refer to the participant's ability to interact with the artwork's interface in an effortless and engaging way, but also describe the sub-conscious psychophysiological processes monitored during biofeedback training.

- **Cognition** refers to the participant's process of learning how the work responds to their body processes. It involves an ongoing process of experimentation, prediction and verification, such as learning how sensors respond to body movements and then learning to influence data displays through conscious changes in psychophysiological organization.

- **Expressive** experiences mark the points at which the user's experience becomes described/inscribed as their own (i.e. 'my experience'). This process includes the moments of self-identification (i.e. 'that's me doing that'; and playful experimentation (i.e. 'I can make the display change its shape ...I changed the shape of the display'). As already suggested, expressive experiences in biofeedback interaction can involve situations in which the participant becomes involved in the process of customizing the appearance and sound of biofeedback signals.

Transitions from one category of experience to another describe crucial moments in the interaction that determine the extent of the participant's involvement with the work, and their experience of themselves within it. The following short examples show how significant these changes are in the development of meaningful and potentially transformative experiences:

- **Fluent to cognitive**: examining breath, heart rate and nervous system responses that are usually hidden beneath our conscious awareness, through the biofeedback signals. Transforming habitual/subconscious responses into a process of experimentation, prediction and observation. Reframing bodily
interactions with technology, away from their usual medical, pathological and sports contexts of use, into an art gallery/museum setting and thinking about the body as a source of aesthetic pleasure and intrigue.

- **Cognitive to fluent**: knowing how to use/play the biofeedback signals/body functions, and knowing how it will respond to certain behaviours.

- Fluent to expressive: usually subconscious processes are transformed into expressive gestures i.e. ‘this is me ...holding my breath ...making my heartbeat faster, I made that pattern by thinking/feeling/breathing like this....’

- **Expressive to fluent**: playful and expressive explorations and identifications facilitate a more intuitive familiarity with the behaviours being monitored.

- **Expressive to cognitive**: playful and expressive explorations and identifications also facilitate reflections on the broader implications of this experience i.e. ‘how do I feel about the experience I am having in this artwork, how does it relate to other experiences I have had, what does it tell me about connections between my emotional and physical state?’.

- Each of the above transitions can then become the basis for *co-experiential* experiences, in which participants and observers discuss their response to the work and the range of experiences that arose during their time with it.
2.6 ‘Transforming Mirrors’ in Interactive Art

Whilst all art experiences could be described as interactive or participatory to some extent, participatory and interactive art experiences locate their audiences within the unfolding of the work’s physical appearance by virtue of the fact that any form of attention is fundamentally active and participatory. Simon Penny (2004) has argued that the emergence of interactive arts practices from the 1960’s onwards mark the beginning of an entirely new kind of aesthetic experience, one based on an aesthetics of behaving computational systems. For Penny, traditional visual arts criticism has only a limited relevance since it is primarily concerned with the evaluation of static experiences and propositions.

With the advent of interactive computer-based artworks, interaction itself the medium for articulating the artists concerns: the specific qualities of engagement and responsiveness that a given work provides its audience begins to emerge as an integral part of the art experience. Interactive artworks respond to their audiences in ways that reflect back to their participants some aspect of their presence, transformed through the prism of the artist’s design. In his essay *The Construction of Experience: Interface as Content* David Rokeby (Rokeby, 1998), underlines the deeper phenomenological and ontological questions at the heart of all interactive-computational systems where he states that:

*By defining a way of sensing and a way of acting in an interactive system, the interface defines the experience of being for that system. Through their design of the interface, the creators have in large part defined the user’s quality of life while they are interacting with the system. Unfortunately, the design parameters for quality of life are pretty undefined. There seems to be no agreement on what makes for a high quality of life. I suspect it’s dependent on a whole range of parameters that we rarely pay attention to. In order to better understand what those parameters are, we need to look at how our experience of the real world is constructed. In other words, what is our user interface for reality? What is the nature of our relationship with the world?*

Interactive works thus become a way for both artists and audiences to work through the various experiential and relational implications that a computational system can display to its participants. The responsive and/or dialogical elements of the work generate an experience of the self, revealed through the exploration of a series of actions and their consequences. Rokeby describes works that engage participants in these kinds of reflections as ‘Transforming Mirrors’. Citing the responsive video installations of Myron Kruger’s *Video Place*, Ed Tannenbaum’s *Recollections* and The Very Vivid Group’s *Mandala*, Rokeby discusses the mirror-like interactions these works invite and the crucial role of the artwork in transforming this interaction from
simple self-absorption, to a form of dialogue in relation to the work’s transformational focus. Interface design, for Rokeby (1995) is a deeply philosophical undertaking, providing artists and designers with a platform for evolving and critiquing the quality and impact of our technologically mediated identities and actions in the world:

> Interactive systems invariably involve feedback loops. The limited representation of the user is inevitably reflected back to the user, modifying their own sense of self within the simulation. The interface becomes a distorting mirror, like those fun-house mirrors which make you look fat, skinny or a bizarre combination of the two. A standard GUI [graphic user interface] ... is a mirror that reflects back a severely misshapen human being with large hands, huge forefinger, one immense eye and moderate sized ears. The rest of the body is simply the location of backaches, neck strain, and repetitive stress injuries. It’s generally agreed that the representation of women or visible minorities in magazine and television advertisements affects their self-image. If we accept this, then we must also accept that interface-brokered representations can exert a similar, though more intimate, effect on the reflected computer user. (Rokeby, 1998)

This idea, that the terms of engagement described by technological interfaces constitute a form of embodiment and self-representation within that system, has clear affinities with the methodologies of somatic bodywork. Considered in this sense, biofeedback artworks could be considered as a potential corrective to the distorted self-images reflected back to us through the limiting interfaces and institutions of contemporary industrialised culture, providing an opportunity to momentarily recover and re-embody what has become lost to us by the force of our daily habits and interactions. The ‘global’ instrumentalism of Dewey’s pragmatist aesthetics, and Shusterman’s somaesthetic framework reminds us that aesthetic intrigue and enjoyment should be understood as fundamental to such processes. This claim for the importance of the aesthetic and somaesthetic experience in human-computer interactions is supported by a growing body of research papers and conferences exploring these themes in Interactive Design and HCI research (Bertelsen and Pold, 2004, Fels, 2000, Fiore et al., 2005, Hansen, 2005, Kallio, 2003, Moen, 2005, Overbeeke and Wensveen, 2003, Petersen et al., 2004, Throop, 2003).
2.7 Summary: Conceptual framework

This chapter has proposed a conceptual and critical framework for developing and evaluating interactive art experiences using biofeedback interaction as a context for aesthetic experience and critical self-representation. Drawing on the methodologies of clinical biofeedback and somatic bodywork, this chapter has outlined an understanding of the body as a locus of aesthetic pleasures and understandings, extending beyond art’s traditional modalities of sight and hearing, to proprioceptive and interoceptive modes of engagement and orientation. A crucial understanding shared by both somatic bodywork and biofeedback training is that the client/participant is not an object to be operated upon like some inert lump of meat, but is an intelligent subjectivity engaged in a process of self-discovery and sensori-motor learning through the skilful facilitation of the therapist/trainer. These interventions, whether in the form of direct person-to-person contact or in conjunction with audio-visual feedback systems, are designed to help the subject differentiate and expand on aspects of their own psychophysiological organization in order to introduce the possibility of new or recovered patterns of action and response.

John Dewey’s pragmatist aesthetics provide a framework for understanding art and aesthetic experience as an inherently instrumental activity. Aesthetic experiences organize our perceptions through a blend of sensations, abstract representations and propositions, enabling us to experience the world and our being in it as more meaningful and satisfying. This notion of aesthetic experience as a momentary patterning of the participants perceptual field, closely matches the processes by which the somatic bodyworker facilitates new experiences of self and sensori-motor organization in their clients. The world appears to us as meaningful because perceptual abilities cultivated through aesthetic experience and somatic bodywork create new possibilities for action, revealing new or forgotten experiences of being and moving in the world. Jodi Forlizzi’s experience-centred approach extends this centrality of experience and action to the design of interactive systems and artefacts, providing a practical framework for observing the process by which people’s interactions with designed products can foster new possibilities of action and understanding. Experience in interaction unfolds through alternating qualities in experience and interaction. By weaving through these different modes of interaction and experience, users bestow meaning on situations, creating life stories and stories of use relating to the designed experience that influence and are influenced by the presence of others through social interactions.

David Rokeby’s notion of the interactive artwork as a ‘transforming mirror’ provides a metaphor for integrating these intensely experience-centred approaches into the context of an interactive arts practice. The structure of the work and its modes of engagement constitute a set of physical and perceptual affordances through which new
Chapter 2 Conceptual Framework

experiences of self, situation and meaning can evolve. Physical interfaces require specific forms of bodily engagement, focussing our experience of ourselves towards those aspects of our being directly engaged by the work. In this way, interfaces become a way of imagining who and how we can be.

Richard Shusterman’s somaesthetic framework calls for a comprehensive re-evaluation of the role of the body in aesthetic experience and broader philosophies of living, combining a contemporary pragmatist sensibility with the deeply embodied methodologies of somatic bodywork. Beyond its obvious possibilities as an externally presentable object of power and desirability, somaesthetics promotes the body as subjectivity whose interactions in the world afford specific meanings and abilities. Somaesthetic methodologies aim to refine the quality and extent of the subject’s bodily inherence in the world. Considered from this perspective, biofeedback-centred art experiences can be understood as a form of experiential and conceptual provocation – facilitating the creation of ‘stories of use’ around the body and proprioceptive perceptions, and providing a point of entry into more detailed and rigorous forms of somatic engagement and cultivation. In contemporary art discourse, the relationship between art, therapy, health and science is still highly problematic and contestable. The spaces opened up by the collapse of certain contextual and methodological boundaries implied in Richard Shusterman’s somaesthetics presents a compelling space for the development of genuinely new cultural practices and practice-based research.

As computer technologies become more ubiquitous, slowly blending into our homes and every day recreational pursuits, and as creativity and aesthetic experiences become sought-after attributes in our increasingly experience-centred economy, traditional boundaries between art, design and engineering seem increasingly hard to maintain. Like many other artists and critics involved in interactive-art, Simon Penny has argued that HCI-based approaches to interactive-arts practice cannot adequately serve the highly subjective and allegedly non-instrumental interests of interactive artists and curators on the grounds that these approaches are essentially utilitarian, in contrast to art which he asserts to be non-utilitarian (Penny, 2004). Jodi Forlizzi’s experience-centred model of audience experience in interaction negates these arguments through its intentionally broad conception of experience-focused products that easily encompasses non-work related products and services, with a strong emphasis on co-experience, subjectivity and meaning.

Art experiences, as we have seen in our examination of Dewey’s pragmatist aesthetics and Richard Shusterman’s somaesthetics, can serve a variety of functions, to the extent that we are prepared to accept that humans have a functional need for enjoyment, novelty, intrigue and meaningful encounters. That these qualities of experience are increasingly sought-after attributes in experience-centred design and HCI research indicates something of the changing cultural and socio-economic landscape we are entering into.
Chapter 3  Context & Precedents

This chapter outlines a number of approaches artists have taken in the development of participation experiences that engage similar processes of perception and bodily experience to those that form the basis of the artworks documented in Chapter 5. It does so with the aim of providing an overview of the field, and a context for evaluating these individual artworks. The four approaches explored here are:

- **Dialogical** practices in which artists interact personally with visitors to their exhibitions, reframing the audience’s experience of the work as an intensely social form of exchange, as exemplified by the practices of Rirkrit Tiravanija and Lee Ming-Wei;

- **Sensorial interventions** that work directly with human perceptual systems, such as touch, vision and personal space, as exemplified by the practices of Lygia Clark and James Turrell;

- **Interactive** artworks exploring mirror-like transformations of participant’s actions and choices, as exemplified by the works of artists such as Myron Kruger, Sydney Fells, John Tonkin and Seiko Mikami; and

- **Physiologically responsive** artworks designed to amplify or respond to aspects of participant physiology such as heartbeats, brainwaves and breathing, as developed by artists such as David Rosenboom, Char Davies, Mariko Mori, Thecla Shiphorst and Christa Sommerer and Laurent Mignonneau.

Whilst psychophysiological and somatic explorations play a vital role in the artworks documented in this exegesis, their intended context is for presentation within contemporary art gallery or museum spaces. The behavioural codes associated with these venues, whilst not without limitations, lend themselves to a more intimate,
spontaneous, sustained and open-ended form of engagement and dialogue, unbound by the strict timelines of traditional performing-arts. Some aspects of the work will take on particular significance or perhaps seem unusual (art as experience, participatory practices, body awareness techniques) that would otherwise be taken for granted in other art forms such as dance, music or community art and cultural development projects.

The central theme of this chapter is observer participation. The image of the active and deeply situated subject-participant engaged in a continual process of orientation and exchange, recurs throughout each of the practices explored here and continues through the development of the conceptual framework, before being analysed in relation to the various experiences and understandings they have afforded in Chapter 7. The observer participation model implies an engagement with new ways of thinking about and practicing the traditional mind-body problem in Western secular culture and its related dualistic separations of observer/observed, art/life, reason/emotion, subject/object. Each of the artworks introduced in this chapter affirm the active and constitutive role of participating audiences in the production of meanings, values and pleasures.
3.1 Participatory Art Practices

The artist Lee Mingwei invites visitors to his exhibition to write letters to long-lost loved ones and share these intimate disclosures with other exhibition visitors; James Turrell creates a fog-like undifferentiated colour field with neon tubing and an architectural void, momentarily suspending the ability to differentiate form from void; and Char Davies creates a ghost-like virtual environment that audiences navigate by adjusting the rate of their breathing. What unites these artists is the way in which their works unfold through the active participation of their audiences – the sharing of your secrets, the testing of your body's perceptual limits, unfolding landscapes with the rate of your breath.

This chapter describes some approaches to participatory practices developed without the use of interactive electronic technologies, as a way of highlighting some of the deeper ontological issues at the heart of this investigation into biofeedback interaction. Interactive and participatory arts practices have their historical roots in the Happenings and participatory art practices that flourished in the 1960's, which themselves were influenced by the Dada, Futurist and Surrealist movements of the 1920-40's. Other significant parallels include fairground thrill rides (roller coasters, merry-go-rounds and ghost trains), and Victorian era occultist and pseudo-scientific parlour games. In many instances these practices prefigure the development of much of the digitally mediated interactive art that emerged from the 1980’s onwards.

3.1.1 Participation and the 'Art/Life' Problem

The notion of participation in contemporary visual arts as a kind of intellectual transgression is intimately bound to the history of Western aesthetics, philosophy and scientific objectivism. It is embodied in the promotion of an allegedly detached, objective attitude, capable of unbiased, unattached and complete knowledge. Although largely discredited by deconstructive, post-structural and phenomenological theories of such writers as Roland Barthes (1977), Michel Foucault (1970), and Pierre Bourdieu (1984), to whom communication and knowledge itself were considered as intensely situated social processes through which power and authority are distributed – the belief in the idea that art experiences can be measured and assessed according to universal criteria of aesthetic distance and disinterested observation continues to compel many fine-arts scholars to reject participatory and interactive practices as inherently compromised and critically flawed. In his account of the history of virtual and illusory art environments in 20th century art and culture, Oliver Grau epitomises this position in his concluding evaluation of interactive and immersive art practice:
As the interfaces seem to dissolve and achieve more natural and intuitive designs so that the illusionary symbiosis of observer and work progresses, the more psychological detachment, the distance from the work vanishes. Without it, a work cannot be perceived as an autonomous aesthetic object. Inside the Omnipresence of virtuality, any mechanism of knowledge acquisition will be affected and influenced. In virtual environments, a fragile, core element of art comes under threat: the observer’s act of distancing that is a prerequisite for any critical distancing: this is an integral part of the civilizational process. As Adorno expressed it: distance is the primary condition for getting close to the content of a work. It is implicit in the Kantian notion of disinterestedness, which demands of the aesthetic stance that it should not seek to grasp the object... Distance is a phenomenon of works of art that transcend their mere existence; their absolute proximity would mean their absolute integration. (Grau, 2003b)

In contrast to these arguments, a number of Modernist and Post-modernist approaches have sought to reformulate the (European Enlightenment) dualisms of the observed and the observer, mind and body, and art and life. In the visual arts, the most radical attack on this concept of the autonomous art object and its disinterested observer developed through the avant-garde’s desire for the transformation of everyday life through aesthetic intervention. From the Dadaist, Futurist and Surrealist performances and found objects of the early twentieth century, to Alan Kaprow’s early Happenings and the various Action and Performance works of the 60’s and 70’s, artists and critics negotiated a range of approaches that for some artists and writers culminated in the eventual dissolution of the art/life problem altogether (Larson, 2004).

Marcel Duchamp is widely credited as being pivotal in this transition from object to experience, but his theories of how artworks function in contemporary practice are widely misunderstood. Contrary to the popular notion that contemporary art is anything an artist nominates as an artwork, Duchamp’s practice, initiated with his infamous ready-mades, was designed to shift emphasis away from the artistic product to the process of its reception and interpretation as an art experience (Baas, 2004).

The sensibilities emerging from this transition from autonomous art-objects to relational systems find articulation in numerous practices that engage audiences in intimate and occasionally transgressive interpersonal exchanges, through devices such as sensory disorientation, the sharing of food and shelter, the collection of personal histories and testimonies, or physical immobilisation.
3.1.2 Dialogical Practices

In *Negotiating Meaning: The dialogic imagination* Eduardo Kac (1999) traces the emergence of dialogical practices in contemporary art and culture from the 1930’s from the two-way radio broadcast of Bertold Brecht’s *Lindbergh’s Flight*, to contemporary interactive electronic artworks that depend on physical and imaginative interactions from the audience, rather than existing as independent entities. Kac uses the notion of dialogue to promote interactions between artwork and audience that extend beyond the conventionally uni-directional (monological) flow of information from artist-author to receptive audience. Kac links these practices to the dialogic philosophies of Martin Buber and Mikhail Bakhtin, highlighting the transformational agendas at the heart of these approaches and the challenges these ideas present for the electronic arts in particular:

*The political dimension of dialogism is intrinsically connected to its aesthetic potential. Buber states that the spirit is not in individuals but between them. For Bakhtin the aesthetic event implies the dialogic interaction of two distinct consciousnesses. ...Rather than reiterating what we already know about point, line, and plane, electronic art can be an art of promoting contact between apparently disparate elements, expanding our awareness by revealing that what may seem distant in fact plays a direct role in our local experience. Nam June Paik once pointed out Jules Henri Poincaré’s insight that in his time we were witnessing, not new things, but new relationships between what was already there. It is important for art to foster the cognisance that it ought to bring in dialogic contact entities that may not seem connected. Electronic art ought to become less clean and enable the coming together of antithetical ideas, public and private places, artificial and natural forces, organic and inorganic matter, intellect and emotion. This might imply that electronic art cannot be exclusively digital. Technology does not exist in a vacuum, and the world, with its smooth and rough surfaces, is analogue. (Kac, 2005)*

On a purely pragmatic level, dialogical processes of one sort or another are intrinsic to the varieties of interaction documented in this exegesis. These works aim to facilitate processes of differentiation between various forms of subjectivity and their associated cardio-respiratory response patterns. The unfamiliar details of these processes to the majority of visitors necessitates a process of careful negotiation i.e. *do they feel confident in their ability to explore the work, or do they require some assistance in finding their way through the interface?* Some participants may have such a limited amount of movement in their breath as to require some assistance in learning to
articulate new movement patterns (i.e. subtle breath-related movements across their ribs and abdomen, or less anxious or effortful forms of interaction). Such processes of negotiation and exploration unfold through direct observation and conversation between individual participants and myself as the experience facilitator and operator. During the course of their interaction with the work, participants often engage in spontaneous disclosures of previous experiences and speculations, as an informal way of making sense of their experience of the work. These conversations become integral to the experience of the work as a whole, establishing a space for being and reflecting in ways that extend an understanding of body, self and social interaction. The quality of engagement with each participant thus becomes an important component of the interaction as a whole.

The dialogue-centred practices of artists such as Lee Mingwei and Rirkrit Tiravanija explore the richness of personal experience and exchange in a way that has helped affirm the value of dialogue and personal exchange, an aspect that has emerged as a significant component of the works documented in this exegesis. In both of these artists’ works, the gallery becomes a site for initiating often very personal discussions between the artist and visiting participants. Relationships and understandings formed through the sharing of stories, food and company as exemplified in the work of Lee Mingwei and Rirkrit Tiravanija reaffirm the significance of actual (as distinct from notional) inter-personal connections and exchanges in the evolution of our understandings, identities and practices – qualities of engagement often overlooked in our hyper-mediated and individualist society.

### 3.1.3 Rirkrit Tiravanija

Rirkrit Tiravanija creates events and artefacts based on a variety of activities ranging from the preparation and sharing of meals, to the provision of free yoga classes, massages and film presentations as the basis for his usually gallery-based exhibitions. Tiravanija’s practice builds on a rich tradition of artists presenting social events and personal exchanges as art experiences i.e. Allan Kaprow, Joseph Beuys, Helio Oiticica, etc., (Bishop, 2005). Like these earlier practices, his art events reframe everyday activities like cooking, eating, reading and resting in ways that highlight the sense of conviviality at the heart of such processes, with the resulting artefacts and residues of these events left on display as a form installation art. For Tiravanija these events serve as a form of provocation, inviting audiences to question the separation of everyday life process and relations from established notions of what is appropriate for consideration in an art gallery setting:

*I would like to redefine how one looks at the way art and the way life could be - and I could introduce other things into that relationship... you know, let’s say*
from other social and political situations that I am involved in. I would say I definitively am interested in blurring the line, in terms of how art is perceived, you know, in terms of how one approaches what is deemed to be art and the possibility of treating it in another way. (Barak, 1996)

Whilst often cited as an example of the relational aesthetic\(^7\) championed by curator and theorist Nicholas Bourriaud (Bourriaud, 1998) on closer examination Tiravanija’s installations (along with many other artists grouped under the Bourriard’s relational umbrella concept, such as Felix Gonzales-Torres and Gabriel Orozco) often appear more propositional and schematic than relational in the sense of an actual relationship developed between visitors, artwork and artist. In contrast to the intensely social and convivial qualities of his live events (massage halls, cooking classes, soup kitchens, etc.) many of his exhibited artefacts appear to provide few opportunities for audience engagement beyond the originating event (i.e. the cooking and serving of food, yoga classes, massages, film screenings). They invite the question: why present these artefacts at all, if they no longer embody or facilitate the specific relationships generated by the original event? Critics of Tiravanija’s gallery installations, frequently refer to the feeling of having arrived at the party too late (Cobb, 2002, Bishop, 2005); or of having intruded into some form of privileged student-clique (Siegel, 1999). Despite these misgivings, Tiravanija’s work continues to provide an important point of reference for my own work especially with regard to its development of conviviality and sharing as a focus for contemporary art discourse.

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3.1.4 Lee Mingwei

Compared to pared down austerity of Tiravanija’s social events and exhibitions, the actions and artefacts of artist Lee Mingwei provide a more inclusive and in-depth context for both participating and non-participating observers to enter into and reflect on the various themes explored by his practice such as birth in Male Pregnancy, death in 100 days with Lilly and The Letter Writing Project, and place in The Tourist Project (Lee, 2005). Through such works, his practice explores the ways in which experience and interaction can serve as catalysts for the development of greater awareness and understanding (Freid, 2000). Processes of disclosure are central to his works, highlighting in various ways our collective need to identify with other people within and across communities. In The Sleeping Project (Lee, 2005) the artist invites a participant, chosen by lottery each night, to bring objects normally found around their usual place of sleep (such as a book, clock or photo) and spend the night with the artist. The next morning, these objects are placed on the nightstand, together with a recording of the previous night’s conversations. Over the course of the exhibition, the accumulation of personal objects and recorded voices provide gallery visitors with clues about the artist’s anonymous overnight guests.

Figure 6 Installation views of The Letter Writing Project by Lee Mingwei (Lee, 2005)

Another project by Lee Mingwei, The Letter Writing Project invites gallery visitors to write the letters we’ve always meant to, but never taken time for (Lee, 2005). The installation consists of three three-sided booths, constructed of wood and translucent glass, each containing a desk and writing materials. Visitors are invited to enter one of the booths and write a letter to a deceased or otherwise absent loved one as a way of offering a message of thanks, forgiveness or apology. Upon completion of their letter, participants can then either seal and address their letter for posting by the gallery, or leave the envelope unsealed for other visitors to read (Lee, 2005). On his website account of this work Lee describes how, as these unsealed letters begin to accumulate over the course of the exhibitions, visitors begin to take increasing advantage of the space as place to share or unburden long held secrets and desires: ‘In
this way a chain of feelings is created, reminding visitors of the larger world of emotions in which we all participate’ (Lee, 2005).

Speaking in relation to the many letters received during The Letter Writing Project Judith Hoos-Fox (2000), curator of the Davis Museum, describes the intensity of some of the letters presented during the exhibition:

> It really seems that there is a need for this kind of work in our society, at a time when communication is everywhere, and yet it’s perhaps losing its meaning. E-mail can be sent instantaneously, but it’s not a contemplative kind of experience; it’s not a sensual kind of experience. The fact that we have so many people coming in and writing letters of a really deeply personal nature in this public setting really indicates that there’s a need for this kind of place in our society, which doesn’t exist, that people need a place to think, a quiet place, an opportunity to say things that they haven’t said. ... Mingwei, the artist, collects, keeps all the letters. He has thousands of them from when the piece has been shown in other places. And he was reading a batch of them each night, and just found that he couldn’t do that any longer. It was really hard - he’s not a trained psychologist. It was just too much of an emotional experience, and he just couldn’t.

What is significant about these projects are the specific relationships brought into play through each visitor’s participation in the work as individual story-givers and collectively as members of a witnessing public. Intensely relational works such as The Letter Writing Project provide audiences with permission to be with other people in ways that are seldom supported in contemporary social interactions. The design of such works needs to be evaluated in terms of the quality of relations supported by the experience as a whole: interaction design in this sense, extends beyond a concern for computational systems and hardware styling, towards an appreciation of the role of imaginative hosts and critical facilitators.
3.2 Sensorial Interventions

The processes of aesthetic experimentation, reflection and appreciation are intimately connected to the psychophysiological circumstances by which we experience the world and ourselves within it. We sense objects, spaces and events within and around us according to our various exteroceptive (externally focused) or interoceptive (internally focused) sensory systems; vision, hearing, taste, smell, temperature, pain, balance and proprioception. Artworks involving perceptual illusions and effects intervene with our innate sensorial predispositions and habitual perceptual responses, drawing our attention to the constitutive role of our senses in the formation of our experience. Perceptual illusions have been used throughout history and across cultures to invoke the extraordinary, magical and numinous to create sensations that resist being resolved into stable understandings, highlighting the intrinsic limitations of our perceptual systems, and by inference, notions of what may lie beyond.

James Turrell and Lygia Clark are two artists whose practices have engaged extensively and consistently with the stuff of human perception, and the poetics of subjectivity as psychophysically embodied phenomena. Both artists’ works serve as cornerstones for my own investigations. They highlight the formative role of the body in our experience of the world, using strikingly simple and direct means to connect us back to pre-linguistic modes of being. Of special significance to my own practice is the fact that both artists eschew representational or symbolic imagery and texts in their works, as means to concentrate our attention on the thing-ness of our own perceptual and subjective behaviour. The artwork in such perceptually focused practices becomes an instrument for the formation of our own poetic insights and self-discoveries. Perception is rendered simultaneously as both an active process of orientation within the world (Gibson, 1966) and more significantly, an object for poetic appreciation and contemplation regarding the nature of our being in the world.

3.2.1 James Turrell

Since the early 1970’s American artist James Turrell has developed a unique body of installation works using light, space and the idiosyncrasies of human visual perception to create installations that suspend our normal categories of visual experience – appearing to observers as being somewhere between or beyond an object and a void. The majority of his work has been developed around the use of the Ganzfeld effect. The Ganzfeld effect occurs naturally in situations like snow storms (white out), thick fog, and conditions of total darkness, where our field of vision is uninterrupted by any information (visible contours, changes in texture, light reflections, edges) that would otherwise help us to construct a coherent three dimensional interpretation. Turrell’s work is especially relevant to the works documented in this exegesis because he is one
of very few artists to work so directly and successfully with the functioning and poetics of sensation and perception. Turrell’s works substitute visual representation and textual proposition with direct personal experience and sensation:

*First, I am dealing with no object. Perception is the object. Secondly, I am dealing with no image, because I want to avoid associative, symbolic thought. Thirdly, I am dealing with no focus or particular place to look. With no object, no image and no focus, what are you looking at? (Turrell, 1993)*

Through the design of the work and his discussion of it in various publications, exhibition and promotional materials, Turrell maintains a careful balance between the scientific, aesthetic and poetic aspects of the work. The intensity and singularity of the experience resist easy assignment as a purely aesthetic or decorative effect – the works create their own terms and conditions of engagement. An experience of his work is never reducible to that of a scientific demonstration or decorative interior. The means of their technical production (plaster, neon bulbs, electricity, fibreglass) are deliberately de-emphasised. Interpretive materials (catalogues, wall plaques) avoid detailed scientific explanations of the effects used.

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*Other prominent artists exploring experiences of the limits of perception and its relationship to subjectivity include Olafur Eliasson, Carsten Holler (Bishop, 2005)*
3.2.1.1 Spiritual References in Perception-based Works

Visitors and critics of Turrell’s installations often speak of his work’s spiritual presence. The spatial ambiguities created by Turrell’s perceptually focused experiences produce an intense sense of otherworldliness. Our perceived presence within such situations gives rise to an equally transformed, otherworldly experience of self and it’s sense of being in the world, invoking the mysterious edges of our own personal journey between birth and death at the thresholds of perceptual becoming and unbecoming. While light and luminosity have long been associated with mystical or transcendent experiences, the intensely suggestive power of Turrell’s perceptual works resides more in the way it alters our perception of space and our sense of self-location within it. Turrell himself has commented on this response, suggesting that such questions of spirituality:

\[g\]et mixed up with how we’ve looked beyond ourselves through organized religion. ...A spiritual presence isn’t something that you put into your work, but art is something special because art is human beings trying to do something special for other human beings that is super special.

(Adcock, 1990)

Whilst a detailed explication of the subject of spirituality, art and the phenomenology of perception is beyond the scope of this exegesis, the relationship between what we experience as spiritual and these moments of self-conscious ontological formation or unbecoming does help account for the intensity of experience reported by many audiences engaging with perceptually focused works such as Turrell’s. Such a relationship might also account for the strong connection that exists between body-mind cultivation methods and experiences of spiritual insight and change, as reported by students of practices such as yoga, tai-chi, massage, cranio-sacral therapy, somatic bodywork (Hanlon-Johnson, 1995c). That many people demonstrate a need to frame their experience of these experiences in terms of the spiritual becomes an important issue for consideration and requires much care in the promotion of such events, lest the unfixed and becoming nature of such experiences becomes fixed into rigidly pre-conceived iconographies and spiritual dogmas devoid of their original transformative power and essential mystery.

3.2.1.2 Art, Technology and Perception

Turrell’s approach has special relevance to my work with bodily-focussed experiences. In the following excerpt from James Turrell: The art of light and space (1990) Craig Adcock summarises the development of Turrell’s perceptually focused aesthetic and his sophisticated experience-centred approach in the use of technology in his works, and
raises a number of issues that have a direct bearing on the works presented in this exegesis:

_In his works since the Art and Technology program, Turrell has increasingly de-emphasised hardware although he continues to pursue similar perceptual goals. In his early work such as the 'Flame Pieces', the 'Projection Pieces', and the experimental Ganzfeld hemispheres designed at Garrett Aerospace, there was considerable hardware left in the system. In later works such as the 'Space Division Pieces', the hardware is reduced to just a few standard light bulbs. Perceptually, the reduction is even more basic: viewers are not directly aware that the light hanging inside the sensing spaces of works like ‘Cumo’, ‘Iltar’, or ‘Laar’ is coming from the light fixtures in the viewing room_

_[James Turrell]: ‘... the first attempts were more deus ex machina. I had to sort of hammer it out more, so that it had to have more devices. It was more done with mirrors, as it were. I paid more attention to the source and how the light came out of it, and less to what it did once it went into the space. So I formed it very crisply and succinctly. And then frankly I got a little better at it or understood it a little better and was interested not only in where the light was, but where it wasn’t.’ (Adcock, 1990)_

The image that Turrell describes here, of the light-bulb (technology), its emanation (the focus of our enquiry) and its observer (the audience), highlights an important design issue faced by many electronic media artists. In works such as Cardiomorphologies (refer to Chapter 5 that seek to direct the observer’s attention inwards toward their own perceptual processes, attention needs to be directed primarily towards the place at which the work takes effect: the intersection between the audio-visual field, the participant’s sensory-perceptual processes, and in the case of the works presented in this exegesis, their moment-to-moment psychophysiological orientation. Where Turrell investigates the experience of ‘looking at yourself looking’, the works presented in this exegesis have sought to explore the experience of feeling yourself feeling.
3.2.2 Lygia Clark

In stark contrast to the numinous and ethereal qualities of Turrell’s light and space works are the raw, low-tech wearable objects and events developed by Brazilian artist Lygia Clark during the 1960’s, 70’s and 80’s. Clark’s works link the analytical and reductive aesthetics of European constructivism to the oral traditions and ritualistic practices of Brazil’s Afro-Indigenous vernacular culture (Osthoff, 1997). Through processes of sensorial isolation, de-familiarisation and social transgression, Clark’s works draw participants into intensely personal experiences that intervene in and transform our experience of body-image, proximity and vision, in ways that resonate strongly with my own investigations into bodily representation, participation and perception. The intensely intimate nature of these interactive experiences (involving actual bodily envelopment, connection and constraint), dissolves the participant’s visual sense into an awareness of the body, redirecting the experience of the body from that of a third-person, body-as-object perspective, to a first-person, somatic perspective of the body as a lived and personally directed experience.

In her Nostalgia for the Body series of sensorial sculptures from the late 1960’s, Clark developed a series of instruments based on gloves, hoods, cloaks, suits and goggles, that encased the participant’s body, transforming their sensory impressions in novel and disorienting ways. In Máscara-Abismo (Abyss Mask) of 1968, participants were blindfolded and enshrouded in an assemblage of clear plastic airbags weighted down by stones hanging from bags made of net, producing ‘real and imaginary sensations that aimed at connecting the body’s inside and outside spaces’ (Osthoff, 1997). Clark’s Dialogue (1968), consists of a pair of mechanically conjoined goggles that restrict the visual field of the two participants to an eye-to-eye exchange with one another, combining visual disorientation with the unavoidable processes of interpersonal negotiation and playfulness inherent in this kind of intimate exchange.
Baba Antropofágica of 1973 (Figure 8) pushes the experience of bodily presence to the limits of social acceptability: participants unwind spools of red thread out of their mouths onto another participant who is laid out on the floor. The body of the latter was gradually buried under the mottled web of regurgitated thread. Clark has remarked that this exchange was not pleasurable and that it was about the vomiting of lived experience, which was then swallowed by others (Osthoff, 1997).

3.2.2.1 Art, Transformation and Healing: A shamanic aesthetic?

Where many artists working directly with sensations of immersion and altered subjectivities invoke a skyward trajectory of transcendence and ethereality, Clark's work suggests a profoundly organic and earthly location, infused with instinctual emotional forces that would eventually lead to her involvement in extra-artistic healing rituals related to indigenous shamanic and faith-healing traditions of her Brazilian homeland. Clark's inter-personal and body-centred aesthetic provides a valuable precedent for this exegesis, articulating an unexpected continuity from the reductive rigour of constructivist and minimal sculptural aesthetics, to the intensely embodied and highly personal processes of self-discovery and healing implicit in the practice of biofeedback interaction.

The transgressive and at times abject flavour of these body-centred experiences led Clark into an exploration of healing processes and the development of what she termed relational objects, devised for the purpose of emotional healing. Between 1976 and 1982, Clark treated many individuals with psychological problems ranging from profound psychosis to mild neurosis, despite having no regular psychiatric training or qualifications (Brett, 1998). Clark held that the sensations caused by the relational objects as she used them on the patient's body, stimulated connections among the subject's senses and awakened the body's memory, helping to restore emotional balance (Osthoff, 1997).

Given her commitment to the power of sensorial stimulation and her expanded concept of the art experience as a process of self-discovery, experimentation and invention, this contextual extension from art to healing seemed inevitable, but also ethically problematic in terms of accountability to her patients. Art has long been acknowledged for its transformative and therapeutic properties, and the role of the artist in this context has often been likened to that of the shaman in hunter-gatherer societies, but such comparisons should not be entered into lightly. Hunter-gatherer societies provide an established and enduring framework for shamanic healing and transformation in ways that contemporary secular societies do not. Shamanic traditions are developed over generations of careful practice and observation, applying an in-depth practical understanding of the body and its surrounding ecology. Contemporary
society on the other hand, offers few equivalent traditions or support structures for artists engaging practically with mental and physical disturbances, beyond the relatively recent introduction of arts therapies into various health-care institutions. The ecological dimensions of traditional shamanic practice provide a further provocation for contemporary art practices. Individual transformative experience is placed within a more deeply situated social and ecological concept of place, identity and being, extending from our own physiology to our surrounding ecology, via the organisms we consume and cohabitate with.

Clark’s investigations into the transgressive and therapeutic dimensions of bodily experience and interaction present a compelling starting point towards the development of a more holistic approach to cultural practice that transcends existing institutional frameworks in an attempt to reconcile individual subjectivity with its physiological, social, and ecological situation.

Figure 9 Lygia Clark, therapeutic interventions using *Relational Objects* (Borja-Villel, 1998).
3.3 Interactive Art as Mediated Reflection

David Rokeby’s model of the interactive artwork as transforming mirror (introduced in Chapter 2.6) provides a powerful framework for understanding and appreciating interactive art experiences as critical practice. Each interface isolates a particular set of behavioural and relational abilities, drawing us into unusual, engaging and dynamic experiences of ourselves in the world. The exploratory and qualitative evaluations invoked during these often playful interactions can help foster critical sensitivity to the quality and range of ways of being and relating. Interactive video works like Sydney Fels, Kenji Mase and Dirk Reiners’ *Iamascope* (1997), Myron Kruger’s *Video Place* (1975) and John Tonkin’s *Personal Eugenics* provide very literal examples of the mirror metaphor described by Rokeby.

3.3.1 Fels, Mase and Reiners: *Iamascope*

*Iamascope* is an interactive video kaleidoscope developed by Sydney Fels, Kenji Mase and Dirk Reiners that generates complex abstract images based on the movements of participants before a statically positioned video camera (Fels, 2000). The speed of the participants’ movements also produces musical notes, creating a ‘musical’ accompaniment to the flow of kaleidoscopic images. The experience of interaction becomes a process of spatially reaching through – learning to anticipate and expressively play with one’s position before the video camera through the changing colours and geometries of the work. Fels describes four categories of relationship between *Iamascope* and its participants: ‘1) the person communicates with the object in a dialogue; 2) the person embodies the object; 3) the object communicates with the person; and 4) the object embodies the person’ (Fels, 2000).

Figure 10 *Iamascope* interactive video installation Sydney Fels, Kenji Mase and Dirk Reiners, showing an example of the kaleidoscopic imagery generated by camera footage of participants located before the projection screen (Fels, 2000).
Fels’ categories describe the dynamic nature of the interaction between artefact and participant that often unfolds through the following varieties of experience:

1) Call-response experimentation to establish the boundaries of the work using largest to smallest gestures as a way of mapping the space of the work;

2) The accomplishment of a sense of expressive control over the object, testing the ability of the work in order to approximate certain predetermined shapes or sounds;

3) Open-ended gestural experimentation without any specific goal; and

4) The attainment of a sense of kinaesthetic union with the artwork in which the dynamics of the artwork become internalised in the participant’s own kinaesthetic sense – the artwork seems to control the participant.

As a model of audience interaction, Fels’ four categories resonate strongly with Forlizzi and Battarbee’s model of experience in interaction (2004) described in Chapter 2.5 and accounts of audience interaction recorded by Muller in her study of audience experiences in Cardiomorphologies v. 2 described in Chapter 5.4.4.

3.3.2 John Tonkin: Elective Physiognomies

Video and movement based interactions like Iamascope and Myron Kruger’s Videoplance (1975) tend to invoke playful kinaesthetic explorations of form and spatial location. Whilst this in itself is an entirely worthy area of artistic pursuit, my own interest is in art’s capacity to engage audiences in more emotionally and cognitively intense forms of interaction and reflection that have the potential to spill over into broader life experiences and perceptions. A different example of Rokeby’s Transforming Mirrors model is developed in John Tonkin’s installation and web-based interactive work Elective Physiognomies, and its related works from his Meniscus series (Seah, 2000), in which audiences engage in playful but emotionally-loaded transformations and evaluations of their own facial features by adjusting various facial proportions. Using our innate tendency to project meaning onto facial gestures and configurations, Tonkin’s Meniscus series demonstrates how even relatively limited physical interactions can be used to produce highly personal and critical reflections in their participants. In Personal Eugenics, users capture an image of their face and digitally manipulate their facial features, using simple variations in facial proportioning to take on a new persona. A printout of their completed series of mutations is generated at the conclusion of their interaction which they are invited to pin up on the wall in the exhibition area. The process of interaction in these works is
limited to one of selectively breeding preferred facial patterns from a set of variations generated by his image-altering software.

In *Elective Physiognomies* (1997), another work from the *Meniscus* series, users rate a series of faces, all of which have been mutated from the same photo of the artist, according to a series of axes: ‘most trustworthy – least trustworthy’, ‘most introspective – least introspective’ and ‘most homosexual – least homosexual’. By isolating the participant’s interaction to the act of selection, Tonkin highlights the intensely personal and value-laden nature of self-representation, and our fixation on external appearances. Using the metaphor of selective breeding, audiences negotiate their own notions of desirability, abjection and unconscious racial profiling through the range of physiognomic associations arising from each mutation.

In works like *Personal Eugenics*, simple acts of choice and assignment become powerful tools for exploring the situated and inevitably biased nature of our own perceptions and choices, reflecting our own values and personal complicity within a range of complex cultural and psychological relationships. Using the body and the face in particular as a readymade expressive interface, Tonkin demonstrates that Rokeby’s ‘transforming mirror’ model of reflective interaction can be extended beyond real time video surveillance, and, given the appropriate interfaces (i.e. faces, body types) can be undertaken with the quite rudimentary interactive systems of a computer mouse and a few graphic slider objects. What matters in works like these is the choice of
representational interfaces, and a recognition and explication of the kinds of personal and cultural significances we as participants extract from them. Our actions become transformed and reflected back to us through the lens of the artist’s representational and analytical framework, as defined by the perceptual and psychological axes and categories through which our actions and reflections are directed.

3.3.3 **Transforming Mirrors and Biofeedback Interaction**

Rokeby’s concept of interactive art as a transforming mirror is especially relevant to the biofeedback-focused interactive artworks documented in this exegesis (*Cardiomorphologies* and to a lesser extent *Drawing Breath*), which function as mirrors through which participants observe, enact and reflect on aspects of their own psychophysiology. In clinical applications biofeedback training is often used to highlight the subject’s conscious involvement in their own mind-body orientation, emphasising bodily processes as continuous or closely related to personal emotional disposition and response patterns. Interaction becomes a way of situating the participant’s subjectivity and bodily experiences within each other as reciprocal phenomena. Bodily processes like breath and heart rate are never simply reflected back to the user unmediated (despite what some artists or scientists may claim), but transformed by the interactive strategies implicit in the design of the work and the terms of interaction proscribed by the artists and host institution: the specific behaviours examined, the behavioural axis to which the work has been designed to respond to (faster-slower, more variation-less variation, calm-excited etc.), and the associational qualities of the feedback signals used to describe them. Each aspect of the experience imbues the work with its own set of historical associations and behavioural cues, for example certain beep sounds invariably evoke the hospital EKG life-monitoring systems, recalling for some audiences experiences in intensive care hospital wards; data visualisations can evoke scientific three dimensional (x-y-z) time series graphs, new age and pre-modern mandala-like patterns or fluid biomorphic structures evoking futuristic exotic life forms; and the dress and demeanour of the staff facilitating the interactions can suggest a diversity of life situations, from medical examination, to psychological consultations, yoga class or nightclub chill-out space.

* In *Cardiomorphologies* these transformations are three-fold: 1) experiential transformation – reducing the participant’s focus to three of their most vital functions: heart, breath and subjectivity/thought; 2) synaesthetic transformation – translating the felt senses of breath movement, heart rhythm and mood into aural and visual sensations; and 3) analytical transformation – revealing and interpreting correlations and gradual transformations in physiology usually obscured by our moment-to-moment experience e.g. synchrony of breath and heart rate changes, and psychologically mediated changes in breath and heart rate.
Even in works without an explicit interactive element such as Justine Cooper's *Tulp* installation (Buckley, 2004), our experience of the body is inevitably mediated by the cultural and technological specifics of the interfaces and the protocols surrounding them. *Tulp* was presented at the Art Gallery of New South Wales as part of Elision Ensemble's *Tulp* music theatre project. During the installation (refer to Figure 12) Cooper recorded participants' experiences of hospitalisation while they observed real-time ultrasound images and sounds of blood moving through their veins and arteries with the assistance of a vascular ultrasound technician. In this instance bodily experience is channelled through our experience of hospitalisation (and maternity care in particular) via the proliferation of ultrasound equipment, furnishings, trained medical technicians, the medical uniforms worn by both artist and technician and the soliciting of personal histories. *Tulp* presents bodily experience through the prism of hospitalisation and medical imaging facilities, and her audience's experiences within these institutions and technologies. Far from simply presenting internal body movements and sounds 'as they are', the medium and means by which the work unfolds provide a predefined set of associations and behavioural codes that mark out the terrain to be explored.

Figure 12 *Tulp* installation by Justine Cooper. Left: a visitor generating sound through the ultrasound machine with the aid of a vascular technologist. Right: the booth installation on site at the Art Gallery of New South Wales.
3.4 Physiologically-responsive Artworks

Physiological sensing and recording technologies have facilitated an evolving practice of physiologically responsive art experiences. This section focuses on the ways in which these experiences have been developed since their introduction in the 1960’s to the present day, and explores some of the key approaches taken by artists in the development of these works as they relate to the works developed in this exegesis. Participatory designs have been integral to many of these physiologically responsive works, enabling audiences to experience aspects of their own physiology extended into the dynamic structure of the artwork/system. This chapter will focus predominantly on this participatory strand and will examine how these physiological sensing technologies have been developed as ways of representing and idealising the mind-body through direct participation.

The diversity of approaches taken by artists including the simple amplification acts presented by Alvin Lucier and Seiko Mikami, the consciousness-responsive (brainwave) works of David Rosenboom and Mariko Mori; the physiologically navigated virtual landscapes of Char Davis and Dianne Gromala; and the physiologically mediated social networks of Christa Sommerer and Laurent Mignoncunceau demonstrate the broad conceptual and experiential scope that physiologically responsive media provide. Its persistence as a genre of body art and interactive media over the past forty years attests to the enduring public fascination for these forms of amplified or extended bodily experience. Notions of control in physiologically responsive systems have been explored by many of these artists. Interactive systems based on the subject’s ability to influence the orientation of their own nervous system and metabolic processes present participants with a profoundly different notion of control than many are accustomed to – trying too hard or engaging in coercive modes of interaction (as might be the case in most computer gaming or gymnasium interactions) generally inhibits the subject’s ability to influence physiological (autonomic) system behaviours. As Edmonds et al (2004) have noted:

> [d]oing something to achieve a goal (track-pad, keyboard, screen, windows, etc.) and being something to have an effect (physiological indicators of affective states represented as output) alters the sense of the word ‘interaction’. When physiological input is used not to ‘control’ something directly, but to ‘affect’ it, the relationship between user and machine is altered in such a way that conventional doing models of interaction would seem in need of revision.

The allegorical implications of this notion of being, as a way of effecting, are not difficult to imagine and are widely prefigured in numerous Eastern and Western spiritual, philosophical and ecological traditions that emphasize (often paradoxical)
notions of selflessness, non-action and openness as a means of achieving a more harmonious way of being in the world. Given the increasing ubiquity of human-computer interactions in both work and home environments, this idea of being as a way of influencing assumes a renewed importance. The fast-paced button-pressing modes of interaction required by many popular computer games and work environments can tend to discourage detailed observations, sustained reflections and cooperative behaviours. Biofeedback interactions on the other hand promote more careful and nurturing orientations: subjects learn to influence the behaviours being monitored by more global forms of self-orientation and feeling, as opposed to conventional notions of highly directed muscular and mental exertion. This process of orientation can involve the use of sustained mental and emotional images and/or scenarios to invoke the required physiological behaviours, and develops through a process of sustained observation, reflection and cross-correlation.
3.4.1 Amplified Bodies

Bio-amplification and magnification technologies have been used by many contemporary artists including Alvin Lucier (1976), the Musica Electronica Viva ensemble (Teitelbaum, 1976), Stelarc (Smith, 2005), Mona Hartoum (1994), and Justine Cooper (Buckley, 2004) to name but a few. These technologies allow us to experience the body as a profoundly fluid network of electrical impulses, peristaltic undulations, cardio-vascular surges, hormonal secretions and respiratory flows, undermining our sense of ourselves as fixed and impermeable entities.

3.4.1.1 Alvin Lucier: *Music for Solo Performer*

Whilst not at all participatory (in the manner being investigated here), Lucier’s 1964 performance of *Music for Solo Performer* deserves mention as the first ever artwork to use bio-electrical signals as a control source for live performance. In *Music for Solo Performer* the performer-composer wears a headband fitted with brainwave sensors. A specially designed bio-electrical amplifier isolates alpha-frequency brainwave activity generated by the performer and uses these brainwave patterns to resonate a collection of percussion instruments that have had loudspeakers attached underneath or directly onto them. These live sounds were accompanied by short bursts of pre-recorded and pitched-shifted brainwave material that would stop and start according to alpha-frequency brainwave amplitudes. Lucier describes his approach to the development of the work in the following statement published in David Rosenboom’s anthology *Biofeedback and the Arts: Results of early experiments*:

> From the beginning, I was determined to make a live performance work despite the delicate uncertainty of the equipment, difficult to handle even under controlled laboratory conditions. I realized the value of the EEG situation as a theatre element and knew from experience that live sounds are more interesting than taped ones. I was touched by the image of the immobile if not paralysed human being who, by merely changing states of visual attention, can activate a large configuration of communication equipment with what appears to be power from a spiritual realm. I found alpha’s [brainwave-rhythm’s] quiet thunder extremely beautiful and instead of spoiling it with processing, chose to use it as an active force in the same way one uses the power of a river. (Lucier, 1976)
Figure 13 Alvin Lucier performing Music for Solo Performer. Photo by Phil Makanna (Lucier, 1976).

Figure 14 World, Membrane and the dismembered body by Seiko Mikami (2004)
3.4.1.2 Seiko Mikami: World, Membrane and the Dismembered Body

In *World, Membrane and the Dismembered Body*, Seiko Mikami (1997) installed a heart and lung-sound amplification system into a purpose built anechoic chamber (a room with no acoustic reverberation. Audiences interacted with the work one at a time and were first fitted with various sensors and microphones by the gallery assistant. The lights were then turned off, leaving the participant alone in total darkness in the space with only the sound of their breathing, heart and viscera amplified back to them. The blacked-out and anechoic room denied the participant any normal acoustic or visual frame of reference, dramatically intensifying their own interior acoustic space. A video projection of a polygonal mesh structure was projected into the space, and responded to changes in the sounds being monitored (Mikami, 1997). Hearing became the participant’s primary means of self-perception and orientation: the self experienced as a fluid and acoustically discernable process of flows, pulses and gurgles.

3.4.1.3 Bio-amplification is Not Always Biofeedback

Artworks that focus primarily on the amplification and or magnification of body processes provide a level of intensity and concreteness that is sometimes lost in more complexly mediated and analytical interactions. However, this simplicity of means can also limit the scope of the audience’s interactions with the work - once the participant establishes the causal connection (e.g. *oh, that is my heartbeat*) their interest can quickly subside. The considerable discomfort and preparation time required by endoscopic procedures such as bronchoscopy and colonoscopy precludes direct audience participation. Representations based on the body of another, as exemplified by such works as Mona Hartoum’s *Deep Throat* (1994) video installation featuring endoscopic footage filmed from with Hartoum’s own digestive tract, or staged performances such as Alivin Lucier’s *Music for Solo Performer* (1976) invariably tend to conform to familiar patterns of self/other, observer/observed. The physiology of the observing audience member remains hidden, and the body is once more represented as something other from *who* and *how* we are: a notional body in contrast to the lived body through which we sense the artwork itself. Notable exceptions to this tendency in amplification and magnification oriented artworks include Justine Cooper’s *Tulp* ultrasound installation (Buckley, 2004) and Seiko Mikami’s *World, Membrane and the Dismembered Body* (1997). In both works, participants very quickly understand that the body processes presented are their own and their relationship to these signals is accordingly more intimate and reflective, based as it is on our fundamental needs and curiosities around notions of self and other i.e. *is that me or is that something other than me? What does this information tell me about my own condition and/or the conditions of my environment?*
Mikami (2004) has stated that her intention with *World, Membrane and the Dismembered Body* was to create a form of disassociation between the subject and their bodily experience:

> [a fundamental gap is born between the body's response, when the heart is made to palpitate and undergo change in the anechoic room, and its result as expressed in the movement of sounds emitted from the body. When the body's heartbeat is thrown off course by an intervention from the outside, the desire arises to try to control the sounds that the body emits. A gap occurs between this event and the resulting desire; thus, the visitor is overcome by the feeling that a part of his/her corporeality is under erasure. The visitor exists as abstract data, only his/her perceptual sense is aroused. The visitor is made conscious of the disappearance of the physical contours of his/her subjectivity and thereby experiences being turned into a fragmented body.]

In this statement Mikami describes the subject’s bodily experience as fundamentally passive. Bodily processes are rendered as 'abstract data' with no reference made to the psychophysiological intelligences from which these signals issue. In place of the self-body as a complex and self-aware biological system, Mikami describes the body as an artefact. She states that no interactional pathways are offered that might allow for a more conscious articulation or intervention into the system dynamics of the body-self, providing a clear example of how an artist’s conception of body-self can become embodied within the design of their works.

While processes of amplification are fundamental to biofeedback interactions, biofeedback systems usually extend beyond simply amplifying pre-existent body processes. The feedback component of biofeedback interactions always implies the encouragement of some form of interpretation and sensori-motor enquiry and response: *what changes within me are reflected in the behaviour of the feedback signal? What does that signal tell me about how I have been, how I am now and how I might be in a moment?* Biofeedback interactions articulate bodily states in terms of one or more behavioural axes – increases/decreases in a given signal, faster/slower, more variation/less variation etc – as a way of developing the participant’s ability to sense, differentiate and enact certain ways of being and responding.

Simple processes of isolation, magnification and amplification presented outside this biofeedback framework have nevertheless formed the basis of a number of conceptually and poetically compelling art works, and the recognition and appreciation of the body as a fluid process remains a valuable contribution to the representation of body-self in contemporary culture.
3.5 Navigable Environments

Biofeedback interactions focusing on notions of journeying and navigation have been developed by several artists from the early 1990’s onwards (Gromala, 2000, Grau, 2003a), the most celebrated being Char Davies’ interactive installations Osmose and Ephemere. Metaphors of journeying and navigation have also been developed by commercial biofeedback equipment manufacturers and include popular biofeedback home use systems like The Journey to the Wild Divine (Smith and Bell, 2003) and Inner Tube (Deluz, 2005). Sensors measuring behaviours such as galvanic skin response, heart rate variability and skin temperature are used to track changes in breathing patterns and nervous system balance, from anxious/excitable to relaxed/calm, and movement along these axes are used to induct the participant through a series of onscreen environments.

3.5.1.1 Char Davies: Osmose

In Osmose (1995) breath rate is used to navigate vertically between a series of imaginary landscapes. Individual participants wearing a head-mounted, movement tracking virtual reality display become immersed in an encompassing 3D landscape. Participants explore each of these landscapes by tilting their body to move forwards, sideways or backwards. Changes in breath rate (as measured by a chest mounted strain

Figure 15 Still image from Char Davies Osmose showing one of the 3D landscapes: Tree Pond (2006).
gauge) raise or lower the participant through the various subterranean land, air and space levels, in a breath-mediated experience of interaction that has frequently been compared to scuba diving (Grau, 2003a). Location and presence within this virtual world is contingent on breath rate, and the participant learns to manipulate their breathing pattern in order to explore the four virtual worlds. The point of focus in these works are the virtual worlds themselves: ghost-like ethereal structures of branches, clouds, roots and numerical arrays in 3D space.

Navigating Otherness or Sensing an Inner Process?

Davies’ *Osmose* and subsequent *Ephemere* installation (1998) have done much to promote the use of physiologically mediated interaction in virtual-reality environments, and have established important benchmarks for immersive interaction in contemporary arts practice by which works by other artists will inevitably be read in relation. One difficulty this presents for the works documented in Chapter 5 are the assumptions that have developed around the notion of interaction as a form of (screen based) imaginary navigation and the presumption of the space of interaction as ‘virtual’ and external to the participant. These assumptions are to a large extent implicit in the act of seeing itself – we see our external environment and we feel our internal being. As Rokeby (1998) has noted, technological interfaces inevitably embody and reproduce certain cultural understandings and ideological commitments.

My own strategy, as developed through the installations documented in Chapter 5, explores biofeedback interaction as a way of representing the dynamic psychophysiology of the participating subject. The gaze of these works is internally directed. Interactions based around navigation through virtual three-dimensional spaces tend to direct the observer’s gaze and attention outwards, away from the

Figure 16 Left: a participant in Char Davies’ *Osmose* (1995) wearing head mounted video display, breath sensing vest, and tilt sensors. Right *Forest Grid* still image captured during interaction in *Osmose* (Davies, 2006).
processes of their own being. This changes the emphasis to concrete self-perceptions, rather than to the exploration of metaphorical or symbolic poetic interpretations of ‘the body’ and bodily experience. One of the challenges in the development of the works presented in this exegesis has been to develop interfaces that maintain this inwardly directed focus, and resist falling back into conventional (Western) perceptual modes of observing-disembodied-self and observed-inert-physicality. To achieve this I propose that the interface always preserve some aspect of its instrumentality, literally as an instrument for reaching into ourselves, rather than through ourselves to some externalised space beyond our own being as provided by works such as *Osmose* and biofeedback games like *Journey to the Wild Divine* (Smith and Bell, 2003).

### 3.6 Attention Dependant Systems: Brainwave Biofeedback

There is a considerable tradition of artists exploring the use of brainwave activity as a medium for interaction and performance, beginning in the early 1960’s and 1970’s with works of such artists as Alvin Lucier, David Rosenboom, and Richard Teitelbaum (Rosenboom, 1976a), extending through to more recent projects such as Ulrike Gabriel’s *Terrain 1* (Giannetti, 1993) and Mariko Mori’s *Wave UFO* (Mori et al., 2003). By adjusting their state of attentiveness, participants in these works are able to alter brainwave activity and thus affect a change in the appearance/sound of the artwork. Brainwave responsive artworks tend to focus on the use of three brainwave rhythms: theta waves associated with lucid dreaming states found between waking and sleeping; alpha waves correlating to expansive, meditative states of consciousness (which also increase substantially with the closing of the eyes); and beta waves associated with a sense of heightened alertness and externally focused concentration.

#### 3.6.1 David Rosenboom: *Vancouver Piece*

The notion of attention-depantant interactive systems was explored extensively by American composer David Rosenboom (1976a, 1990), through a series of performances, installations and writings developed between 1972 and 1990. Using sensors attached to the participant’s scalp, changes in the quality of attentive focus according to the intensity of specific brainwave patterns are tracked, from alpha, to beta and theta waves. Changes in the amplitudes of these brainwave patterns are then used to control an interactive art experience that is responsive to changes in attention. The participant’s subjective engagement with the work influences the work’s development, rendering our experience of subjectivity and conscious engagement as a profoundly active and directed process. In his installation *Vancouver Piece* of 1973 (Rosenboom, 1976c), two participants sit facing each other in a completely darkened room, divided by a two-way mirror system. A light above each participant (one red, the other green) is activated by increases in alpha wave activity. When one participant’s
alpha wave threshold is triggered, the light above them is triggered and they see their own reflection in the mirror. The illuminated participant is also visible to the participant on the other side of the mirror. When both participants synchronise their alpha activity, their illuminated faces become superimposed on each other, alluding to a form of self-transcendent cooperative process.

A repeated theme throughout much of Rosenboom’s work of this period is the paradoxical nature of alpha wave and biofeedback control: conventional notions of control by force-of-will generally inhibit increases in alpha-wave activity. Sudden changes in focus (i.e. surprise, excitement, disappointment) also disturb alpha brainwave patterning. In alpha brainwave-based interactions such as Vancouver Piece participants must learn to enter into a state of gentle open-focussed attentiveness in order to affect an increase in alpha wave activity – being-as-a-way-of-doing in contrast to the conventional notions of forcefulness as a way of exerting control over. Other works by Rosenboom (1990, 1976b) have explored brainwave activity within the context of systems-oriented compositions for concert style performances, integrating the dynamics of the performer’s brainwave activity into the compositional and narrative dynamics of his systems-oriented performance scores.

### 3.6.2 Mariko Mori: Wave UFO

Telekinetic, mystical and meditative associations frequently arise in literature surrounding brainwave biofeedback (neurofeedback) based artworks (Kaul, 1997, Lutyens and Ron, 2002, Kahata, 2005). Brainwave-based interactions embody our experience of mental activity, highlighting the directed and physically manifest artefacts of mental and subjective states. Mariko Mori’s Wave UFO (Mori et al., 2003) consists of an elaborately constructed installation in the form of a biomorphic spacecraft. Up to three visitors at a time can enter into the enclosure and observe an interactive video that monitors brainwave activity using a visualisation system devised in collaboration with Masahiro Kahata.
In the first stage of the experience, six undulating biomorphic cells represent brainwave rhythms in the left and right lobes of each of the three participants' brains. A waving line moves in correspondence with blinks and other facial movements, incorporating the experience of watching the projection, and the interaction between the three viewers. The colour and shape of these forms responds according to three types of brainwaves, showing which type is most dominant. Alpha (blue) waves indicate wakeful calm, Beta (pink) waves indicate vigilance or agitation, and Theta (yellow) waves indicate a dreamlike state approaching sleep. Two cells coming together demonstrate coherence between the two lobes of the brain. Mental functions such as thinking in foreign languages or doing mathematical problems immediately transform the characteristics of the graphics. Synchronisation of all three participants’ brainwave rhythms triggers the second stage of the interaction in which a pre-recorded animation of colourful abstract forms slowly expand and evolve into shapes like single cells and molecular structures, representing a primordial or transcendent state of union between the three installation participants (Mori et al., 2003).

Mori's aesthetic vision presents a fusion of contemporary science-fiction, fantasy art, new-age styling, and Sino-Japanese Buddhist iconography. Although Mori aligns herself to Buddhist concepts of non-dualism and oneness-of-mind-and-body (Mori and Jacob, 2004, Ozawa-De Silva, 2002), her visual aesthetic suggests an intense sense of dematerialisation. Images of floatation, radiance, time travel and release from gravity and mortality abound in her numerous digitally manipulated self portraits and installation environments, demonstrating a clear translation of the visual and symbolic iconographies of East Asian Buddhism. In contrast to Mori’s use of biofeedback as a tool for invoking notion of transcendence, the works documented in Chapter 5 explore biofeedback interaction as a way of reflecting on the concrete and particular qualities of the participant’s physiology and our embodiment within these systems.
3.6.3 Social Bodies: Multi-user physiological interactions

In recent years a number of artists have developed physiologically responsive systems designed to augment or challenge interactions between two or more participants, exploring the expressive and communicative properties of physiological responses such as breath, heart rate and sweat gland activity, as non-verbal communicators of affective (emotional) states.

Initiated in 2002, Thecla Shiphorst’s *Whisper Research Group* has been exploring the use of electronically mediated breath, heart rate and body temperature data in the development of non-verbally negotitated social interactions, based around highly structured experience modelling workshops that explore how multiple participants experience and negotiate interpersonal contact through heart rate, breath and body temperature data exchanges (Schiphorst, 2005).

![Figure 19 Whisper wearable interactive research project by Thecla Schiphorst and Susan Kozel. Left: participants illuminating each others garments through touch. Right: interactive data visualization projected on floor (Schiphorst and Kozel, 2004).](image)

Christa Sommerer and Laurent Mignonneau have explored similar possibilities in their work *Mobile Feelings 2* (2003). Small biomorphic handheld devices record and transmit breathing, heart rate and sweat gland activity to other participants, this data is then transmitted to other participants in the exhibition space using a combination of electromechanical actuators, vibrators and fans also embedded within each of the hand-held devices. Each of these devices display an image of other connected participants: by selecting one of these displayed images, participants can transmit body data to other participants, creating a novel form of tactile communication. An unusual and occasionally erotic ambiguity between participants is established through the exchange of blowing gestures, sweat gland and pulse activity and stroking actions (Sommerer and Mignonneau, 2003).

Each of the above mentioned works attempts to re-embody interpersonal contact through the inclusion of playful and sometimes quasi-erotic interactions, in response to the increasingly disembodied nature of our modern everyday communications, mediated via mobile phone technologies, text messaging and e-mail.
correspondence. Such works can also be read within the context of ongoing developments in the fields of wearable and affective computing, that aim to extend and enrich the means by which we interact with computing and communications technologies in general. Unfortunately very little literature exists regarding actual audience experiences of either of these works. Existing biometric sensing technologies for the recording of heart rate, breath rate, brainwave and sweat gland activity are notoriously difficult to work with in uncontrolled public exhibition contexts, especially with the introduction of body movement and the enormous variability of physiological data sets across multiple participants. Without access to first-hand participant accounts it is hard to assess the significance and effectiveness of these works as interactive art experiences.

Figure 20 Participants interacting through Christa Sommerer and Laurent Mignonneau’s *Mobile Feelings II*, transmitting pulse and breath through biosensors and bio-transducers embedded inside the egg shaped sculptures (Sommerer and Mignonneau, 2003)
3.6.4 Group Participation in Interactive Art

In her PhD thesis *A Study of Audience Relationships with Interactive Computer-Based Visual Artworks...* Beryl Graham (1997) identified a general preference on the part of gallery and museum audiences for shared interactions with interactive artworks or displays. Referring to two case studies involving interactive, desktop-based artworks Graham noted that even in situations where the work was clearly intended for engaging one participant at a time, participants would go to significant trouble to find a way of engaging with work other people:

> Perhaps the most surprising finding to emerge... was the frequency with which subjects chose to use the artworks with other people, and to interact with other people whilst using the work, even when there were other vacant spaces... even when the work was very obviously designed to be used by one person only (especially Sonata), even when factors such as wearing headphones made it difficult to interact other than in gestures...

Graham’s findings challenge the predominant assumption by many makers of interactive artworks and museum displays, audiences engage with interactive artworks and interpretive materials on an individual basis, and this problem has since been explored by a number of other researchers working in the fields of museum design (Heath and Lehn, 2002, Bradburne, 2002). Socially focused works such as *Whisper* and *Mobile Feelings 2* present important precedents that open the way for further research into the role of the body and bodily intimacy in the cultivation of social systems, and provide a more socially oriented counterpoint to the single-user interactive artworks as developed in this exegesis. Graham’s findings highlight the fundamentally social nature of gallery based interactive practices. Whilst this exegesis focuses exclusively on individually focused interactions the implications these findings together with precedents established by artists such as Lee Ming-Wei and Rirkrit Tiravanija have played an important role in the development of the approaches documented in Chapter 5, especially with regard to the development of the exhibition as a space for social interaction and reflection.

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10 These issues are given further consideration in Chapter 6: Conclusions, and are re-examined within the context of co-experience and its role in the formation of meaning from experience.
3.7 Summary: Context and precedents

Artist-participant and participant-participant dialogue is an essential element in the unfolding of the art experience into wider life experience. Retrospective reflections and conversational exchanges strengthen the relationships, appreciations and tacit understandings developed through the experience of the artwork. Such dialogues, reflections and exchanges are implicit in most if not all art experiences, but artists engaging with participatory strategies generally seek to intensify this aspect of the experience. Participatory art events can constitute a kind of public research laboratory or forum in which each participant is invited to re-experience themselves through the multiple sensations and relations afforded them by the artists' composition/situation and the specifics of their own interactions with it (Kaprow, 1993, Osthoff, 1997, Bourriaud, 1998). Rokeby’s notion of the transforming mirror describes an approach to interactive art based on the idea of interaction as a form of critical reflection: the participant's own presence within the artwork-system is transformed and filtered through the lens of relations and aesthetic strategies drawn together by the structure of the artwork. This exegesis focuses on the development of art experiences that reflect the embodied nature of our own subjectivity: the body as both the instrument of our grasp upon the world and practices that reveal the indivisibility of body-mind. Somatic practices provide a means of refining our ability to perceive and respond both physically and psychologically to our perceived environmental circumstances.

Bio-electrical sensing technologies and biofeedback training methodologies developed since the 1960’s have enabled researchers, practitioners and clinical subjects to observe the inner workings of a multitude of body functions in real time, and to consciously influence the behaviours of these processes. Artists have engaged with the aesthetic and conceptual possibilities of these technologies and processes as early as 1964 with Alvin Lucier’s Music for Solo Performer and David Rosenboom’s numerous works for brainwave-facilitated interactions and concert performances throughout the 1970’s and 1980’s. Beginning in the 1990’s and leading up to the present, artists’ use of biofeedback and bio-electrical technologies have become increasingly entwined with research into the creative possibilities of human-computer interaction: wearable computational devices that sense and respond appropriately to their user’s psychophysiological orientation, virtual reality gaming environments that cultivate the gamer’s ability to regulate their own psychophysiological response patterns, along with gently playful and sensuous kinaesthetic experiences that amplify bodily processes via abstract and immersive responsive multimedia compositions.

Artworks that engage directly with the structures of perception and bodily functioning reveal the fundamental and mediating role of the body in our experience of the world and of our selves, often providing a valuable corrective to the traditionally disemboding tendencies of Western culture that have tended to place mind and matter
in opposition to one another. Rokeby’s *Transforming Mirrors* model, together with his writings on the *Interface as Content* (1998) provide a useful critical framework for revealing the various commitments and strategies at the heart of such works – the abilities each work draws on, the range of trajectories and reward structures implicit (or not) within their design, and the hierarchies implied by such structures.

Each of the works explored in this chapter reveals the diversity of understandings and intuitions their creators bring to bear on their works through the terms and conditions of their engagement. The often playful formalism of these works, belie a range of far-reaching and sometimes contradictory assumptions and speculations regarding the nature of self, body-mind, and the cultural practices and institutions that frame them.
Chapter 4  The Body as Interface

The artworks documented in this exegesis focus on autonomically mediated changes in heart rate and breathing as a way of exploring links between human subjectivity and physiology. This chapter introduces the psychophysiological basis of the works presented later in Chapter 5, beginning with an introduction to the autonomic nervous system as a control system, its influence on breathing and heart rate, and the technologies with which these processes can be measured as a basis for interaction. By replacing the standard mouse and keyboard of conventional human-computer interactions with physiological sensors controlled by normally subconscious bodily processes, we radically alter the nature of the participant's experience of the artwork, their self-representation within it, and the meanings these representations entail.

The autonomic nervous system is a branch of the human nervous system that mediates changes in metabolism in response to the requirements of our external or internal environments: diverting energy outwards towards rapid mobilisation and environmental engagement during the fight-flight (sympathetic nervous system) response, or directing energy inwards towards processes of recuperation and self-care during the complimentary rest-digest (parasympathetic nervous system) response. Where the somatic nervous system relays information from our common senses (sight, hearing, touch etc.) to the central nervous system and coordinates voluntary body movements, the autonomic nervous system regulates normally subconscious or unconscious functions such as breathing, blood circulation, digestive processes and hormonal activity. Body functions regulated by the autonomic nervous system were once considered by western medicine to be entirely involuntary. Biofeedback training technologies have transformed our understanding of autonomically mediated behaviours enabling us to observe how these responses can be influenced through conscious attention and training.

Changes in the autonomic nervous system are closely tied to how we experience and engage our environment. Generally speaking, an increase in parasympathetic activity is associated with a disengagement from the external environment towards processes of self-care and recuperation (such as afforded by
secure, comforting and non-threatening situations), while increases in sympathetic activity are usually in response to a perceived environmental novelty, opportunity, challenge or threat. Autonomic balance can thus be seen as a primary psychophysiological orienting reflex, reconfiguring our energies according to the needs and opportunities afforded by our immediate or imagined circumstances (Recordati, 2003).

<table>
<thead>
<tr>
<th>Sympathetic</th>
<th>Parasympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement with environment</td>
<td>Disengagement from environment</td>
</tr>
<tr>
<td>Externally focused perceptions (exteroceptive engagement)</td>
<td>Internally focused perceptions (interoceptive or proprioceptive engagement)</td>
</tr>
<tr>
<td>Exit from sleep</td>
<td>Entry to sleep</td>
</tr>
<tr>
<td>Muscle exercise</td>
<td>Post exercise and stress recovery</td>
</tr>
<tr>
<td>Mental arousal: novelty of task and novelty of environment, including emotional expression</td>
<td>Repetition of stimuli, absence of external stimuli</td>
</tr>
<tr>
<td>Fight-flight responses</td>
<td>Rest-digest responses</td>
</tr>
<tr>
<td>Stress, anxiety</td>
<td>Grooming and self-care activities</td>
</tr>
<tr>
<td></td>
<td>Vita Parva (fasting/starvation)</td>
</tr>
<tr>
<td></td>
<td>Diving into water (dive reflex) also stimulated by the sensation of cold air or water on the face</td>
</tr>
</tbody>
</table>

Table 1 Sympathetic and parasympathetic autonomic nervous system responses correlating to specific patterns of engagement between subject and environment (Recordati, 2003).

Table 1 lists a range of correlations between qualities of engagement and autonomic response. With the exception of the dive reflex, parasympathetic arousal is closely linked with a general pattern of withdrawal from the external environment towards processes of rest, integration, digestion, and an absence or reduction in external stimuli. It is significant that many forms of devotional, ascetic and aesthetic experience evoke strong parasympathetic responses through the use of repetitive chant, dance, drone, and sensorial immersion or deprivation. Many of these practices use the regenerative and integrating functions of the parasympathetic response and haptic/visceral sensation (e.g. vibration, visceral resonance, hunger and proprioceptive awareness) to facilitate embodied understandings of complex psychosocial and eco-physiological understandings.

Such practices provide strong precedents for my own work with heart and breath focused biofeedback interaction as a form of embodied enquiry and aesthetic experience. In both cases, introspection and self representation are extended beyond the mental realm towards a more holistic, whole-body reorientation. Artworks seeking to differentiate these contrasting states (such as those documented in Chapter 5) must pay close attention to the close relationship between qualities of stimulus and
participant engagement and the autonomic responses these actions afford. This is particularly important for works seeking to differentiate strong parasympathetic responses, as too much stimulation or novelty can have an inhibiting effect.

Table 2 lists a range of autonomically mediated body functions, showing the often-antagonistic action of sympathetic and parasympathetic nervous system responses. These autonomically mediated physiological responses provide a basis for the notion of subjectively responsive artworks – artworks capable of responding to, or embodying, contrasting forms of subjective orientation based on the degree of intensity to which these feelings illicit either a sympathetic or parasympathetic autonomic responses. Of the list of functions described here it is clear that only a handful can be observed non-invasively\(^1\). The artworks documented in this exegesis concentrate on the development of breathing and heart rate patterns, based on the strong symbolism these functions are often associated with and the relative ease with which they can be traced using real time sensing technologies.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Sympathetic Stimulation</th>
<th>Parasympathetic Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iris (eye muscle)</td>
<td>Pupil dilation</td>
<td>Pupil constriction</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Saliva production reduced</td>
<td>Saliva production increased</td>
</tr>
<tr>
<td>Oral/nasal mucosa</td>
<td>Mucus production reduced</td>
<td>Mucus production increased</td>
</tr>
<tr>
<td>Lacrimal (tear) glad</td>
<td>n/a</td>
<td>Secretion increased</td>
</tr>
<tr>
<td>Heart</td>
<td>Heart rate and force increased</td>
<td>Heart rate and force decreased</td>
</tr>
<tr>
<td>Lung</td>
<td>Bronchial muscle relaxed, breathing becomes faster, effortless for long periods at a time</td>
<td>Bronchial muscle contracted, breathing becomes slower and effortless</td>
</tr>
<tr>
<td>Stomach</td>
<td>Peristalsis reduced</td>
<td>Gastric juice secreted; motility increased</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Motility reduced</td>
<td>Digestion increased</td>
</tr>
<tr>
<td>Large intestine</td>
<td>Motility reduced</td>
<td>Secretions and motility increased</td>
</tr>
<tr>
<td>Liver</td>
<td>Increased conversion of glycogen to glucose</td>
<td>n/a</td>
</tr>
<tr>
<td>Kidney</td>
<td>Decreased urine secretion</td>
<td>Increased urine secretion</td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Norepinephrine and epinephrine secreted</td>
<td>n/a</td>
</tr>
<tr>
<td>Bladder</td>
<td>Wall relaxed, sphincter tightened</td>
<td>Wall contracted, sphincter relaxed</td>
</tr>
<tr>
<td>Hair follicles, arrector pil muscles</td>
<td>Contraction (raising of hairs)</td>
<td>n/a</td>
</tr>
<tr>
<td>Fingers and toes</td>
<td>Decrease in surface temperature due to vasoconstriction</td>
<td>Increased temperature due to vasodilation</td>
</tr>
<tr>
<td>Hands</td>
<td>Increased sweat gland activity</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Table 2 Autonomically mediated changes in visceral activity, showing the contrasting influences of the sympathetic and parasympathetic nervous systems. Adapted from Tortora and Gabrowski (1993) and Gilbert & Moss (2003).

\(^1\) Other autonomically mediated functions that can be explored using non-invasive sensing technologies include skin temperature (using thermometers), sweat gland activity (using instruments to measure electrical conductivity based on moisture content), and intestinal motility (using stethoscopes to record 'tummy rumbles').
4.1 The Heart as Interface

As a centre of emotional energy the heart occupies a special place in the popular imagination. Common terms and expressions like broken hearts, warm hearts, big hearts, cold hearts, etc. can be found across many cultures. The wide spread use of the heart as an symbol for emotional balance, vitality and intention ('their heart's in the right place', 'put your heart into it'), and the relative ease with which it can be monitored either acoustically or bioelectrically make it an ideal focus for exploring subjectivity as an embodied phenomenon.

Although most people understand that a sudden surprise or shock can induce a rapid increase in heart rate (sympathetic response) there is a widespread misunderstanding that a steady heart rhythm is a healthy heart rhythm. Two internal pacemakers govern the rate at which the heart beats: the sinoatrial and atrioventricular nodes. These pacemakers are in turn regulated by the autonomic nervous system – increases in heart rate are activated or increased by sympathetic nervous system activity, and decreases in heart rate are activated by increased parasympathetic nervous system activity via the action of the vagus nerve. The balance between these accelerating (sympathetic) and decelerating (parasympathetic) systems produces a complex and ongoing pattern of heart rate oscillations. Multiple biological rhythms overlay one another to produce the resultant pattern of variability, as illustrated in the time series graph in Figure 21. This pattern of variability is referred to as heart rate variability (HRV). HRV analysis can provide an important indication of a person’s overall physical well being: regular exercise increases heart rate variability, while old age and illness tend to be associated with a decrease in heart rate variability, changes in heart rhythm occur before a foetus goes into distress, and decreased variability may predict sudden infant death and clinical depression has also been associated with decreased heart rate variability (Task Force of The European Society of Cardiology, 1996).

Figure 21 Time series graph showing periodic variations in heart rate over time.
HRV biofeedback is a powerful tool for observing interactions between subjectivity and physiology. In clinical settings HRV biofeedback is used to train subjects to reorientate deeply-seated subjective response patterns such as panic attacks, anxiety and rumination. Subjects learn to entrain parasympathetic response patterns using breathing and relaxation techniques, combined with intentional focus, memory and/or visualisation to restore overall autonomic balance (Moss, 2004).

HRV biofeedback can involve the monitoring and reinforcing of a number of different aspects of heart rate variation. The simplest form of HRV biofeedback focuses on increasing average heart rate variability by increasing the maximum and minimum heart rates over a given period of time. Another method (widely used in medical research) monitors the standard deviation of the ‘N to N interval’ (SDNN)\textsuperscript{12}. HRV training is usually performed in combination with breath rate biofeedback, in which subjects focus on producing an effortless slow breathing pattern at around six breaths per minute.

\textbf{4.1.1 Heart rate Variability Spectrum Analysis}

A more sophisticated technique for HRV training uses a statistical technique called \textit{spectral analysis} to reveal the component oscillations that combine to produce the overall HRV pattern, in much the same way as one could analyse the harmonic content of a vibrating string on a musical instrument. Different physiological processes have been attributed to specific frequency ranges within this spectrum. The Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996) has established a standard for the classification of these frequency ranges according to the following four bands of activity:

- High Frequency (HF) oscillations in the range $0.15–0.4$ Hz
- Low Frequency (LF) oscillations in the range $0.04–0.15$ Hz
- Very Low Frequencies (VLF) oscillations in the range $0.0033–0.04$ Hz,
- Ultra Low Frequency (ULF) oscillations below $0.0033$ Hz, only observable over a 24-hour recording period.

\textsuperscript{12} N to N is the statistically normalized beat to beat interval, and SDNN is the standard deviation of these intervals expressed in milliseconds. In this case the aim of the training is to increase SDNN.
Researchers (Moss, 2004) have proposed correlations between these different frequency ranges and the following influences:

- **High Frequencies** – parasympathetic nervous system activity, and the influence of respiration at normal breath rates.
- **Low Frequencies** – the influence of blood pressure rhythms (baroreceptors). Meditative/slow breathing actions can also increase this range of frequencies.
- **Very Low Frequencies** – parasympathetic nervous system withdrawal, homeostatic processes relating to visceral and thermal regulation. Anxiety and rumination can also increase activity in this range.
- **Ultra Low Frequencies** – slower acting circadian influences (strongly influenced by changes between day and night).

Figure 22 shows three HRV time series accompanied by spectral displays revealing the relative amplitudes of these different heart rate oscillations. During HRV spectral analysis training, subjects learn to increase or decrease HRV activity in specific frequency ranges. These correlations are explored in my interactive artworks *Cardiomorphologies v. 1* and *Cardiomorphologies v. 2* (refer to Chapters 5.2 and 5.4), both of which use changes in LF and VLF heart rate oscillations to track changes in autonomic balance and subjective orientation.
4.1.2 Heart Rate Sensing Hardware

Heart rate measurements can be recorded using a basic electromyogram (EMG) sensor to record the powerful electrical impulse generated by the heart muscle during each heartbeat. As with most other forms of biofeedback interaction, it is important to bear in mind that most sensor technologies do not record the actual behaviour being studied, but instead record externally measurable traces of these processes (e.g. heart rate is calculated from periodic electrical impulses measurable from the surface of the body, breath is measured by changes in airflow at the mouth or chest diameter). Heartbeats are produced by rhythmic contractions of the heart muscle and an electrocardiogram works by measuring the electrical impulse produced by this muscle activity, which are measurable throughout the body (to vary degrees of intensity) as a sharp, periodic transient.

Cardiomorphologies v. 1 (Chapter 5.2) used a common EMG three-electrode system, with two electrodes attached to one arm (forearm and wrist), and one electrode attached to the other (forearm). From these three points, a basic electrocardiogram was assembled for heart rate calculations. The quality and reliability of this signal depends on the quality of contact between the surface electrodes and the subject’s body. Because they are measuring electrical activity produced by muscle actions this kind of ECG can be particularly vulnerable to noise produced by arm and wrist movements, and therefore requires the subject to keep their hands and arms still in order to avoid spurious heart rate recordings.

Cardiomorphologies v. 2 (Chapter 5.4) used a wireless heart rate sensor requiring only two points of contact. The sensor itself is comprised of two cylindrical objects connected by a flexible cord. Participants hold one of these cylinders in each hand. Bioelectrical signals from these sensors are then transmitted wirelessly to a nearby receiver and from here they are decoded and analysed in a separate computer software application.

Photo-plethysmographs measure heart rate as revealed through changes in light passing through the subject’s finger or earlobe: with each pulse the amount of blood at the location of the sensor increases and then decreases (similar in principle to the throbbing one can feel in one’s finger after hitting or cutting it). Infrared pulse plethysmographs shine light through the fingertip and record the amount of light reflected back into the sensor from the underlying finger bone. An infrared pulse plethysmograph was used in the installation res’onance-body (-box) (Chapter 5.1) but the results were far from reliable. Because both photo and infrared pulse plethysmographs depend on the amount of circulation in the subject’s finger or earlobe, they can give inaccurate readings for subjects with poor circulation, or in colder environments where blood circulation is reduced.
Figure 23 Top: Fingertip infra-red pulse plethysmograph used in resonancel-body [box] Middle: the basic simple three-electrode ECG system used in Cardiomorphologies v. 1. Bottom: the wireless hand-held heart rate sensor used in Cardiomorphologies v. 2.
4.1.3 Breath as Interface

Breath holds a universal significance across cultures as a vital function associated with notions of life essence. Breathing techniques (including chant) are a common feature of many meditative, trance and shamanic practices around the world, being especially prominent in many forms of Eastern meditation (Pranayama, Zazen, Qi Gong, etc.). In somatic bodywork practices, the quality and extent of breath movements can provide practitioners with an indication of the level of effort or discomfort encountered by pupils/clients in a given situation. Breathing and breath rate play an important role in the interactions documented in Chapter 5, where it is used as a way of influencing heart rate patterning.

Breathing is a multidimensional behaviour comprised of a number of interrelated processes, ranging from subtle changes in blood chemistry and pH, to the coordination of rib and diaphragmatic muscles. Our experience of breath moves across these various categories of sensation and function in a fluid and dynamic way from one moment to the next. This fluidity renders the task of sensing and reflecting breath in an interactive artwork both rewarding and challenging.

As a body function, breath is unique in that it is controlled by both the somatic (musculoskeletal) and autonomic nervous systems. Adjustments to breath rate are for the most part autonomically regulated, but breath can also be controlled voluntarily, through the conscious manipulation of the chest and abdominal muscles, as is the case when we speak or sing. Sensory organs in the brain, aorta and carotid arteries monitor blood oxygen and carbon dioxide levels. In healthy people, an increased concentration of carbon dioxide is the strongest stimulus for increases in the depth and rate of breathing. Conversely, when the carbon dioxide concentration in the blood is low, breath depth and rate is reduced. In quiet breathing (i.e. normal circumstances), an average adult inhales and exhales about fifteen times a minute (Merck, 2006).

The relationship between breathing patterns, stress, relaxation and autonomic balance is complex. Environmental factors can have a significant influence on breath pattern and topology: the most prominent being the body pattern of anxiety that Feldenkrais (Rywerant, 2003b) describes as an instinctive, inborn contraction of the flexor muscles (body curls inwards), accompanied by a simultaneous inhibition of the extensors\(^\text{13}\) (anti gravity muscles). This pattern inhibits breathing movement and is a natural response to danger, such as might be the case when being attacked or fearful of falling. It can be produced by a violent stimulation of the vestibular apparatus or a sudden loud noise, and commonly accompanies feelings of inadequacy and anxiety. When these sensations or feelings persist, this reflex can grow into a low-level bracing action that can persist long after the anxiety producing event has passed, reducing the

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\(^{13}\) Extensor muscles are responsible for the extension of limbs and spine and are used during stretching and reaching actions.
subject’s mobility and substantially inhibiting the free movement of their breath (Rywerant, 2003b). In contrast, feelings of safety, wellbeing and confidence can be characterized by a much freer movement of breath in absence of this contraction reflex, hence such common breath-related expressions for these feelings as ‘breathe easy’, ‘breathe freely’ and ‘a breath of fresh air’.

4.1.4 Breath Sensing Hardware

Figure 24 illustrates the involvement of the intercostal (rib) muscles and diaphragm in the action of breathing, providing the basis for the use of chest or abdominal movements as a measure of breath movement and rate. The most common form of breath sensing device in clinical biofeedback is the respiratory strain gauge: a simple belt device that measures changes in abdominal or rib cage diameter. A transducer is inserted into the middle section of the belt, and provides data representing variations in (usually breath related) circumference. Second order characteristics such as displacement, velocity and breath-rate can then be calculated. Strain gauges are cost effective and reusable, but require subjects to focus on their breathing and to stay relatively still. Constriction at the point of connection of the belt to their body may encourage exaggerated or self-conscious breathing and some subjects may be inclined to breathe around, rather than through such a constriction.

Airflow sensors are not usually used in clinical breath-rate biofeedback training, but are used extensively in respiratory research and in the diagnosis of respiratory complications such as asthma. Spirometers measure the amount of air

Figure 24 Diagram illustrating the involvement of the ribs (intercostal muscles) and diaphragm in the action of breathing (Merck, 2006).
moving in and out of the lungs irrespective of how the chest and abdominal muscles are involved. Another method of measuring airflow uses a temperature sensor taped to the underside of the subject’s nose, and measures changes in temperature between inhaled air (cooler) and exhaled air (warmer). Capnometers measure levels of carbon dioxide in the breath, and can be used to measure breath rate via the periodic lowering of recorded CO2 levels during inhalation. Airflow sensors and capnometers have the disadvantage of being physically intrusive (requiring the insertion of a 3 cm diameter tube into or around the subject’s mouth) and requiring replacement or sterilization between users, making them impractical for public exhibitions with a high number of users.

Figure 25 Airflow spirometer distributed by Vernier Ltd, showing disposable filter attached to front end.
Chapter 5  The Installations

This chapter details the development of the four interactive artworks that form the core of the portfolio discussed in this exegesis: res'onacci-body [-box] (2003), Cardiomorphologies v.1 (2004), Drawing Breath (2004-2005) and Cardiomorphologies v.2 (2005). It examines the range of experiences arising through interactions between the design of the artworks and individual subjects, the process by which these experiences were realised and the decisions these processes involved. Each of the artworks documented in this chapter are presented according to the following four-part structure:

• Introduction, aims and developmental context
• Design and implementation
• Interaction analysis and audience response
• Evaluation

The works presented here represent a major change in the direction of my practice as an artist, from studio-based installations working primarily with pre-recorded and usually static compositional systems, to a practice centred on real time interaction and responsiveness. During this process of transition and reinvention, a great deal of time and energy has been consumed by problems of data acquisition, analysis, visualization and sonification that, whilst being fundamental to the resulting artworks, are also embedded and hidden within the system, and thus generally unperceived by the casual observer.

The task of data-sonification14, integral to all of these works, has demanded a steep and often arduous learning curve. Where previously I had worked with a highly controlled process of layering and filtering essentially static units of sampled and

14 the representation and communication of data by sound
synthetic sound (i.e. *Pillowsongs* (1997) and *Nightshift* (2003) installations), the works examined in this chapter required the mapping of sound variables (frequency, harmonic content, amplitude etc) to highly variable data sets (heart and breath rate, velocity, spectral content etc) in ways that often compromised my wish for a tight control on the overall tone, colour and balance. A combination of sound textures that present as compositionally balanced under one set of conditions (i.e. breathing at a certain rate and average velocity), might under other conditions lead to an overall sound that could be either too loud, soft, or jarring.

In addition to these largely operational negotiations, the four works examined in this chapter trace the development of my understanding and strategic approach to the wider aesthetic and philosophical dimensions implicit in these interactive designs and experiences. What exactly are we seeking to observe through these interactions? How do the terms of interaction collectively frame or obscure perceptions of body-mind interaction? What has been assumed about the nature and extent of the participant’s innate perceptual abilities, and how has this influenced or not influenced the design of the work?

Towards the completion of the final work documented in this exegesis (*Cardiomorphologies v.2*) it became clear that many of these philosophical and aesthetic questions were inseparable from the practical design variables already mentioned. Practice, evaluation and iterative development become a way of doing philosophy. Each work provides a vehicle for articulating my intuitive attraction to physiological interaction (biofeedback), with each iteration clarifying my appreciation of the issues raised by these works and the processes by which they come to be embodied within the design of the works themselves and the interactions they facilitate.
5.1  *res’onance-body [-box]*

Gallery Barry Keldoulis (GBK) Client Viewing Room  
1/42-44 Meager Street, Chippendale, Sydney, Australia  
November 28th to 30th, 2003

Presented as part of the inaugural Sydney Esquisse design festival

Credits:

Kari na Clark – installation design, initiating artist and producer  
Julia Charles – installation design and construction  
George Poonkhin Khut – installation design, and production  
Luiz Pampolha – LED lighting-system programming and production  
Jon Drummond – Data analysis algorithms (Max-MSP)  
Angelo Fraietta – customised adjustable CV-MIDI device for heart and breath sensors  
Barry Keldoulis – gallery director, Gallery Barry Keldoulis (Sydney)
Figure 26 Above and below: res’onance-body (box) installation views showing the bed like platform and colour changing lighting system in two contrasting states. Photography by Julia Charles.
5.1.1 Introduction

res’onance-body [box] was an immersive installation project initiated by Karina Clarke in collaboration with Julia Charles and myself, with additional assistance from Jon Drummond and Luiz Pampolha. Audiences entered into the installation via a long corridor dramatically illuminated with a colour changing LED lighting system which continued into the main installation space: a medium sized room furnished with a bed-like platform covered in a deep shagpile fabric, and a large floor-to-ceiling relief panel located at the end of the bed/platform. The floor of the space was covered with black carpet that provided an intense contrast to the highly saturated and slowly changing colours illuminating the walls and ceiling of the installation space. The overall effect of was designed to be highly immersive. The colour changing lighting system, whilst not interactive, nevertheless contributed to a strong sense of flow and quiet immersion. The work ran for three days, from 11am to 6pm. Operation of the work included greeting visitors, explaining the installation and how they could interact with it, connecting the sensors and manually adjusting various sensor sensitivity and the final sound mix levels in situations where the mix would become too loud or too soft.

Audiences interacted with the work one at a time, reclining on their backs on the bed/platform, with a breath sensor (respiratory strain gauge) attached around their chest or abdomen, and pulse sensor (infra-red pulse plethysmograph) fitted to their index finger. Participants were informed that the work responded to changes in breath rate, ranging between twelve to five breaths per minute, and was specifically designed to respond to slower than normal breathing rates. After being fitted with the sensors, participants were invited to see if they could gently lower their rate of breathing to navigate the different layers of the sound design. Emphasis was placed on gently lowering the breath rate within the limits of their perceived comfort zones. Participants were asked to avoid effortful over-breathing that might lead to hyperventilation and feelings of dizziness or light-headedness. Non-participating visitors or participants-in-waiting were able to observe the installation on seating located to the rear of the centrally located bed/platform.

A running average of the participants’ breath rate was calculated according to chest or abdominal movements sensed with the respiratory strain gauge, and the resulting estimations were used to navigate a continuum of electronic drone and noise textures responding to breathing rates between fifteen (fast) and five (very slow) breaths per minute. In general, faster breath rates where mapped to higher frequency textures, and slower breathing patterns to lower frequency textures. Peaks and troughs in breath related movements were indicated with a quiet bell-like tone. Heartbeats were measured with an infra-red pulse plethysmograph, and used to trigger a short pulse sound that was a combination of sub-bass and ultra-high frequency tones at the thresholds of audibility (30-60 Hz and 11000-15000 Hz). Changes in estimated heart
rate were used to increase or decrease the pitch of this pulse sound by a small, but nevertheless discernable amount.

*res'onance-body [box]* was presented as part of the inaugural Sydney Esquisse 2003 festival of contemporary design, art and street culture, and was awarded two first prizes for best-in-category for the exhibition themes of ‘No place like it’ and ‘Mother Love’. The festival was conceived and produced by the Sydney design studio *PLAY*: Yann Flahault, Simon Hörauf, Martin Kornberger, Sandrine Vinay and Johannes Weissenbaek.
Chapter 5.1 res’onance-body (-box)

**Hardware**

- Custom made bed/platform structure
- Infrared pulse plethysmograph (UFI)
- Respiratory strain gauge, breath sensor (UFI ‘Pneumotrace’)
- CV-MIDI device (designed and built by Angelo Fraietta)
- PowerBook G4, 1Ghz processor (OS 10.3)
- Stereo amplifier x 2 speakers
- Colour changing LED lamps x 50 (Color Kinetics icove 12)
- DMX lighting controller/sequencer for Color Kinetics LED lamps

**Software**

- Max-MSP v.3.5 (Mac OSX)
- Max-MSP breath rate analysis algorithm designed by Jon Drummond

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Figure 27 Plan view of res’onance-bod’y [-box] as installed at Gallery Barry Keldoulis, Sydney.
5.1.2 Aims and Developmental Context

res’onance-body [-box] was the first of the four works documented in this chapter, and many of the issues identified during the works development would be developed and refined in subsequent works.

Karina Clark, an experienced interior designer and furniture maker, initially invited me to develop a collaborative work with her for the inaugural Sydney Esquisse design festival. Her basic vision for the project centred around the concept of an immersive environment that would allow visitors to enter into and inhabit it in some way for an extended period of time. After working through a variety of concepts, from web-like sculptural environments to macroscopic video projections of sea-sponges, I proposed a simple bedroom/lounge space in which participants could experience changes in breath rate through a gradually changing soundscape. Designer Julia Charles’ interest was in 60’s and 70’s design aesthetics, and her response was to develop a ‘futuristic’ 60’s/70’s inspired resting space and relief sculpture. Clark secured in-kind sponsorship from architectural lighting company Xenian, enabling the installation of a continuous row of colour changing LED lighting units around the inside of the gallery space, creating an intense colour field environment. Inspired by the minimal light and space works of James Turrell (Noever, 2001) and colour field photography of Richard Misrach (Misrach and Solnit, 2000) our aim was to have these lights vary according to breath rate. However, the development of a customised control system for the LED lighting system was unfortunately beyond the scope of what could be developed with the available time and funds.

My principal aim with the project was to explore the use of breath rate as a form of interaction. Having some experience with the breath awareness and counting meditation techniques used as an introductory technique in the practice of Zen Buddhist sitting meditation (zazen), I wanted to create an immersive environment and subjective space that participants could explore by focussing attention on their breath rate, which was reflected back to them through gradual changes in the drone textures of the sound design. Most of the sounds contained in work could only be accessed by breathing at slower than normal rates, such as those associated with many meditative breathing processes, i.e. between 8 and 5 breaths per minute (Lehrer et al., 1999, Song and Lehrer, 2003). Using slower than normal breath rates of 5-8 breaths per minute as a condition of interaction enabled me to explore how audience subjectivity could be influenced by the terms of interaction established through the structure of the work’s interface and responsiveness.

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15 Under normal circumstances (i.e. light breathing) the average adult inhales and exhales about 15 times a minute (Merck 2006).
Figure 28 Visual inspirations for res‘onance-body [-box], above left: Untitled photograph by Richard Misrach (Misrach and Solnit, 2000); above right: Wide Out installation by James Turrell, 1998 (Noever, 2001)
5.1.3 Design and Implementation

res’onance-body [-box] was my first experience of designing for interaction, and my aim with this work was simply to devise a system that would sense changes in breath and heart rate, and to use this data to navigate through an immersive drone-based soundtrack. The analogy I worked with throughout the development of the work was of a radio-like sound continuum in which participants would slowly and seamlessly drift through, from station to station. Different breathing rates would thus be associated with different sound textures and tonalities, arranged along a continuum from higher pitched sounds at faster breathing rates (from 10.5 to 7.5 breaths per minute), to deeper and richer textures for slower breathing rates (from 7.5 to 5 breaths per minute). The appearance of these various sound layers was thus contingent on the participant’s ability to breath in such a way as to a) be discernable as a series of discrete breath periods, and b) pace these breath-cycles at rates between 10.5 to 5 breaths per minute.

Technically, the work introduced some key elements of interaction and physiological sensing that would be built upon in subsequent works, such as sensor design and construction, sensor in-out hardware for interfacing with computer hardware and software, breath and heart rate data processing, analysis and mapping algorithms, and real time sound synthesis and sample playback. res’onance-body [-box] also provided my first experience with working with gallery audiences in the face-to-face interactions involved in the process of inducting participants into and out of the work, and the process of attaching and adjusting the breath and heart rate sensors to them.
5.1.4 Data Mapping

Figure 29 Data flow-chart for res’onance-body [-box], installation
Chapter 5.1 res’onance-body (-box)

Figure 30 Data mapping flow-chart for res’onance-body (-box), breath and heart rate sonification
5.1.5 Technical Developments

5.1.5.1 Breath Sensing and Analysis

The breath sensor used (UFI Pneumotrace) was piezo-electric capacitance sensor, housed in an adjustable belt device that could be fitted between the upper ribs and abdomen, according to the breathing patterns of each individual. The controlled voltage signal from this sensor was converted to MIDI\textsuperscript{16} data, using a sensitivity-adjustable controlled voltage to MIDI (CV-MIDI) device that converted changes in belt diameter (displacement) to a continuous stream of MIDI 0-127 values which were then analysed by a purpose-built Max-MSP algorithm developed by Jon Drummond.

The principal challenge in the development of this algorithm was to find a way to differentiate one breath cycle from the next based only on changes in thorax (chest or abdomen) diameter recorded by the (stretch-sensing) breath sensor. The exact location of the sensor and the degree of fit significantly influenced the range and form of the breath movements recorded. Emphasis could shift from rib related movements to abdominal movements and back again over the course of a few minutes, and was greatly influenced by posture (sitting, standing or lying down) and the clothing or materials between the participant’s body and the sensor belt. Significantly, the presence of the sensor itself and the quality of the feedback signal generated from it could influence the way participants breathed during their interaction, often leading them to breathe in an exaggerated and effortful manner, or causing them to involve parts of their body (ribs or abdomen) that they would not otherwise engage in their normal breathing patterns.

Individual time-series graphs shown in Figure 31 provide an example of the diversity of possible data obtainable from different individuals, the impact of varying degrees of tightness/looseness in the belt attachment and the specifics of the participants’ own breathing and impact signal attenuation at the CV-MIDI stage of data conversion. Drummond’s approach was to calculate the gradient of sensor displacement (velocity) and have amounts of change, falling within a certain range of sensor displacement, trigger a timing mechanism. It was necessary to place restrictions on the kinds of gradient transitions that would be used for breath rate calculations, as the sensor data could be quite ‘wobbly’ (see Figure 31, examples a, b, e and f) and these ‘wobbles’ could lead to misleading breath period calculations (i.e. breath rates much faster than in actual fact).

Despite these measures and others testing a variety of sensitivity thresholds for calculating transitions in breath cycle, there remained a considerable margin for error in breath rate calculation, given the unpredictability of the sensor fit in relation to the

\textsuperscript{16} Musical Instrument Digital Interface, or MIDI, is an industry-standard electronic communications protocol that allows electronic musical instruments, computers and other equipment to exchange data in real time.
participant’s own chest or abdominal movements (breath related or otherwise). This difficulty in extrapolating breath rate data from belt-type breath-sensing devices would persist through the development of the artworks documented in this exegesis.

Figure 31 Comparison of breath sensor data from different interactions, showing the extreme variability of breath sensor data.
5.1.5.2 Heart Rate Sensing and Analysis

A basic heartbeat impulse was obtained via an infrared pulse-plethysmograph\textsuperscript{17} (see Chapter 4.1.2) that measured changes in the amount of blood at the tip of the finger attached to the sensor. The sensor device required a customized interface to the existing CV-MIDI converter, that in addition to receiving the extremely low voltage variable output, would also supply power to the sensor for its infra-red light source. Pulse data gathered by this sensor was then used to trigger a sub-bass pulse sound along with an ultra-high frequency pulse sound. Some early attempts at cardio-respiratory analysis were undertaken with Drummond to identify degrees of phase alignment between breathing periods and cycles of respiratory sinus arrhythmia (breath-related variations in heart rate). However, owing either to inefficiency of the software (\textit{Max-MSP version 3.5}), hardware or our analysis algorithms, the results of these preliminary analysis approaches were too unreliable to be implemented in this project.

5.1.5.3 Visual Aesthetics

From the outset, Clarke and I both wanted to work with some form of colour-changing ambient lighting system. Early explorations included the use of television monitors as a lighting source, controlled by a simple monochromatic interactive video design (\textit{Max-MSP Jitter}) with the light from each monitor being used to illuminate the installation interior, however the number of video displays required to obtain a suitably immersive and chromatically intense impression far exceeded the project’s financial capacity. Clarke subsequently secured in-kind sponsorship from Xenian, a Sydney-based business specialising in architectural lighting, allowing us to explore the use of colour-changing LED lighting technology, capable of colouring an entire interior with intense washes of colour that could be varied continuously from one hue to another.

As mentioned previously, my attraction to these lighting systems was greatly inspired by the light and space works of James Turrell (Noever, 2001) and the sky-scape photographs of Richard Misrach. What attracted me to Misrach’s sunset and sunrise photos in particular, was the innate relational structure built into this kind of expansive and slowly evolving visual experience. Watching the sun set or rise is a commonly enjoyed experience that draws observers into a form of sustained and careful observation that is very closely related to the kinds of aesthetic qualities and interactions central to the works developed in this exegesis: a general sense of openness, gentle attentiveness and the aesthetic delight that can be found in profoundly primal but nevertheless everyday events. Whilst not interactive in any way,

\textsuperscript{17} \textit{Model 1010} pulse transducer produced by UFI, California, USA.
the gradually changing colour scheme did enable us to invoke this quality of engagement as a context for relaxation, stillness and breath-focused reflections presented in a semi-public space.

5.1.6 Audience Response and Interaction Analysis

Operating the work for duration of its showing provided the opportunity to observe the varieties of audience interaction and responses to the work first-hand. Participants often visited the work in small groups of two, three or four, and would occasionally share the bed structure whilst one of the participants wore the sensors. Although most participants interacted with the work by themselves, their friends would usually observe from the seats located behind the bed. This pattern of social engagement challenged our initial assumptions about the work being a primarily solitary space for sensing and reflection, highlighting instead the often social nature of art engagement and the degree of interest that people take in observing their friends and relatives engaging in physiologically responsive works – witnessing some otherwise hidden and intimate personal process.

Most audiences expressed enthusiasm for the idea of a body-responsive artwork prior to their actual engagement with the work, and generally welcomed the opportunity to be still and internally focused in an immersive light and sound environment. The sense that the work was in some way about, or related to them seemed to be an important factor in sustaining their attention. Words and images used by participants in response to their interaction centred around words like ‘spacey’, ‘like a yoga meditation’, ‘like a scene from the movie Barbarella’, ‘chilled-out’ and ‘I could stay here forever’, indicating not only that the work was facilitating strong feelings of immersion, but also that the intensity of this immersion may have been overwhelming the more reflective and analytical aspects of the interaction that I was interested in developing.

Despite the fact that participants where encouraged to adjust the sensor fitting as needed, some participants felt unable to initiate or request such adjustments and would inform me afterwards that they found the breath sensor slightly uncomfortable to wear. Many participants asked half-jokingly if they were ‘OK’, implying that the work might offer a form of diagnosis or polygraph-based psychological assessment. Physiological sensing devices tended to carry strong medical overtones for many audience members, recalling experiences of hospitalisation or physical examinations. These associations can influence the way many people experience and interact with the work: believing that something is going to be done to them (i.e. administering electrical shocks or emotional provocations) or that their behaviour and the data extrapolated from it is being scrutinized for signs of pathology. A few participants experimented with intentional bursts of hyperventilation despite my request that they avoid such
behaviour. Extreme forms of interaction such as hyperventilation or vigorous physical exercise immediately prior to interaction constitute boundary-testing behaviours that can be observed in most forms interactive art, enabling the participant to assess the capabilities and limits of the work.

Several participants commented on delays in the ping sound or water drop effect that would signal the computer’s registration of transitions between inhale and exhale. This scrutiny of the degree of fit between action and response highlighted the need for improved responsiveness in the overall design of the feedback signals. A few participants asked whether they were controlling the lighting, but even after being informed that they were not, would recall after their interaction moments of apparent synchronicity between their internal experience and the state of the room’s lighting. This ambiguity between elements arising directly from audience interaction and more coincidental or seemingly random elements raises questions around the true value of interaction and its role in the larger aesthetic experience: do such extra-interactive elements compromise the quality of interaction or simply create a more complex and subjectively rich space for reflection and aesthetic reverie?
5.1.7 Evaluation

res’onance-body [-box], provided a useful starting point for my research into physiological sensing and biofeedback, establishing a basic familiarity with the technologies, data analysis processes and production logistics that would become central in each of the three works that would follow (Cardiomorphologies v.1, Drawing Breath and Cardiomorphologies v.2). Audience response to the work confirmed the attractiveness of this kind of interaction for contemporary arts audiences (it’s all about you!). As an immersive installation environment the work succeeded in creating a very inviting and calming environment, but in relation to my own long-term goals for exploring breath and heart rate as vehicles for aesthetic experience and self-knowledge through biofeedback interaction, much work remained to be done.

Closeness-of-fit emerged as a vital concern in relation to the accuracy of analysis and the quality of feedback signals: res’onance-body [-box], was limited to providing information about gradual changes in breath rate taking place over the course of one minute. The lighting system created a strong sense of atmosphere but the fact that it was in no way related to the participant’s breathing substantially diluted the sense of a coupling between the artwork and the participant’s breathing processes, diverting attention from the processes that were to be central to work as originally conceived.

To achieve a closer sense of connection and bodily extension, participants required some form of immediate feedback regarding the quality and extent of actual breath movements. The means by which this quality of feedback could be achieved eluded me during the development of res’onance-body [-box]. Sensor displacement on its own did not yield appropriate sonic feedback: the range of movement was too unpredictable and often too narrow. Mapping sensor displacement to the amplitude of a given sound texture yielded mediocre results that failed to express anything of the actual felt experience of breathing, providing no clear recognition of different phases of the breathing action: inhale, crest, exhale, pause, inhale etc.

The breath sensor (respiratory strain gauge) required around two minutes or more for fitting and adjustment at the start of each interaction, and some participants had difficulty locating an appropriate location on their chest/abdomen for optimum response. Respiratory strain gauges often require a specific method of breath – a gentle but clear expansion and contraction of upper ribs, lower ribs, or the abdominal area – that be quite unfamiliar to some participants. This raises the issue of whether the work is sensor-focused or breath-focused in its approach to interaction. During res’onance-body [-box] my approach to the interactions was to encourage participants to explore how the sensor belt could respond to their breathing as registered by the inhale and exhale registration tones (ping sounds or water drops), but over the course of the
Chapter 5.1 res’onance-body (-box)

showing I became aware of a clear and problematic gap between observing ‘natural breathing’ and breathing to produce a response for a specific sensor technology.

Heart rate sensing with infrared pulse plethysmography, although more convenient compared to conventional electrocardiography, proved to be unreliable, as these devices are dependant on the degree of circulation in the fingertips. Poor circulation in some participant’s fingertips lead to missed beats and erroneous heart rate readings.

5.1.8 Implications

The relationship between the artwork and the participant’s physicality in res’onance-body [-box], was highly ambiguous. The intensity of the lighting design and the fact that it was not in any way responsive to the behaviour of the participant, created a feeling of otherworldliness and immersion that worked against the more inwardly directed processes of body awareness and differentiation that I was seeking to facilitate. This led me to question how I might work with such qualities in future works: how is the nature and direction of the participants’ engagement (gaze) constituted through the design of the artwork, and the structures through which it is communicated? Is a quality of immersion desirable for the kinds of interactions I am aiming to develop, or does the feeling of immersion actually work against this inwardly directed focus?

In response to these ambiguities I began examining how I might strip the whole experience back to a more minimal or concrete experience, removing any elements unresponsive to the behaviour of the participant and focussing exclusively on interactions between heart rate, breathing and psychophysiology as communicated through sound and video graphics.

On a technical level, sensor analysis accuracy had been compromised by fluctuations in the computer’s processor capacity. To overcome this problem, data analysis and sound synthesis tasks were separated and placed on different machines altogether. A custom coded JAVA based analysis algorithm was created to transmit sensor analysis data to a Max-MSP sound synthesis patch on the other computer, via the Open Sound Control networking protocol (Wright et al., 2003).
5.2  Cardiomorphologies v. 1

Performance Space
199 Cleveland Street, Sydney, Australia
July 5th to August 7th, 2004

Artist’s residency and public exhibition presented by Performance Space

Credits:

George Poonkhin Khut – installation concept, design and art direction,
John Tonkin – data analysis algorithms and visualisations (JAVA)
Sophie Gibson – event production and logistics, Performance Space (Sydney)
Fiona Winning and Blair French – residency curators, Performance Space (Sydney)
Figure 32 Installation views of Cardiomorphologies v.1, presented at Performance Space, Sydney 2004, showing participant observing cardio-respiratory visualisations (top) and attached to sensors (bottom). Photography: Julia Charles.
5.2.1 Introduction

Cardiomorphologies v.1 was presented as a part of the 'Headspace' artist residency and creative development program of Performance Space during July – August 2004. The work was installed, tested and exhibited over a period of five weeks, during which time, over eighty visitors participated in the work and its associated interview process.

Individual participants were seated in a comfortable reclining chair positioned in the centre of the darkened gallery space, before a large floor-to-ceiling video projection of a series of concentric circles. The circles expanded and contracted in response to breath-related movements and changes in heart rate, and were superimposed with a bar graph displaying a real time frequency analysis of their heart rate patterning. Visitors to the installation could observe participants interacting with the work, from seats placed behind the participant. Over a period of time ranging between ten to thirty minutes, individual participants observed and experimented with modifications to aspects of their breathing, heart rate and psychophysiology, as revealed to them through both the audio and visual components of the work, and with their own felt sense of themselves interacting with the work.

Breathing movements collected from a respiratory strain gauge attached around the participant’s chest or abdomen were translated into a synthesized breathing sound, generated from white-noise that was filtered and amplified according to the velocity and rate of the participant’s breathing. The resulting sound varied from a light hissing sound to an extremely deep rumbling sound, like the crashing of ocean waves or a roaring furnace-like sound. Individual heartbeats detected via the Waverider\textsuperscript{18} electrocardiogram were used to trigger a strong sub-bass pulse sound reminiscent of the low frequency throbbing of an actual beating heart. Increases in heart rate were indicated by increasing the timbrel brightness of this heartbeat sound, as well as by a see-sawing tonal pattern played out by a bell-like drone that responded to the rising and falling of breath related changes in heart rate (respiratory sinus arrhythmia).

Each interaction lasted between ten to thirty minutes (maximum), and participants were free to conclude their interaction at any stage. Participants were invited to observe and differentiate relationships between breath movement and heart rate as revealed through changing diameters of the coloured concentric circles in the video projection and the sound of the work, and see if they could influence the phase relationships between the expanding and contracting movements of the respective circular visualisations. This task oriented approach required a process of verbal and practical induction that could sometimes take up to ten minutes, during which I (as the artist/operator/facilitator) would explain how breath and heart rate related changes were reflected in the look and sound of the work, and suggest some ways that

\textsuperscript{18} Distributed by MindPeak, USA
participants could initiate and then observe some changes in their heart rate and breathing patterns as revealed through the work and their own felt sense.

Interviews were recorded with many of the installation participants at the conclusion of their interaction with the work. These interviews lasted up to twenty minutes, during which participants reflected on aspects of their experience they found interesting, the extent to which they felt they were able to sense and perhaps influence the behaviours being monitored, aspects of the experience they found confusing or frustrating, and any suggestions they had as to how the work might be further developed in the future.
Chapter 5.2 Cardiomorphologies v.1

**Hardware**
- UFI ‘Pneumotrace’ breath sensor
- Angelo Fraietta CV-MIDI device
- Waverider sensor hardware (heart sensor)
- Apple PowerBook G4, 1Ghz (OS 10.3)
- HP Notebook (Windows XP)
- Stereo amplifier x 4 speakers
- Reclining chair
- Data projector

**Software**
- MAX-MSP (Mac OSX)
- Wavewares software for Waverider
- Java 2d visualisation and analysis
- by John Tonkin

Figure 33 Plan view of Cardiomorphologies v. 1, as installed at Performance Space, Redfern, Sydney, Australia
5.2.2 Aims and Developmental Context

The primary aim of *Cardiomorphologies v.1* was to explore mentally and emotionally mediated changes in heart rate variations (HRV) introduced in Chapter 4.1, by developing an interactive artwork that would enable participants to sense and enact these heart rate patterns through the conscious manipulation of breathing, audio-visual feedback, felt experience, mental activity and emotional recall.

*Cardiomorphologies v.1* used a relatively pared-down, almost laboratory-style aesthetic compared to immersive and dream-like atmosphere of *res’onance-body [-box]*. The emphasis in this work was focused more on the participant’s ability to identify and engage the various signals being monitored, and how this engagement might in itself constitute a form of aesthetic or somesthetic experience. The visual interfaces used abstract, mandala-like animations as a way of highlighting the instrumentality of the artwork-interface. It was important that the interfaces were not experienced as some form of exotic external phenomena, but as a very concrete extension or representation of the participant’s own physicality. The visualisations needed to be simple enough to be intuitively discernable to viewers when they entered into the more inwardly-focused state of consciousness that the work invited, without requiring them to leave this state in order to apply a more analytical mode of engagement.

HRV spectrum analysis\(^9\) was introduced as a way of observing interactions between emotionally mediated changes in nervous system arousal and heart rate patterning. In contrast to breathing patterns, which can be consciously shaped through the coordination of chest and abdominal muscles, heart-related behaviours (especially those examined in HRV spectrum analysis) present a much more elusive set of behaviours. As a basis for interaction, this kind of data presents a number of challenges, most notably, the extremely low frequency of the waveforms being measured (as low as a half or a quarter cycle per minute) and the unfamiliar nature of frequency-domain (power-spectrum) measurements to the majority of audiences, relative to the more familiar time-domain measurements such as clocks, calendars and electrocardiograms etc.

*Cardiomorphologies v.1* provided a starting point for my exploration of ethnographic fieldwork processes as a form of audience interaction and practice-based research. Interviews describing their experience of the work were recorded with participants after their interaction, and were presented as an integral component of the exhibition experience via a bank of portable compact disk players. This provided an opportunity to explore how this kind of research process and the audience narratives it documented could be reincorporated into the work as a whole. In addition to providing

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\(^9\) Refer to Chapter 4.1.1 for a more information about Heart rate Variability spectrum analysis.
valuable feedback on the perceived strengths and weaknesses of the various interface elements, the interview process was seen from the outset as a way of facilitating and documenting discussions around bodily experience and psychophysiological phenomena grounded in the lived experiences of each participant. This use of the exhibition as a framework for dialogue and the sharing of stories, builds on the work of artists such as Lee Mingwei, as discussed in Chapter 3.1.2.

5.2.3 Design and Implementation

Cardiomorphologies v.1 was developed with the assistance of computer programmer and new media artist John Tonkin. His role was to develop the analysis and visualisation aspects of the work according to the various physiological variables I sought to monitor, and to develop the simple visualisation scheme envisaged for this work. Technically Cardiomorphologies v.1 represented a substantial development from the simple breath rate controlled soundscapes of res’onance-body [-box].

The flowchart in Figure 37 illustrates the analysis processes used in Cardiomorphologies v.1. Breath velocity was implemented as a way of identifying different stages of the breath cycle. Electrocardiogram data was gathered using Waverider biofeedback hardware, with adhesive surface electrodes attached to the participant’s forearms. Waveware (MindPeak, 1994) software was used to extract individual heartbeat impulses along with a measurement of the moment-to-moment inter-beat interval (IBI) expressed as beats-per-minute. JAVA analysis data was transmitted both internally (to the visualisation system) and externally (to MAX-MSP running on a Macintosh PowerBook) using Open Sound Control (OSC), a network-based communications protocol for computers, sound synthesisers, and other multimedia devices (Wright et al., 2003). Many of the data sonification algorithms used in Cardiomorphologies v. 1 incorporated manually adjustable logarithmic scaling algorithms using Klaus Filip’s ll.log and ll.!og objects for Max-MSP, providing a much improved quality of responsiveness to the participant’s actions (refer to Figure 38).

The breath and heart data was visualized through a set of expanding and contracting concentric circles representing breath movement, breath rate, heartbeat and heart rate20, and were inspired by the simplicity and hypnotic intensity of 1960’s Op Art and colour field abstraction Visual feedback provided a partial bridge towards an appreciation of these often-unfamiliar phenomena. Unfortunately, the spectral analysis and visualisation capabilities required for this project were only completed in the second half of the residency21, limiting the amount of time available for implementing this data into the sound and visual design of the work.

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20 Refer to Table 3 for a description of the visualisation data-mapping scheme.
21 Refer to example reproduced in Figure 35.
The actual process of inducting participants into and through the work emerged as a critical component of their experience. The fact that I supervised the interactions, and was available to answer any questions they had regarding the work and how it was responding to their presence, intensified the already intimate and personal nature of the experience. This informal dialogical element, between artist operator and participating audience, opened the way for a more detailed consideration of the role of the artist/operator in the presentation of this type of physiologically embodied enquiry, recalling the dialogical practices examined in Chapter 3.1.2 and the important role of the practitioner-facilitator in clinical biofeedback and somatic bodywork practices.

5.2.3.1 Data Mapping

Figure 34 Process flowchart overview for Cardiomorphologies v. 1 showing feedback loop between participant and physiologically responsive artwork.
<table>
<thead>
<tr>
<th>Data collected from body</th>
<th>Sound feedback</th>
<th>Visual feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breath, basic in-out motion of</td>
<td>Deep breath-like sound, similar to sound of deep breathing or waves crashing</td>
<td>Circular form expanding outwards during inhalation, and contracting inwards during exhalation.</td>
</tr>
<tr>
<td>diaphragm/chest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breath rate, how fast or slow</td>
<td>Relative pitch of the breath sound: higher pitched breathing noise for faster breathing, very low frequency, deep rumbling noise for very slow breathing</td>
<td>A thin light-blue coloured ring, expanding outwards with slower breathing, and contracting inwards with faster breathing</td>
</tr>
<tr>
<td>Heartbeat</td>
<td>Low frequency throbbing noise, pulsing in time with heartbeat.</td>
<td>Brightness of red coloured heart rate circle, pulsing in time with heartbeats.</td>
</tr>
<tr>
<td>Heart rate variations (inter-beat</td>
<td>Heartbeat sound increases low-pass filter cut-off frequency as heart rate increases, and decreases cut-off frequency as heart rate becomes slower. See-saw drone patterns, alternating according to changes in heart rate velocity</td>
<td>Gently pulsing red coloured circle, expanding outwards with increased heart rate, and contracting inwards with slower heart rate. Pulsing in time with heartbeat.</td>
</tr>
<tr>
<td>interval)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate variability spectrum,</td>
<td>Some work was done to try to map data from the 128 bands of spectral analysis to sound, using averaged levels of each of the three frequency groups. Average levels of each frequency group were used to control the volume of three distinct sound textures.</td>
<td>Heart rate variability rendered spectral display: 128 bands, grouped into three distinctly coloured groups.</td>
</tr>
<tr>
<td>analysis, measuring ultra-low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>frequency oscillations in heart rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>taking place between 0.005 Hz to 0.4 Hz, and generally discernable as three bands of activity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Very Low Frequency (VLF) HRV</td>
<td>Abstract incoherent chattering voices/whispers</td>
<td>Red bars</td>
</tr>
<tr>
<td>oscillations between 0.005 – 0.05 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Low Frequency (LF) HRV oscillations between 0.05 – 0.15 Hz</td>
<td>High-pitched tinkling bell sound</td>
<td>Pink bars</td>
</tr>
<tr>
<td>• High Frequency (HF) HRV oscillations between 0.15 – 0.4 Hz</td>
<td>Rain sound</td>
<td>Blue bars</td>
</tr>
</tbody>
</table>

Table 3 Audio and visual data-mapping scheme used in Cardiomorphologies v.1. Refer also to example of final visualization scheme in Figure 35.
5.2.4 Technical Developments

Cardiomorphologies v. 1 implemented electrocardiogram-based heartbeat sensors, replacing the less-reliable infrared pulse plethysmograph sensor used in resonance-body [-box], and also introduced the use of breath-velocity data and heart rate variability spectrum analysis. Open Sound Control (Wright et al., 2003) was used to transmit sensor data between computers allowing the multiple machines to work with a common set of sensor analysis data, with one machine focusing on visualization and the other on sonification tasks.

5.2.4.1 Hardware

The breath-sensor used in Cardiomorphologies v. 1 – the same as that used in resonance-body [-box] – broke down twice during the residency, highlighting the
fragility of this sensor under intensive use\textsuperscript{22}. Considerable time was spent investigating the peculiar responsiveness of this sensor, which was incapable of responding accurately to breath-holding manoeuvres. Any sustained displacement (stretch) readings would gradually return to the default un-stretched value over a period of approximately twenty seconds. Consultation with engineers at AD Instruments Australia revealed the problem to be inherent to the capacitor-coupled nature of piezo-electric sensors in general. This inability to measure breath-holding actions (sustained periods of displacement) impacted significantly on the accuracy of the breath-rate analysis and the perceived closeness of fit between participants’ actions and the artwork. The \textit{Waverider} biofeedback device required that participants be fitted with three adhesive surface-electrodes (one electrode attached to the participant’s wrist, the other two electrodes attached to left and right forearms). The use of these surface electrodes created a strong feeling of being ‘wired into the system’ introducing an element of suspense or caution for some participants, but also a degree of unreliability as the quality of sensor data was dependant on the quality of electrical conductivity afforded by the participant’s skin.

\textbf{5.2.4.2 Software}

\textbf{Heart Rate Analysis: Data Processing with ‘Wavewares’}\textsuperscript{22}

By default, the \textit{Waveware} software application required to receive and process the \textit{Waverider} sensor-data transmits via MIDI note and velocity values. An important concern at the early stages of this project was to find a way to preserve as much of the accuracy and resolution of the original data as possible. MindPeak, the US company that produced the \textit{Waverider} system, provided a DLL functionality, which they claimed would enable \textit{Waveware} to transmit floating-point data in real time from any of its data-analysis windows, but this was found to be incompatible with the existing (Windows XP) operating system. MindPeak also claimed that \textit{Waveware} could transmit sensor analysis data via MIDI double-precision control data (eg. 75.15 BPM), but this was also found to be unsupported. Inter-beat intervals (IBI) were subsequently expressed in BPM (beats per minute) rounded to the nearest integer. This rounding-off was deemed acceptable given that our focus was on the extremely low-frequency heart rate oscillations in the area of between 0.04 Hz (2.4 BPM) and 0.15 Hz (9 BPM).

\textsuperscript{22} Pneumotrace piezo-electric respiratory strain gauge produced by UFI and distributed by AD Instruments Australia.
Breath Analysis Using Sensor Displacement Velocity

The velocity of breath-sensor data (displacement caused by movement of chest or abdomen) emerged as a vital component of the breath sonification process, providing a simple way of mapping changes in breath displacement to sound amplitude. Figure 36 illustrates the relationship between breath-sensor displacement and velocity time-series, revealing the coincidence of displacement peaks and troughs with velocity zero-crossing points. Breath displacement velocity data had previously been used in res’onance-body [-box], but only as a means of obtaining periodic breath rate data. Cardiomorphologies v. 1 worked with velocity data as a relatively continuous\textsuperscript{23} control signal (i.e. wave-shaped control signals).

\textsuperscript{23} Velocity data was calculated from displacement data re-sampled at a rate of approximately fifty samples per second.
Figure 37 Process flowchart for sensor data analysis Cardiomorphologies v. 1, as performed by John Tonkin’s JAVA data processing and analysis software.
Logarithmic Data Mapping

Logarithmic scaling of feedback signals emerged as a significant improvement in the overall responsiveness of the various data sonification designs. Since human perception is often logarithmic (Paine, 2002), it follows that logarithmic scaling can help provide a more natural sense of responsiveness during interaction. Cardiomorphologies v.1 and subsequent works have made extensive use of Klaus Filip’s *ll*log and *ll!.log* objects for MAX-MSP (Filip, 2004) for the logarithmic scaling of physiological data for auditory feedback. Logarithmic scaling is especially useful for scaling physical gestures such as reach, stretch, expansion and contraction, and is thus especially useful in the scaling of inhale/exhale data, by lending strong emphasis to movement in particular parts of the movement. In Cardiomorphologies v.1, when mapping raw MIDI (0-127) control data from the stretch sensor, logarithmic scaling was used to emphasise movements towards the end of the inhalation and the start of the exhalation movement, using perceived change as a way of encouraging participants towards a fuller breathing action.

Breath rate provides another good example of the use of logarithmic scaling for improving the quality of responsiveness in a feedback signal/physiological sonification, where it can be used to help guide the participant from their initial (usually faster) breathing rate, towards a slower more even breathing rhythm. Logarithmic scaling would be used to emphasise the amount of change at the earlier stage of the transition from faster breath rates at around fifteen breaths per minute, down to slower rates of eight to six breaths per minute. Logarithmic scaling in this instance still provides some room for mapping breath rates slower than six breaths per minute, but changes in breath rate below this rate are given less emphasis.

Figure 38 Logarithmic scaling with Klaus Filip’s *ll*log object for MAX-MSP, demonstrating response curves based on various degrees of logarithmic scaling. Note the two plots from the right: -5.0 will emphasize changes towards the end of the scale, while +5.0 will emphasize changes at the beginning of the scale.
Heart Rate Sonification: Steps, waves and latencies

Heart rate sonification presented a number of challenges during the development of Cardiomorphologies v.1. The initial sonification of each heartbeat was a fairly simple low frequency, pulsed, filtered-noise sound (resembling an actual heartbeat pulsing sound) that would increase and decrease in pitch/brightness according to changes in heart rate from one beat to another. This in itself may have been enough to suggest changes in heart rate, but I was hoping to generate a much more fluid form of feedback that might help participants sense the soft action of breathing-related changes in heart rate as a gentle swinging motion. A wave-like pattern was generated from changes in inter-beat intervals, with faster intervals mapped to lower frequencies. A substantial amount of low-pass filtering (smoothing) was applied to the heart rate variability (HRV) time-series to transform it from a step-like motion to a smooth, flowing wave motion. This wave motion was then used to cross-fade between a number of bell-like drone textures, producing a gentle seesawing tonality.

Whilst the resulting sound texture did indeed sound fluid and invoked a sense of gentle wave-like motion, it became apparent that this motion lagged behind the original signal by nearly a whole second, and was thus redundant as a signal for biofeedback training. For example, when the wavelike sound approached its zenith, the participant’s actual heart rate variability pattern had already begun its decent into the slower inter-beat intervals (refer to Figure 39). This delay is inherent to the low-pass filtering process used to transform the periodic heart rate measurements into a continuous, wave-like interpolated signal.

Figure 39 Time series graph of inter-beat intervals recorded over a twenty second period. Actual heart rate measurements are indicated by the black dots, while the smoothed and interpolated signal is indicated by the solid grey profile. The arrows show examples of latency between original impulse (heart inter-beat interval) and smoothed signal.
Figure 40 Process flowchart for Cardiomorphologies v. 1 heart rate sonifications.

Heart-rate sonification 1: ‘heartbeat’ sound

1. Receive basic heart-rate data at 40-120 bpm via network (OSC) from JARA app.
2. Narrow heart-rate data to 0.0 to 1.0, using average min. and max. values from past 12 beats.
3. Scale to cut-off freq. for resonant low-pass filter: 75Hz (Rest) - 35 Hz (HRW).
4. White noise generator.
5. Resonant low-pass filter.
6. Digitally controlled amplifier (DCO).
7. Attack-decay envelope generator.
8. Low-pass filter.
9. Mix to stereo.
10. Process through additional treatments like graphic eq., hi-pass filters and reverberation.

Heart-rate sonification 2: ‘see-saw’ drone sound

1. Receive “sitting” message with each heart-beat via network (OSC) from JARA app.
2. Divide heart-rate time-series data into increasing and decreasing changes.
4. Scale increasing heart-rate to 0.0 to 1.0.
5. Map standard-deviation to cross-fade between six pairs of drone textures.
6. Velocity controls drone envelopes (gain).
7. Bank of six looped drone textures for decreasing heart-rates. Arranged from lowest to highest pitches, and mixed according to amount of standard-deviation.
8. Bank of six looped drone textures for decreasing heart-rates. Arranged from lowest to highest pitches, and mixed according to amount of standard-deviation.
9. Mix to stereo.
10. Process through additional treatments like graphic eq., hi-pass filters and reverberation.

Heart-rate sonification 3: “HRV FFT sonifications”

1. Receive FFT data: VLF data normalized as a % of total FFT power via network (OSC).
2. Scale FFT bin amplitude to volume.
3. Looped drone texture: rain sound.
4. Mix to stereo.

1. Receive FFT data: LF data normalized as a % of total FFT power via network (OSC).
2. Scale FFT bin amplitude to volume.
3. Looped drone texture: raining bells.
4. Mix to stereo.

1. Receive FFT data: HF data normalized as a % of total FFT power via network (OSC).
2. Scale FFT bin amplitude to volume.
3. Looped drone texture: incoherent whispers.
4. Mix to stereo.
5. Mix to computer 2 stereo output.
Figure 41 Breath-data sonification process flowchart for Cardiomorphologies v. 1 showing the two banks of off-set resonant band-pass filters used to distinguish inhalation sounds from exhalation sounds.
5.2.5 Interaction Analysis and Audience Response

Approximately ninety individuals interacted with the work. Most participants expressed pleasure in watching their body functions represented as visuals and sounds at the start of their interaction. In general, most participants focussed primarily on the visual feedback, with the exception of a smaller group of participants with a strong auditory bias.

In general, participants found no difficulty in interacting with the basic breath displacement visualization, but took some time to understand the breath-rate feedback; a deep blue or yellow ring that increased in circumference as breathing rates became slower, and contracted towards the centre as breathing became faster. This was partly attributable to the somewhat unreliable breath rate recordings obtained by the piezo-electric sensor, and the fact that under normal, relaxed conditions, breathing can become quite shallow/gentle and will not always register clearly enough (as a movement in the breath-sensor device) to obtain reliable results. Many participants engaged in breath-holding manoeuvres, usually within the first ten minutes of the interaction with the work, as a way of testing the work’s responsiveness, but the work was unable to respond to these actions due to the piezo-electric design of the breath-sensor. This failure to accurately respond to breath-holding behaviours was a regular source of fascination and sometimes disappointment for many participants, and highlighted the close level of attention that participants brought to their engagement with the work.

Heart rates varied significantly across participants, ranging from 119 BPM to as low as 42 BPM, exceeding the predetermined minimum and maximum heart rates that the work had been designed to respond to.

One participant expressed her discomfort with the visual interface, finding the large pulsating red circle that represented pulse and heart rate data intensely threatening. This response raised interesting questions about instinctive, autonomically mediated fight-flight response patterns associated with certain flashing red objects and throbbing sounds. Another participant felt that the sound was too loud and requested that it be turned off altogether in order that they could concentrate entirely on the visual feedback. Several participants engaged in unprompted experiments exploring startle and stress effects, inviting their companions to try to surprise them at some stage with a loud noise or sudden contact, or by holding their breath in order to observe changes in heart rate.

The FFT-based HRV spectrum display was implemented in the last week of the residency (refer to example of spectrum bar graph visualization in Figure 35). Participants were invited to see if they could influence the height of the different

24 Fast Fourier Transform – frequency domain analysis of periodic signals
coloured bars by thinking of contrasting situations or emotions – recalling mentally or emotionally challenging situations or tasks to increase the size of the pink bars (very low frequency oscillations) or recalling/imagining pleasant and comforting situations or memories to increase the height of the red bars (low frequency oscillations). Around half of the participants who engaged with this interface were able to initiate some form of change in the balance between pink and red bars after sustaining a particular feeling or mental task for a period of over five minutes. One participant in particular was able to initiate changes in the balance between red and pink bars (ratio of VLF to LF) over the course of their interaction by alternating between a memory of being a child sleeping in his grandmother’s lap (peaceful, warm and comforting) and a recollection of his workplace to-do list (mentally demanding or stressful), with the colour bars responding accordingly.

5.2.5.1 The Participant Interviews

Interviews with participants after their interaction with the work provided many valuable insights into the viability of the work and ways it could be improved and further developed. A team of volunteer interviewers recorded seventy-eight interviews. Participants where asked to respond to the following questions:

- What was the most interesting aspect of your experience?
- What connections between your body and the sounds and visuals did you find the most interesting?
- To what extent did you feel you that were able to influence aspects of your breath and heart rate?
- To what extent did the sounds and visuals help you do this?
- Were there any aspects of the work that you did not enjoy?
- Do you have any other suggestions for how this work might be developed in the future?

5.2.5.2 Methodology

The aim of this initial research into audience experience was to explore the range of experiences and reflections generated by the work and to consider the viability of including these experiences as form of dialogical practice. This exploration of audience experience provided a valuable starting point for my subsequent collaboration with
curatorial researcher Lizzie Muller on Cardiomorphologies v. 2. Interview material was coded according to recurring patterns of response, based on notes made from listening back to each of the interviews. The coding process focussed on which aspects of the work participants found most interesting, and the extent to which they felt able to influence certain aspects of the work and their own physiology. The combined data from all of these interviews was then sorted according the number of similar responses or associations given to each of the interview questions, providing a rough overview of key responses emerging from audience experiences of the work. Whilst far from ideal as a method for rigorous qualitative research, this simple survey process did enable the identification of a number of important issues that would be addressed in the work’s subsequent iteration, Cardiomorphologies v. 2.

5.2.5.3 Participant Responses

What was the most interesting aspect of your experience?

Most participants reported the ability to visually observe changes taking place inside their own body as the most interesting aspect of the experience. Most participants also enjoyed the experience of observing and learning to regulate some aspect of their breathing and heart rate. Many participants noted the interesting quality of self-recognition the work provided, and were also quick to note subtle discrepancies in the way the design would respond (or not) to changes they were making to their breath patterns. There was a general agreement that the work had a lot of potential for further development. Participants appreciated the simple mandala-like design of the visuals, commenting on how easy it was to read in comparison to the numeric readouts at the bottom of the screen displaying breath rate, depth and heart rate information.

What connections between your body and the sounds and visuals did you find the most interesting?

Breath was central to most participants’ engagement with the work, as revealed to them by either its visual representation or its sonification. Several participants became interested in discrepancies between what they felt within their own body and what was displayed on screen and through the sounds: these were perceived as either latencies in the artwork’s responsiveness, or as mostly beyond the participant’s control. Much of this was due to the inability of the breath sensor to accurately reflect breath-holding manoeuvres.
To what extent did you feel you were able to influence aspects of your breath and heart rate?

As expected, the majority of participants felt that they were able to influence their breath rate, but on the whole, felt less able to influence their heart rate.

To what extent did the sounds and visuals help you do this?

Most participants found the visuals helpful in learning to influence breathing and to a lesser extent, heart rate activity.

Were there any aspects of the work that you did not enjoy?

Some audiences reported feelings of unease or embarrassment at the prospect of other observers gaining some insight into their own physiology, feeling slightly uncomfortable with the notion of something so personal being aired for all to observe. These feelings would usually subside once they immersed themselves in interaction with the work. Many participants reported a sense of information overload in trying to comprehend what all the sounds and shapes represented, but would usually narrow their focus down to aspects they felt able to understand. Some test interactions were conducted in which participants were deliberately not informed about what the different sounds and shapes corresponded to. In these instances it was found that participants would request some explanation as to what they were supposed to 'do' and what the signals meant within the first ten minutes of the interaction. Several participants requested that the sound be turned down or off altogether. The sound of their own heartbeat translated into a loud low-frequency pulsing sound was felt to be especially overbearing.

Do you have any suggestions for how this work might be developed further in the future?

Many participants reported a tension between the desire to engaged with the highly hypnotic qualities of the visual design and the instinct to close their eyes in order to focus their attention and awareness on their breathing and heart rate. Many participants suggested the development of more organic or biomorphic visualizations, and a more immersive but gentler sound design. Several participants also expressed an interest in the idea of the work being available as a device for relaxing at home.
5.2.6 Evaluation

Cardiomorphologies v.1 was a successful proof-of-concept artwork, providing real-world exhibition and interaction conditions for evaluating the overall direction of the work and its viability as a form of public, gallery-based interaction. The work succeeded in providing a challenging forum for audiences to interact with aspects of their own breathing and heart activity, and a space for considering links between subjectivity and physiology in a far more detailed way than had been achieved in resonancel-body [box]. The length of interaction was determined by participants themselves and on average lasted between ten to twenty minutes, suggesting that the work was sufficiently engaging for this length of time. Exhibiting the work as part of an artist’s residency program helped to frame the audience’s experience of the work as form of experiment and research, encouraging a sense of enquiry and experimentation highly conducive to the aims of the work itself.

The simple two-dimensional data visualisation provided an intuitive system for discerning increases and decreases in physiological data. However, this could occasionally become too distracting, such as when the different circles nested inside one another to produce the illusion of a tunnel-like space. This was problematic from a data-readability standpoint, but attractive as a visual and spatial effect and added to the aesthetic experience. Rather than avoiding such intense effects, they could be harnessed as kinaesthetically expressive devices describing or reinforcing the behaviours being monitored, and thus incorporated more deeply into the work.

Audience evaluations recorded during the residency provided valuable insights into user experience and communication issues regarding my initial experiential goals for the work. Information overload during the induction into the work was a recurring experience, suggesting the need for more a simplified introduction. Most participants were unfamiliar with the concept of heart rate variability (HRV), believing a ‘healthy’ heart rate to be absolutely regular. Some time was required before they felt clear about the concept and how they could observe it through the artwork/feedback signals.

In order for subjects to accurately sense and respond to biofeedback data, the feedback must be as immediate as possible. For heart rate feedback to be workable, it must respond as quickly as possible to changes in heart rate which is itself retrospective by nature (as a measurement of the amount of time between the two most recent heartbeats). One solution to this delay problem may be to represent these abrupt transitions through gentler delay-based signal processors such as phaser, flanger or chorus effects, which would provide noticeable shifts in sound quality whilst maintaining the essential stability or flowing characteristics of the original sound source. It is also possible that changes in blood pressure could provide useful correlations to respiratory-sinus-arrhythmia, HRV and baroreflex behaviours.
associated with Evgeny Vaschillo’s research into cardio-respiratory resonance (Lehrer et al., 2000, Vaschillo and Lehrer, 2003).

Spectral analysis of HRV in basic form was implemented in the last two weeks of the residency, and the spectral profiles obtained by this analysis revealed a diversity of data within and across different individuals. These results confirmed the viability and rich potential for heart rate variability spectrum analysis as a mode of interaction and way of imagining mind-body continuities. HRV spectrum analysis requires a minimum of five minutes of recorded data before it can begin its analysis – at the beginning data is generated from an initial transition from zero, and manifests as a series of ‘shock-waves’ that settle down after the first five minutes. In Cardiomorphologies v. 1 this initial five minutes of noise was not concealed from the participant, creating an unnecessary confusion as to the meaning of the spectrum display during the first few minutes of the interaction. Some method for concealing this display until it had recorded the necessary five minutes of data needed to be implemented to avoid this confusion.

Towards the end of the residency, the breath sensor device (UFI Pneumotrace device) broke down and had to be replaced, highlighting the fragility of that particular sensor design. One of the broken sensors was eventually disassembled to provide the basis for developing my own, more robust design, which would eventually provide a partial solution to the shortcomings of this sensor.

On a practical level, the rapidly growing complexity of the MAX-MSP patches developed for Cardiomorphologies v.1 highlighted the need for a more modular approach to the process of data mapping and scaling required by the work. Navigating around the many layers of algorithms that made up the data sonification system became an increasingly time-consuming and confusing experience. This led to the development of a modular, matrix-based approach to the construction of the various data mapping and sound synthesis algorithms to provide a faster and more flexible working environment for Cardiomorphologies v.2 i.e. inputs and outputs could be assigned via a manually programmable matrix or from drop down menus, providing a flexible and easily reconfigured system for exploratory data mapping.

5.2.7 Implications

The duration of interactions and quality of engagement confirmed the viability of this kind of highly focused interaction, despite logistical issues associated with the limited number of people who could engage with the work in a given day. The dialogical qualities introduced through the participant interviews along with conversations that arose spontaneously during each interaction, emerged as an important part of the experience as a whole and would continue to be explored in Cardiomorphologies v. 2.
Given the intensely proprioceptive nature of the interactions developed through this exegesis, it is logical that audio feedback should take precedence over visual feedback. However, over the course of this work’s development, it became clear that my ambitions for how I wanted the work to sound far exceeded my abilities as a computer music engineer and designer. Faced with this limitation, and the strong visual bias of most participants, I decided in the short-term to concentrate primarily on the development of the data visualizations.

The simple chart-like visualizations used in Cardiomorphologies v. 1 provided a useful reference point for future works, but left little room for describing differences between individual participants. Feedback from participants indicated an overwhelming desire for the work to reveal the substantial differences between different participants. Graphic variables such as hue, saturation, and shape density could be explored as additional parameters for data visualization that could help differentiate one participant’s interaction from the next, and intensify the expressive qualities of the artwork.

HRV spectrum analysis did demonstrate the possibility of emotionally mediated changes in heart rate patterning, but the presentation of this data in the form of a conventional bar-graph was at odds with the circular format used to visualize the other behaviours. As the sole basis for interaction (as initially envisaged), this kind of (frequency-domain) display would be problematic for most participants, compared to the more tangible (time-domain) breath and heart rate feedback displays. More research would need to be done in relation to how these two domains of analysis and visualization could be integrated into the artwork as a whole.

Difficulties were starting to emerge regarding the suitability of the respiratory-strain gauge sensor belt for the type of interaction I was interested in working with. The belt-based design of this sensor tended to encourage a self-conscious and often effortful quality of breathing, in contrast to the highly nuanced qualities of movement and reflection I had envisaged. This problem was intrinsic to the design of the sensor, and in lieu of a more suitable alternative, required an alteration to the way in which I described the sensor and the patterns obtained from it to participants. Regardless of how well such a belt is fitted, the wearer’s breathing will naturally tend to move around the point of constriction. It was therefore necessary to make it clear to participants that the belt was simply responding to the involvement of one section of their chest or abdomen in the larger sequence of events that constituted the process of their breathing.
5.3 **Drawing Breath (versions 1 & 2)**

*Drawing Breath v.1*, was exhibited in the group exhibition *Asian Traffic: Phase five* presented by Asia Australia Arts Centre (Gallery 4A)

Gallery 4A 181-187 Hay Street, Sydney, Australia

24th August to 11th September, 2004

*Drawing Breath v.2*, was exhibited in the group exhibition *Open Letter: Phase two* presented by Asia Australia Arts Centre (Gallery 4A) and Asialink

Exhibition tour dates:

Gallery 4A, Asia Australia Arts Centre

Sydney, Australia, April 14th to May 14th, 2005;

Metropolitan Museum of Modern Art,

Manilla, Philippines, October 5th, 2005 to January 13th, 2006;

National Art Gallery,

Bangkok, Thailand, August 5th to 28th, 2005;

National Art Gallery,

Kuala Lumpur, Malaysia, February 14th to April 16th 2006.

Credits:

George Poonkhin Khut – installation concept, design and art direction,

John Tonkin – data analysis algorithms and visualisations (JAVA), hardware support

Bing Hui Huang-Fu – curator
Figure 42 Installation views of Drawing Breath v.2 as exhibited at Gallery 4A. Top: view showing projected imagery with participant. Bottom: view of participant wearing stretch-sensing breath sensor. Photography by Krzysztof Osinski.
5.3.1 Introduction

*Drawing Breath v.1* and *Drawing Breath v.2* were two breath-responsive artworks that translated chest or abdominal movements collected by a stretch sensor worn around the participant’s chest or abdomen, into a flowing three-dimensional video projection and sound design. Each breath was transformed into a wave-like sound that flowed around the participant, gradually transforming from a high-pitched hissing sound to low-frequency rumbling according to the rate and depth of the wearer’s breathing. John Tonkin’s interactive graphics created a tangled mass of white lines that lengthened and expanded from the centre of the screen – outwards with each inhalation – creating a strong sensation of expansiveness. The sensuous and slightly irregular turbulence of the design evoked the fluid movements of marine life forms or fireworks displays. Unlike *Cardiomorphologies v. 1*, participants were free to interact with the works on a casual basis without the need for an appointment or supervision.

*Drawing Breath v.2* explored the use of breathing as a rhythmic device for the recitation of a series of layered bi-lingual texts. Two of these spoken texts counted the number of breaths taken by the participant, counting from one to one hundred in Mandarin Chinese and English simultaneously, interspersed with a separate body of text consisting of various randomly sequenced phrases in Mandarin Chinese and English relating to the theme of breath. The breath-counting text referenced a common Buddhist meditation device for beginners, used as a way of attention training.
Chapter 5.3 Drawing Breath versions 1 & 2

**Hardware**

- Respiratory strain-gauge
- Angelo Fraietta CV-MIDI device
- Apple PowerBook G4, 1Ghz (OS 10.3)
- Pentium-4 desktop computer (Windows XP)
- Stereo amplifier x 4 speakers
- Data projector

**Software**

- MAX-MSP (Mac OSX and Windows XP)
- Custom-coded Java data analysis and visualisation software (Windows XP)

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Figure 43 Plan view of Drawing Breath v.2 as installed in Open Letter group exhibition, Gallery 4A, Sydney, Australia
5.3.2 Aims and Developmental Context

*Drawing Breath v.1* was conceived as a semi-portable installation that could be exhibited without the need for a full-time operator or attendant. Joanne Kee and Roland Peelman of The Song Company, a Sydney based vocal ensemble specializing in early and contemporary music repertoire, were interested in the idea of presenting an interactive installation as part of their up-coming concert of compositions exploring the concept of breath: *Drawing Breath*. Around the same time, Binghui Huangfu, then director and curator of the Asia-Australia Arts Centre (Gallery 4A) invited me to develop a work for her *Asian Traffic* group-exhibition in August, 2004. The *Drawing Breath* series of works developed out of these two invitations, and compared to *Cardiomorphologies v.1*, aimed to provide a much more casual and playful form of interaction to be exhibited in touring group-exhibitions with minimal site preparation.

In response to audience suggestions recorded during *Cardiomorphologies v.1*, the *Drawing Breath* series of works explored three-dimensional and biomorphic visualizations of breathing movements. Early visual concept included swarming clusters of objects, and jellyfish and sea anemone-like marine life forms that would translate the movement of the participant’s breath into a turbulent flow of particles or tentacle-like strands. Sonically, *Drawing Breath v.1* and *Drawing Breath v.2* built on the breath sonification systems developed in *Cardiomorphologies v.1* using the same idea of filtered noise and crackle sounds processed through paired offset filter banks.

The spoken texts in *Drawing Breath v.2* represent the first step in the exploration of breath as a metering device for poetic recitation. This had been a long-term interest of mine, and *Drawing Breath v.2* provided a good opportunity to experiment with how this idea might be developed. *Drawing Breath v.2* also implemented a new breath-sensing belt, using my own custom-built stretch-sensor design as a way of obtaining more reliable measurements of breath-holding actions (refer to chapter 5.2.4.1). A number of prototype designs working with different sensor technologies were constructed and tested, resulting in the use of an elastic, stretch-sensing material produced by Merlin Robotics (UK), in conjunction with an improved scalable CV-MIDI in-out device constructed by Angelo Fraietta.
5.3.3 Design and Implementation

*Drawing Breath v.1* and *Drawing Breath v.2* built on the breath analysis and sonification algorithms established during *Cardiomorphologies v. 1*. Important improvements were made to the design of the breath-sensor in *Drawing Breath v.2* and both works provided the opportunity to reflect on issues surrounding the use of sensors and their relationship to the sensation of breathing. *Drawing Breath v.2* implemented a quadraphonic speaker design in an attempt to create a more encompassing and spatially dynamic sound design that translated the in/out movement of breathing into a forwards/backwards movement in relation to the participant. Breath-rate sensing continued to be a highly problematic task, based as it was on the continued use of the belt-based respiratory strain-gauge design, and exacerbated by the fact that the work relied on participants fitting and adjusting the sensor belt themselves, without assistance from an experienced operator or interaction facilitator.

Because breath rate was calculated on the basis of successive durations between each breath, the last duration recorded by the system was in fact the period between participants. This meant that without some form of switching device to restart the data mapping system, every interaction would begin with a transition from a very long duration (i.e. when no one was attached to the sensor) to the actual duration of the new participant’s breath rate. As both works were exhibited without an operator to start and stop each interaction, a need arose to address how the work would recognise and respond to the start and end of each participant’s interaction. A switching algorithm was constructed to reset the work to a default state as soon as the work detected a breath duration longer than forty-five seconds (see Figure 45).

Figure 44 Image sequence from *Drawing Breath v.2* video documentation, showing the expansion and contraction of the particle-based breath visualisation system designed by John Tonkin.
Figure 45 Process flow-chart for Drawing Breath v.2 sonification, including presence detection algorithm to reset breath rate data at the start of each participant’s interaction.
5.3.4 Technical developments

5.3.4.1 Breath Sensor Hardware

The extreme fragility of the UFI Pneumotrace breath-sensors became evident during Cardiomorphologies v. 1 and Drawing Breath v.1. A range of alternative breath-sensing methods had already been considered (temperature sensors or microphones taped under the nose, air-flow spirometers requiring insertion into the participant’s mouth, etc), but at this stage the use of such highly intrusive physiological sensing devices seemed out of the question, as they would require large quantities of costly, disposable components that would have to be disposed of, or sterilized after each use.

My first attempt at building an alternative breath sensor was modelled on the piezo-based pressure-sensing design of the UFI sensor, replacing the original piezo component was with a more robust pressure-sensing device. Unfortunately this design was unable to respond with the required sensitivity and reliability at the point of inhalation. A second version replaced this design with a much simpler stretch-sensing product produced by Merlin Robotics. Whilst not completely linear in its response to displacement, this sensor was a major improvement in responsiveness and robustness compared to the original design. Important improvements were also made to the initial scaling of the controlled-voltage (CV) signal to MIDI data, with the introduction of a manual calibration control to set minimum and maximum CV output from the sensor to the MIDI control inputs.
Attach the breath-sensor to interact with this work... The belt clips in at your side, make sure the red wire loop is in your middle Please handle the sensor with care, especially the middle section.
When you exhale, the sensor belt should fit close, but not tight.

Adjust the position of the sensor to where you feel the most movement when you are breathing at a slow and comfortable rate. If you breathe more from your abdomen, try moving the belt to fit around your abdomen… if you breathe more from your ribs, move it to fit around your ribs.

Breathing is measured according to the amount of movement in your ribs and abdomen. The work is designed to help you explore how your lower ribs and abdomen can be involved in your breathing.

The lines in the video projection expand outwards as you breathe in, and contract inwards as you breathe out. The image becomes larger as your breathing slows down – try gradually extending the duration of your exhalations, and see how the image and sounds change.

Figure 46 Instruction poster installed inside the Drawing Breath v.2 installation space, describing how to attach the breath-sensor and how the work responds to the movement of the participant’s ribs or abdomen.
5.3.5 Interaction Analysis and Audience Response

The *Drawing Breath* series of works were designed to be exhibited without the need for supervision, but in reality this often proved problematic. The breath-sensing belt required proper fitting so as to record the maximum dynamic range, with a minimum of conscious exertion on the part of the wearer. If worn too loose or too tight, the resulting data lacked the sufficient dynamic range to produce reliable breath-rate and velocity data needed to drive the work. The belt also needed to be worn around a section of the participant’s chest or abdomen sufficiently involved in the action of breathing so as to cause the belt to expand and contract in time with their breathing.

Many participants tended to wear the belt either too tight or too loose. Bulky jackets and jumpers hampered the belt from registering breath-related movements and rapid or shallow breathing patterns were also not able to be registered. As a result of these factors, audience experiences with *Drawing Breath v.1* and *Drawing Breath v.2* varied significantly from one participant to another.

In spite of these difficulties the work was enthusiastically received by most of the audiences who engaged with it. The duration of individual interactions varied substantially, with most participants spending around five minutes with the work and a few visitors spending between ten and twenty minutes. Once again, it was observed that audiences usually visited the gallery with a friend or group of friends, with each member of the group interacting with the work for a few minutes before handing it to another member of the group while the others watched, commented or offered suggestions.

The issue of latency was raised by a number of participants with the observation of a one or two second delay between the initiation of the breath movement and its representation on screen and in the sound design. Some of this can be attributed to inherent delays between the movement of different parts of the participants chest and abdomen, while other delays where introduced by the smoothing processes applied to the sensor data to reduce unwanted transients. Another factor influencing the perceived responsiveness of the particle-based visualisation was a tendency for participants to perceive the movement of the particle trails according to the length of the trail, rather than the position of the leading particle: this effect was especially pronounced when the particles curved back on over of their existing trails.

Informal feedback from several participants suggested a need to increase variety or responsiveness from one participant to the next. Many participants expressed their desire for the work to reveal some sense of individuality in relation to the patterns and sounds created by other users, and to offer a greater degree of complexity in the way the work responded to their breathing movements (i.e. not just zooming in or out from the particle cluster).
5.3.6 Evaluation

The Drawing Breath series of works represented a deviation from the highly focused and dialogical interactions developed in Cardiomorphologies v. 1, but provided a valuable space for examining the use of breath and the limitations of breath-sensing technologies explored so far. My aim in working with these technologies was to facilitate the exploration of slower than usual, effortless breathing patterns, but the design of the belt-based sensors used tended to emphasize a self-conscious form of breath control. This shift from effortless observation to self-conscious manipulation provides a very clear example of how the design of a sensor or interface informs and reinforces the quality of the participant’s interactions with that design. Audiences observing that the work did not respond to their normal breathing patterns (shallow, irregular, and topologically variable), explored ways to engage the sensor and produce discernable and stimulating changes in the visual and audio display – this was generally achieved through voluntary contraction of the participant’s chest or abdominal muscles.

Force-sensing technologies such as the breath-sensors used in these works will by nature tend to encourage forceful and coercive forms of interaction and in unsupervised exhibition settings are extremely prone to being broken through the use of excessive force. Many participants’ first impulse when engaging the belt was to apply as much force as possible by tightening the belt far beyond the appropriate level of tension required for monitoring breath-related changes in chest or abdominal circumference. Both versions of Drawing Breath where plagued with sensor breakdowns caused by being stretched beyond their breaking point, despite the display of large-print instructional posters requesting that the sensors not be worn too tightly. Subsequent iterations (Drawing Breath: Three) remedied this problem with the insertion of a pair of flexible but strong nylon threads along the length of the sensor to prevent overstretching.

The use of text in Drawing Breath v.2 aimed to stimulate reflections on the centrality of breath in everyday life as revealed through common figures-of-speech, but contributed little to the overall experience of the work compared to the breathing sounds and visualisation. More work would need to done regarding the actual content of the texts and their ability to generate some form of compelling narrative. The randomly sequenced fragments of text emphasised a feeling of arbitrariness that detracted from the perceived authenticity of the basic interaction (i.e. ‘that is me breathing—but that is not me talking’).
5.3.7 Implications

Compared to Cardiomorphologies v.1 the Drawing Breath series presented a far more limited and simplistic set of behaviours. While the Drawing Breath works were logistically easier to exhibit, it became clear that the intensity of interaction and supervision required by Cardiomorphologies v.1 was also a strength. The trade-off of intensity of engagement for ease of presentation provided valuable public exposure, opening the way for the presentation of more intensive works exemplified by Cardiomorphologies v.1.

The need to differentiate one interaction from another, first encountered in Cardiomorphologies v.1 arose once again in the Drawing Breath series. Differences that may have existed between the behaviours of different participants’ sensor data tended to be de-emphasised in the interests of aesthetic control and predictability through processes of limiting and normalizing sensor data to ensure reliability across a diversity of interaction conditions. These differences should be harnessed as a way of personalising each participant’s interaction with the work. Examples of data that vary considerably from one interaction to the next include:

- Average tightness;
- Dynamic range of the breath-sensor;
- Average breath velocity; and
- Overall quality of breath-movement\(^{25}\).

New sonification and visualisation variables capable of responding to such data needed to be devised, whilst preserving the intelligibility of the primary data mappings. Some examples of variables that could be introduced include:

- Graphic movement qualities that vary from random (squiggly) to flowing curvilinear lines, and
- Sounds that vary from entirely noise-based (enharmonic) textures to harmonically rich drones and modal structures.

\(^{25}\) Smooth or erratic breath-related movements could be interpreted with an FFT based spectrum analysis similar to that employed in Cardiomorphologies v.1 for the analysis of heart rate oscillations.
5.4 Cardiomorphologies v.2

Beta_space gallery, Powerhouse Museum, Sydney, Australia
September 14th – 21st, 2005

Presented by Powerhouse Museum and University of Technology Sydney

Credits:

George Poonkhin Khut – installation concept, interaction design and art direction
Greg Turner* – data analysis, routing and visualisations systems (Max-MSP)
Lizzie Muller* – interaction design, audience research, event production and logistics
Kier Smith & Chris Caines – video documentation
Matthew Connell – exhibition director, Powerhouse Museum, Sydney ‘Cyber Worlds’

* University of Technology Sydney (UTS), Faculty of Information Technology, Creativity & Cognition Studios (CCS)
Figure 47 Details of the final Cardiomorphologies v. 2 data visualisation system in action, as exhibited at the Powerhouse Museum Beta_space gallery, showing blue light at the centre of the screen, representing breath exhalation (top image) and inhalation (bottom image). The ray-like emanations represent the relative amplitudes of sympathetic (green-yellow) and parasympathetically mediated (orange-red) heart rate oscillations. Photography by Greg Turner.
5.4.1 Introduction

Cardiomorphologies v. 2 was the final work to be developed as part of the presented portfolio, and was developed in close collaboration with the curatorial researcher Lizzie Muller and computer scientist and interaction designer Greg Turner between April and September 2005. Parts of this chapter have been adapted from Evolving Creative Practice: A reflection on working with audience experience in Cardiomorphologies – a paper co-authored with Lizzie Muller and presented at the conference Vital Signs: Creative Practice & New Media Now (Khut and Muller, 2005).

Although structurally similar to its predecessor, Cardiomorphologies v. 2 was the culmination of an intensive series of design workshops, user-testings and evaluations. Our aim throughout this period of collaboration was to develop a deeper understanding of audience experiences in Cardiomorphologies, and to use these experiences to inform and evolve the design of the work and our understanding of the subjectivities they afforded. This chapter documents the development of Cardiomorphologies v. 2 from my vision for the work following Cardiomorphologies v. 1, through to its final public presentation at the Powerhouse Museum, Beta_space gallery. Details of audience experience were examined using methods adopted by Lizzie Muller from the field of Human-Computer Interaction (HCI) and human-centred design research, enabling us to record and evaluate the work in relation to the actual experiences they generated. The resulting artwork and audience response demonstrated the viability of these methods as tools for the development of interactive and participatory art experiences.

Audiences interacted with the work an individual basis, seated in a comfortable reclining chair before a large video projection. On entry into the exhibition, visitors were introduced to the work and invited to interact with it for a period of up to twenty minutes at a time. After reading and signing the required information and consent forms, participants were fitted with a breath-sensing belt around their upper chest. Heartbeat activity was monitored using a newly introduced wireless hand-held device in the form of a pair of palm-sized cylinders. Data from these cylinders was used to control an abstract circular video projection and quadraphonic sound design. The initial process of connection and sensor adjustment took between two to five minutes. Participants determined the duration of their interaction up to the maximum of twenty minutes, and could conclude their session by placing the hand-held heart sensors down on the footstool before them, causing the heart sounds to stop and the remaining breathing sounds and visuals to slowly fade away. Approximately two hundred visitors participated in the work, with most interactions lasting between five to fifteen minutes. Eight interviews were recorded and subsequently transcribed by Lizzie Muller and an evaluation of these interviews is presented towards the end of this chapter.
Figure 48 Top image: Lizzie Muller with participant, explaining the use of the wireless hand-held heart rate sensors in *Cardiomorphologies v. 2*. Bottom image: George Khut, Lizzie Muller and volunteer during the second week-long intensive development segment at UTS, Creativity and Cognition Studios, September 2005. All photos by Greg Turner.
5.4.2 Aims and Developmental Context

Cardiomorphologies v. 2 was the last work to be developed for this portfolio, and represents a considerable development in my understanding of the principles and concerns at the heart of this research. Where audience experience had previously only been considered in the final evaluation of the works, Cardiomorphologies v. 2 situated participant experiences deep within each stage of the work's development. My goal thought this process was to create a work that allowed participants to explore the embodied nature of their subjectivity through a detailed and sustained focus on their own breathing and heart rate patterns.

5.4.2.1 Collaborating with curator Lizzie Muller

Cardiomorphologies v.1 provided a valuable point of entry into the world of audience research and story sharing, affirming my interest in the development of these materials as an essential component of the experience of the work as a whole. What I lacked at the time, was a method for structuring these materials and processes into something that could provide a more robust framework for understanding and developing the experience of the work, both from my own perspective as a practice-based creative arts researcher, and for the participants engaging with the work as form of critical reflection. It was also clear that a more detailed exploration of these processes would be beyond the scope of a single researcher, given my commitment to the already considerable technical and artistic challenges raised during the presentation of Cardiomorphologies v.1.

Lizzie Muller’s practice-based PhD research into experience-centred approaches to the making and curating of interactive artworks (Muller, 2008) provided an ideal opportunity to develop my interest in participant experience. The complimentary nature of our respective research questions – how to understand and work with experience in biofeedback as art – and – how to develop and curate interactive artworks through close attention to the details of lived audience experience – provided the basis for a highly productive and mutually beneficial research collaboration. This collaboration was also significant in that it marked the beginning our shared interest in the Pragmatist aesthetics of John Dewey and Richard Shusterman as conceptual frameworks for understanding and evaluating experience and instrumentality in contemporary art practice.

Working quite literally with the idea of the gallery as public research laboratory we embarked on a series of iterative design workshops, pro-type exhibitions and evaluations. Traditional boundaries separating artistic and curatorial practice were eschewed in favour of a collaborative approach based on our shared interest in the qualities of experience supported by interactive artworks and the insight these interactions provided us as makers, curators, critics and audiences. Lizzie’s role
throughout this process was to ground the development of the artwork within the experience of the audience, which she achieved through the introduction and adaptation of a variety of user-centred design research methods. Beyond their usefulness as frameworks for evaluating and refining the design of the works, these methods also provided a framework for clarifying and evolving our understanding of the experience and potential of – in my case body-focused interactive artworks – and in Lizzie’s case – interactive art more generally, as forms of reflective practice.

*Cardiomorphologies v. 2* involved five main development stages:

1. Articulating experiential goals for the work – what did I want audiences to feel, see, hear during their interaction with the work? Some preparatory work with ‘Personas and Scenarios’ (“Danny”) to ground these goals within imagined details of another person’s subjective experience.

2. An initial two-week design development phase with Greg Turner, sketching out basic interface ideas and design functionalities, including processes for collaboration.

3. Three days of intensive user testing and audience evaluations, using group analysis, video-cued-recall (retrospective reporting) and further work with ‘Personas and Scenarios’ (“Sonia”) introduced by Lizzie Muller to evaluate existing design proposals and generate new visions for the work’s behavior.

4. A final two-week implementation and testing phase with Turner, incorporating findings from audience evaluations and ‘Personas and Scenarios’ exercises.

5. A seven-day public showing of *Cardiomorphologies v. 2* at the Powerhouse Museum Beta_space gallery, Sydney, including a second series of interviews with audiences using the video-cued-recall interview method adapted by Lizzie Muller.

An outline of the process developed by Lizzie during the development of *Cardiomorphologies v.2* is presented in Table 4. Included in this table are a number of process developed subsequent to our collaboration on *Cardiomorphologies v.2*, during the development of Gina Carnecki’s *Contagion Prototype* at the Beta_space gallery (Muller, 2006) – these additions provide a context for understanding the role that collaboration plays in Lizzie’s work as a curator and critic of interactive art, and how her practiced developed beyond our collaboration on *Cardiomorphologies v.2*. 
<table>
<thead>
<tr>
<th>Stage</th>
<th>Aim</th>
<th>Method and rationale</th>
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| Experiential Design Sessions | Talking and thinking experientially | **Set Experiential Goals** — these frame the artwork in experiential language, and guide and evaluate activity throughout the process  
**Identify existing Design Issues** — these articulates known problems and options for testing and development  
**Paper Based Personas and Scenarios & Movement Personas and Scenarios** — these ground the design process in experiential thinking, flesh out design issues and generate new possibilities |
| Prototype Exhibition | Including audiences and gathering experiential material | **Experience workshop** — helps generate an experiential language and shared understanding between artist and audience, and helps to expand and modify the initial Experiential Goals  
**Video-cued recall** — recordings provide rich, natural video and spoken accounts of experience. Intensifying audience experience through reflection. These reports can also be used for documentation and archival purposes  
**Semi-structured interviews** — gather rich verbal accounts to support audience’s experience of the prototype through dialogue and information exchange. These reports can be used for documentation and archival purposes  
**Group interviews** — to reflect informally on the work with audiences and stakeholders, to support audience’s experience of the work through reflection and dialogue |
| Reflection / Analysis/ Experiential Design Sessions | Working with experiential material | **In-situ and short term reflections on audience experience** — using Experiential Goals and Design Issues as a guide, initial responses are developed through conversations between artist and curator and individual written reflections by both  
**Modify Experiential Goals** — initial experiential goals are appraised in light of real audience experiences and new design issues are identified  
**Transcribe and circulate data** — to keep the audience experience in the frame as design work continues  
**Structuring Meaning through Narrative** — to describe the trajectory of the experience of the work, to summarise experiences while maintaining richness, to build on Personas and Scenarios in generating design issues and solutions  
**Meaning Condensation** — to summarise and condense experiential data, to uncover structure and essential components of experiences |
| Repeat previous two stages over 2nd iterative cycle, time permitting | | |
| Exhibit final iteration of artwork | Including audiences and gathering experiential material for evaluation | **Video-cued recall**  
**Semi-structured interviews**  
**Group interviews** |
| Reflection/Analysis | Evaluation and critical account grounded in audience experience | **Categorise experiences against experiential goals** — to evaluate success of the design process and uncover how the artwork produces its experiential effects  
**Categorise experiences against experiential framework for interactive art** — to develop the theoretical framework through "productive encounter" with experiences  
**Interpretation** — to produce critical accounts of the artwork grounded in experience, which make use of, and develop the experiential framework for interactive art |

Table 4 Lizzie Muller’s experience-centred process for making and curating interactive art. *Indicates processes developed subsequent to Cardiomorphologies, for Gina Czarnecki’s artwork Contagion Prototype (Muller, 2006)
Collaborating with Greg Turner: ‘Data Toys’

Having conceived the development of Cardiomorphologies v. 2 as an iterative process, a system was required that would enable us to explore a variety of visualisation ideas, and variations within a relatively short amount of time. Like many other artists working in the fields of digital media and the performing arts, collaboration is an essential part of my practice, enabling me to engage technologies and processes far beyond my own specialized set of abilities and skills. In Cardiomorphologies v. 1 and Drawing Breath, Tonkin realised analysis and visualisation processes in the form of an essentially static (pre-compiled) body of code, designed in response to a brief prepared by myself. Adjustments to the behaviour of these systems were then negotiated through a series of meetings in which I would refine or expand on aspects of the initial brief. Whilst the final results of this process provided a high degree of stability, as a design process it was disadvantaged by being both time-consuming and prone to occasional misunderstandings, leaving little room for extended periods of design experimentation and play.

Greg Turner is an interaction designer and Human-Computer-Interaction (HCI) researcher whose PhD work was focused on the development of alternative models of collaboration between computer programmers and creative arts practitioners. HCI research has traditionally focused on the use of technology in the workplace, as tool for improving the efficiency of clearly definable work-related tasks. With the increasing ubiquity of microprocessors in domestic and recreational settings, there has been a shift to include more playful and emotional qualities in human-computer interactions. Creative arts practices and the complex subjective processes they employ embody these qualities in an intense way, and have been the subject of a growing number of HCI conferences and research projects. A key contribution of these HCI-led approaches has been to examine the processes and assumptions underpinning artist-programmer collaborations and the degree to which they support or inhibit creative processes.

As a part of his PhD research, Turner has been exploring the idea of data manipulation ‘toys’ as tools for collaborative design and artistic support. Turner’s approach acknowledges the importance of play and experimentation in the production of artworks. Data manipulation ‘toys’ allow artists to literally play with the behaviour of the work in their own time, significantly reducing the amount of time spent negotiating the finer points of the system’s behaviour with the system programmer. Turner’s research highlighted the shortcomings of the very goal-oriented briefings I had previously prepared for Tonkin26. In retrospect, this method of collaboration failed

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26 The idea of providing manually adjustable variables for data manipulation could in principal have been implemented in my work with Tonkin on Cardiomorphologies v. 1, and was flagged by Tonkin during an early stage of the works development, but not pursued due to production constraints.
to take into account the determining role of process and playful material engagement in
the production of aesthetic experiences, relying instead on Tonkin’s own sophisticated
aesthetic decision-making abilities and the limited amount of time available to
negotiate the finer points of the work’s behaviour. During the development of
Cardiomorphologies v. 2, Turner’s ‘toys’ approach provided me with a far greater level
of artistic control and play-time with various aspects of the work’s appearance and
behaviour.

Using the Max-MSP programming environment as a shared language, and in
response to my initial brief, five prototype visualisation ‘toys’ were constructed during
our first two-week technical development phase; Tuft (Cross-hairs), Discs/Rings, FFT,
Background and Grids. These prototypes explored different approaches to the
visualisation of breathing and heart rate data, building on work designs explored
during Cardiomorphologies v. 1.

Tuft (Cross-hairs) was the simplest visualisation, and showed the breath and
heart rate on an XY axis, which expanded and contracted in real time, with the aim to
provide a very clear and easy to read visualisation that participants could quickly
understand. (see Figure 49 below).

Figure 49 The five test-visualisations developed for Cardiomorphologies v. 2 using Greg Turner’s initial data
visualization system. Top row, from left to right: Tufts (Cross-hairs); Discs/Rings and FFT (Heart rate
variability frequency analysis). Bottom row: Grids and Background.
Rings mode provided a more abstract visualisation of the heart and breath rate in real time. A simple blue ring expanded and contracted with the breath. This ring would appear softer and larger with slower breath rates, and harder and thinner with faster breath rates. A red ring represented the heart rate and would decrease in size according to a decreasing breath rate. The aim of the rings was to create a relationship between physical (proprioceptive) sensation and visualisation. The expansion and contraction of the rings had an analogous relationship to the associated expansion and contraction of the ribs/abdomen with breath, and metaphorically suggested the cycles of respiration and blood circulation.

FFT was a display of heart rate variability power spectrum data, and was more complicated and less immediate than the information presented in the simpler visualisations. In theory however, this could be more representative of the participant’s affective state (Schwarz et al., 2003, McCraty et al., 1995, McCraty and Childre, 2001, Song and Lehrer, 2003). This display was integral to my vision for the Cardiomorphologies project as it showed how psychological orientation, such as sustaining a thought about a relaxing or stressful situation, could stimulate different physiological responses.

In addition to visualisation systems, Turner also developed a data processing algorithm (*gt.spring2*) to introduce the effects of inertia and springiness to outgoing control data and algorithms for performing FFT-based spectrum analysis of heart rate data\(^2\). The object *gt.spring2* allowed for considerable improvements in the quality of many audio and visual feedback elements, providing a highly controllable sense of flow and viscosity to the behaviour of individual feedback elements.

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\(^2\) Existing FFT algorithms in Max-MSP are focussed exclusively on the analysis of audio signals, and are not appropriate for the analysis of non-audio sensor data.
5.4.3 Designing with Audience Experience

The first attempt to record audience experience was conducted during Cardiomorphologies v. 1. These interviews (refer to Chapter 5.2.5) yielded some useful information about the interaction process, including a general enthusiasm for this unusual form of interaction, new interface ideas, and comments indicating difficulties in communicating the principles behind the interaction concept to audiences. The interviews were limited in that they tended to produce analytical (as opposed to experiential) responses that often seemed to mirror the questions asked rather than evoking a close account of the actual lived experience of the artwork. In pursuit of more natural and detailed verbal accounts of the experience itself, we turned from this interview process to a technique called video-cued-recall.

5.4.3.1 Video-cued-recall Interview Method

Video-cued-recall is a method for investigating user experience, in which participants are video-recorded during their interaction (in this case with Cardiomorphologies), and then asked to give an account of their experience whilst watching the video of themselves after the event (Suchman and Trigg, 1991, Costello et al., 2005). Because interviews are conducted after the subject’s experience, this method offers significant advantages over think-aloud methods, which can tend to inhibit the subject’s normal flow of experience and engagement in the situation under observation. As a form of retrospective reporting video-cued-recall helps ground the subject’s recollection within the details of lived experience and help to bypass some of the interpretive filtering that can take place when subjects are asked to recount an experience from memory alone (Costello et al., 2005).

Five interviews were recorded by Lizzie Muller during the last week of our May 2005 Performance Space residency to test the viability of this interview method for an artwork like Cardiomorphologies (refer to Appendix A, DVD #2, Chapter 1). Lizzie asked participants to recount every detail of their experience, no matter how mundane it may have seemed, and to adhere carefully to what they remembered of their experience as it unfolded rather than speculating or analysing. The video assisted the participant in their recollection and helped to avoid selective interpretation. Audience accounts form the basis of the design process. One of the strengths of these detailed, in-depth accounts is in the revelation of the trajectory of the participants’ experiences, which include many common elements such as moments of uncertainty, realisation, abandonment and absorption.
Costello’s study on this method had focused on audience experiences of the artwork *Iamascope*28 (Costello et al., 2005) a highly animated interactive video that responded to very active participant movement in front of a video camera. By contrast, *Cardiomorphologies v. 2* involved virtually no physical movement on the part of the participant and a relatively static audio-visual interface comprised of subtly shifting hues and repetitive pulsing actions.

Over the course of their interaction, each participant was shown three separate breath and heart rate visualisations: *Cross-hairs*, *Rings* and *FFT* (refer to examples in Figure 49). Breath was sonified using the same synthetic breathing sound used in *Cardiomorphologies v. 1* while heart rate data was sonified through either a percussive clock-tick sound that varied in pitch according to heart rate, or a tamboura-like drone sound that was band-pass filtered according to the participant’s heart rate. A video camera filmed their interaction from behind, recording an image of the participant’s head below the centre of the screen that showed most of the video display, and the process of attaching and removing the various sensor devices at the start and end of each session.

Contrary to our initial concerns, the resulting interviews yielded surprisingly detailed accounts of each participant’s experience of the work, confirming the viability of this method and providing a number of useful insights into the design of the work and the social interactions surrounding it. The majority of interviewees felt that their sequence of memories were more or less accurate and that the visuals had prompted specific memories at specific points. However not all respondents were sure that they had correctly identified the right memory at the right moment in the tape, and there was a good deal of self-correction in which people reported a memory and then, seconds later, re-identified the moment when the memory occurred. Muller’s evaluation of these interviews (Muller et al., 2006b) provided the following insights and suggestions for improving the quality of engagement between audience and artwork:

- The initial *Cross-hairs* provided a very clear introduction to what was being recorded, but quickly became boring as an experience, suggesting the potential for this interface as a calibration tool at the start of the interaction.

- The blue breath-controlled *Ring* visualisation was the most enjoyable aspect of each participant’s interaction, especially when their breathing rate slowed down and it filled the screen with a diffuse blue-white glow. There is evidence in the reports that the rings encouraged experimentation and play, which deepened engagement: ‘at this point...I’m all engaged by the circles... I think they’re amazing and I was trying to experiment with my own breathing to see

28 Refer to Chapter 3.3.1 for a more detailed description of this work.
how much of the shape I can sustain [...] I’m trying to create something with my breathing here. It’s a very joyful experience.’

- Pronounced changes in the perceived hardness or softness of such images elicits feelings of intensity and bodily identification that go beyond strictly analytical correlations between graphic elements and physiological ‘data’, to include deeply embodied forms of aesthetic engagement.

- Colour was a key part of the appeal and the limitation of the Rings interface, several participants commented on how visually attractive the colours were, but several also became bored with the lack of variation, and wished the colours would change.

This feedback suggested that the visualisations needed to offer the participants more varied and creative possibilities, whilst not undermining the hypnotic and concentrated simplicity they found in the rings. Richness needed to be added, but not complication.

The ring-shaped heart rate visualisation was designed to expand slightly with each heartbeat, creating a throbbing effect. Several participants found this interface uncomfortable to engage with. Switching this behaviour to a contracting movement provided a more comfortable and intuitive visualisation of the heartbeat impulse. Also, large flashing red objects often suggest a sense of danger or confrontation that could be counter-productive to the experiential aims of a work like Cardiomorphologies v. 2.

Participants found the FFT spectrum display of heart rate variability patterns interesting but confusing, and had difficulty feeling a sense of connection to the display. Only one participant was able to observe correlations between the appearance of the visual display and their own mental tasks and imagined emotional experiences.

The work would sometimes trigger a series of speculations and reflections on aspects of the participant’s own life situation that bore little or no immediate relationship to the work at hand. Such ruminations and reveries suggested a failure on the part of the artwork to elicit a strong enough sense of absorption or immersion within the art experience itself (Refer to experiences described by participants in the final Beta_space exhibition in Chapter 5.4.4).
5.4.3.2 Working with Peers and Experiential Goals

It was clear from our initial data gathering exercise that a large proportion of the audience for Cardiomorphologies had a professional interest in art, and often in experimental and new-media art. At first, we had sought ways to avoid this, in the belief that we needed to concentrate on ‘real’ audiences. However, we later realised that in avoiding this section of the audience we were basing our design process on an unrealistic and non-representative version of audience experience. We were also interested in the insights that might come from the experiences of this specialised subgroup. One problem we foresaw was that specialists might only be able to give professional opinions of the work, which may not exactly reflect their actual experience. To address these issues we decided to develop a collaborative tool that would enable us to work with representatives of this specialist group on a professional level, yet keeping as close as possible to their lived experience of the work.

The tool that Lizzie introduced was loosely adapted from the Future Workshops participatory design model (Jungk and Müllert, 1987; Kensig and Halskov-Madsen, 1991), with most of the actual techniques created specifically for our needs (Muller et al., 2006a). A group of six professionals working with art, interaction design and sound individually experienced a series of prototype interface designs over the course of the day, and then reconvened at the end of the day for a structured group discussion. The discussion began with the generation of a shared descriptive language. For this phase, participants took turns to describe the experience of the work as it unfolded over the course of their interaction. They were asked to adhere as closely as possible to what they did or felt at the time. The rest of the group listened and noted down on two different coloured stacks of paper, key phrases that concurred with or contradicted their own experience of the work, marking the phrases as either positive or negative.

In the second stage we introduced a list of eight experiential goals that Lizzie had asked me to identify at the start of our work together, as being central to my vision for the work – they were:

1. Close fitting – reflecting as accurately as possible changes in physiology;
2. Sensual and kinesthetic – generating sensations of changing weight, motion and patterning within the body;
3. Quiet, concentrated, inwardly focused;
4. Explorative;
5. Simple/minimal aesthetic;
6. *Enabling* – facilitates an ability to physically sense changes in heart rate/inter-beat-interval, and how these patterns interact with different mental/emotional states;

7. *Instructive* – participants have a sense that they have learned something about their own psychophysiology; and


Participants were asked to assign words and phrases generated in the first stage of the workshop to different experiential goals, in order to find out whether any of the experiential goals coincided with the participants’ own understanding of their experience. If so, then we were interested in what language they used to describe those experiences and what aspects of those experiences were positive or negative.

The categories *Quiet, concentrated, inwardly focused* and *Close Fit* were extremely meaningful for participants, the former attracting a large number of positive comments and the latter a mixed response. From this we judged that we had achieved the right atmospheric approach, but that the visualisations and sound needed to reflect people's physical feelings more closely and respond more exactly and rapidly to changes.

On the other hand, the experiential objectives *Enabling* and *Instructive* did not resonate with the participants. Although we considered the possibility that these goals may work over a longer period of time, it was clear that they were not being delivered in an observable way by the experience as it was. In spite of this apparent indifference, a closer examination of the workshop data suggested that these objectives were being delivered by the research process surrounding the experience.

The majority of the participants’ accounts – both from the peer discussion and the video-cued-recall – showed that framing the audience approach and expectations to the work in the context of research actually helped people to orient themselves to the work and to reflect on and deepen their engagement with it. The notion of framing the artwork more performatively as a kind of experiment in which the audience is invited to participate, suggests itself as a design response to this conclusion.

### 5.4.3.3 Experience-centered Design with *Personas and Scenarios*

Our initial data gathering exercise gave us a multi-layered picture of the various ways that different people approached and interpreted the artwork. To integrate this knowledge into our ongoing design process we used *Personas and Scenarios*; a set of imaginative, generative and flexible techniques for representing users in the design process, based around characterisation and narrative (Bødker, 2000, Cooper, 1999, Cooper, 2004).
Personas are composite characters, based on user research (such as our initial interviews) that summarise characteristics of the audience. They include rich amounts of detail including goals and motivation, knowledge and experience, physiological characteristics and sometimes, social relationships. Their value lies in their power to mobilise observed characteristics in a believable and at times unexpected and living way. The usefulness of personas as a tool to support the design process of artworks has been piloted by Toni Robertson and her team in the Bystander Field Project (Kan et al., 2005, Loke et al., 2005). We built our personas on models created by Robertson et al which were constructed from numerous observations of audience behaviour in a range of different interactive environments adding details based on our own audience accounts. Scenarios are narratives in which personas act out situated actions. They are used as a tool for revealing and solving design problems and possibilities through a focus on the user experience. They provide examples of action that can be useful at any stage of the design development lifecycle. The narrative structure provides an internal consistency and flow that creates a powerful representation of the real possibilities of user experience and action.

For Cardiomorphologies v. 2 we used scenarios as generative and collaborative thinking tools by writing in relay; first concentrating on the curatorial aspects of how the persona’s experience would be shaped until their physical encounter with the work, then continuing their experience through their interaction. In this way, we integrated our own different perspectives into the scenarios. The resulting narratives revealed unexpected problems, including such factors as what aspects of the work they found engaging, confusing or uninteresting, along with specific physiological data that could or could not be monitored by the work. Personas and Scenarios form an ongoing strand of the process, continually being revisited, revised and developed at different stages of the project. They provide a way to reliably think beyond our own perspectives as (interactive-artwork) designers, and to integrate our different areas of concentration (curating and designing) into one cohesive account of an audience experience.

The persona ‘Danny’, an eleven year old boy is presented here as an example of how Personas and Scenarios were used in the development of Cardiomorphologies v. 2, demonstrating the richly detailed, embodied subjectivities personas invoke, and the varieties of aesthetic experience they can offer as tools for re-imagining the design of an interactive artwork.
'Danny' persona prepared by Lizzie Muller

Danny is an only child who lives with his parents in the western suburbs of Sydney. He has trouble reading – although he is in the fifth grade, he reads at a second or third grade level. As a result, he dislikes reading and tries to avoid it, even when it’s required for school. He likes going on school excursions but doesn’t like to be told what to do.

Danny suffers from attention deficit hyperactivity disorder and has problems sitting still and concentrating in the classroom environment. He likes excursions because it’s a great way to have fun with his school friends. Danny is a very good cricket and basketball player and has several trophies for his sport results.

Danny’s father is a salesman for an office equipment firm. He enjoys watching DVDs and both he and Danny enjoy action and adventure films. Danny’s father has his own video camera, digital camera and computer.

They both enjoy using computer applications for working with photos and film. His schoolteacher is trying to encourage him (with no success) to develop other skills such as reading and maths. Danny is very good at computer games and has designed his cricket club website.

'Danny': scenario A, prepared by Lizzie Muller

Having filled in the forms they go in together and Danny goes first. The space is dark and empty compared to the rest of the museum. Danny gets quite silent and unresponsive when the artist begins to explain what’s going to happen. He doesn’t really understand what the artist is talking about. Though he is interested in the sensor being strapped to his finger, he really doesn’t like the idea of the band around his chest, and doesn’t want to let the artist attach it. His father tries to insist and offers to put it on for him, Danny then agrees.

He sits down and watches the screen. Concentric circles expanding and contract as he breathes, he can hear a sound like his breathing, but the sound of the outside exhibits bleeping and other children screaming divert his attention, and he continually turns his head to see if he can see what’s happening. He is also worried that someone else will come in and see him sitting on a chair, he really doesn’t want to sit still, although he is quite interested in the images on the screen. His father asks him if he can see a connection between the images on screen and his breathing. Danny says no,
although he is not completely sure. He says he thinks it is broken. He asks if he can stop, and his father says he should stay another couple of minutes and try breathing fast or slow.

Danny thinks he probably won’t be able to make a difference to the circles, and is getting increasingly frustrated with sitting down. The artist suggests he tries yelling loudly to see what difference that makes - Danny refuses, the artist says ‘just say hello hello’, Danny does this and there is some variation in the circles, which catches his attention for a moment, he then tries yelling, and the circles change rapidly, he wonders if it is noise that has made the difference, now he has started yelling he won’t stop...

Negative or seemingly dysfunctional scenarios can help identify potential sticking points, and in this case reframe our own assumptions regarding the kinds of interactions that could be expected to take place in a family-oriented museum setting. While it is obvious that an artwork can never be all things to all people, it was important for me that Cardiomorphologies v. 2 be accessible to a variety of audiences on a number of different levels of engagement.

Children, and to a lesser extent adults, demonstrate a strong attraction to quasi-cathartic forms of play and expression. During Cardiomorphologies v. 1 several participants engaged in games, involving friends providing some form of shock or surprise in order to observe how this might be revealed through the work. Other examples include vigorous aerobic exercise immediately prior to participation. These behaviours constitute a form of cause-and-effect boundary testing that participants use to assess the extent of their representation in an interactive artwork. How an interactive artwork responds at this stage of the interactive experience will have an important influence on the participant’s subsequent explorations. Instead of denying these behaviours, interactive designs need to provide ways to acknowledge these behaviours and to then encourage participants to move towards a more detailed exploration of the work’s intended focus.

In preparing Scenario A, we tried to work as closely as possible to the behaviour of the artwork as it was at that stage of its development. In the following alternative scenario, I re-conceived the behaviour of the artwork by imagining the cultural and representational frameworks that would be appropriate to ‘Danny’ in relation to the sensations and feelings I was interested in facilitating, along with details of the experience that would be of particular interest to him.
’Danny’: scenario B, prepared by George Khut

It takes a while to negotiate who goes first, father or Danny. In the end Danny decides to go first. He is quite restless. I ask Danny if he likes watching sci-fi movies like Star Wars or Lord of the Rings, and he coyly confirms his interest. I explain to him that this work is like a futuristic space ship controller, and that we will be using our own bodies to control the space ship. He is very interested in this idea! I show Danny’s father how the breath sensing belt needs to be fitted, and explain that we need to as much contrast in belt tightness and looseness as possible: it should be tight when Danny breathes in, and loose when Danny breathes out.

It takes a couple of minutes to explain this, but we keep the conversation centred around the notion of preparation for a space ship journey. Once the sensor is fitted, I switch on the video display (which has been blank up to now) and explain to Danny that this picture is controlled by the way his tummy and chest move in time with his breathing.

The dynamic range of the breath sensor data is fairly narrow at first. I suggest Danny make a few exaggerated inhale and exhale movements to test out how responsive the sensor might be, but Danny is suddenly a little shy. I check the sensor fitting and tighten up the belt and adjust its position on Danny’s torso, then start to adjust the threshold setting on the sensor control device, to increase its sensitivity. I then turn on the video display and Danny’s father tells him that his breathing controls it. I tell him that we have to get the space ship warmed up by making the breathing pattern bigger but we also have to keep it kind of slow. Danny starts to over breathe, and I tell him not to breathe so hard, as he will make himself sick and won’t be able to fly the space ship.

I then introduce the heart sensors, and tell Danny and his father that we are going to listen to Danny’s heartbeat using special electrodes attached to his forearms. This is another 'special technology' for the space ship, and we will make the space ship move with his heartbeats. I attach the leads to his forearms, and start up the heart rate displays that are superimposed over the breath patterns.

We observe the pulsing line of his heartbeat at the bottom of the screen, and notice the red circle inside the breathing circle, moving in and out of the centre, in time with the clicking sound that is activated by his heart beating. Danny is moving his arms around and generating a lot of noise in the heart sensors, which are responding by producing lots of chaotic beating noises. I tell him we need to be quiet in order to concentrate the special energy needed
to start up the spaceship. He calms down a little. Danny’s heart rate moves between around 60 and 90 beats per minute. We have a good clear signal.

Breath rate and heart rate variability are visualized by another two rings that are more like halo patterns than lines, with hazy outer edges that trail behind the leading edge of the form. I explain to Danny that these rings represent the amount of special energy that makes the space ship move, and that if he can become very calm the energy rings get bigger and bigger. We help Danny slow his breathing down, and see if he can change the diameter of the breathing circles. We explain to Danny the link between his breathing rate and the size of the fuzzy blue halo shape. We can also see that now as his breathing is starting to slow down, the red circles are also starting to change. To provide a comparison, we then ask him to stop breathing slowly and just take tiny breaths and see how it changes: the circles become smaller and dimmer.

About ten minutes has already elapsed since they entered the room, and I am aware that we will need to keep the interaction running on time – I have someone else booked in to start in another twelve minutes. I invite Danny to see how big he can make the ‘special energy’ halo circles by becoming calmer and calmer. He is concentrating quite hard. The blue breath rate halo is growing, but the red halo reaches its limit and doesn’t move much more. I manually adjust the scaling and sensitivity of the artwork so that it is more sensitive to changes in heart rate-variability, and we are able to increase the red halo. Danny’s father encourages him and praises him for being able to make the ‘special energy’, then I tell him that it is ‘time to come back to earth’, and the heart circles are faded out, followed by the breath circles, until there is just the background colour. We remove the sensors.

While in hindsight this scenario may seem unreasonably optimistic, this particular exercise marked a turning point for how I imagined the behaviour of the work as it was finally exhibited, suggesting the image and sensation of a ball of concentrated light surrounded by a complexly coloured series of halo-like emanations. Using science-fiction imagery as point of reference, ‘Danny’ provided a novel way for imagining the sensations and references that might be evoked through interaction. Trying-on an imagined subjectivity distinct from one’s own habitual preferences and pre-occupations as an artist-designer provides a powerful tool for generating new aesthetic experiences and design solutions. The task of imagining sensations and perceived relations through the embodied subjectivity of another, no matter how impossible in reality, demands an attention to detail of the aesthetic experience that can often be taken for granted by
artists and designers, immersed as they are in the minutiae of project logistics and numbed by their familiarity with the artistic vision/design brief at hand. Scenarios can also be scrutinised in retrospect to reveal important but overlooked logistical details and inconsistencies, such as the amount of time required for certain forms of interaction, or ways in which technologies may be subverted to ends not intended by the artist-designer but that may be of interest to the participant.

Figure 50 Prototype imagery generated in Photoshop, inspired by the Personas and Scenarios exercise ‘Danny’, exploring halo-like forms that would provide the basis for the data visualisation system used in Cardiomorphologies v. 2.
5.4.3.4 Technical implementation: drawing it all together

A final two-week technical development and implementation phase was undertaken with Greg Turner. Drawing from the problems and opportunities identified during our work with audience experience, this last phase of development focused on the implementation of a new wireless heart rate sensing technology and the testing of a new data routing and visualisation system. An important aim during this last phase was to differentiate the appearance of individual interactions, using existing differences in sensor data to control complex changes in hue and intensity of the various visualisation elements. We also needed to simplify the process of induction and sensor attachment and disengagement. Working from the halo prototypes generated from the *Personas and Scenarios* work, I expanded upon the initial *Rings* visualisation to create a much richer and multi-layered visualisation. Breath and heart rate data were visualised using a combination of sixteen disk/ring objects. New parameters included options for disk or ring shapes, edge density and improved colour controls (red, blue, green and alpha (opacity) levels for each object).

![Figure 51](image)
Multiple data variables were mixed together to control the hue and intensity of each Disk or Ring object, resulting in complex transformations of hue and colour temperature that would vary from one participant to the next. Delays were introduced into certain layers of the visualisation to differentiate the stages of breathing movement, adding a quality of fluidity to the previously rigid movements. Heart rate variability spectrum analysis data, previously visualized using a bar-graph or time series, were visualised as a series of rays emanating from the centre of the halo system, with HRV spectrum analysis frequency bands represented as a series of sixteen hues ranging from green (fight-flight responses) to magenta (rest-digest responses).

The new data mapping and routing system provided a fast and flexible way of generating, auditioning and playing with complex data mapping ideas, and featured a ‘dashboard’ control interface that displayed the activity of the various parameters using slider objects, providing a clear overview of the visualisation system as a whole using a relatively small amount of screen space.

### 5.4.3.5 Cardiomorphologies v. 2 at Beta_space Gallery

The extensive process of research and development documented thus far culminated in a seven-day exhibition at the Sydney Powerhouse Museum Beta_space gallery. Beta_space is a dedicated public research laboratory designed to offer interactive artists and researchers the opportunity to test and evaluate interactive artworks in a busy public museum setting with a strong science, design and popular culture focus (Muller and Edmonds, 2006). Over two hundred individuals interacted with the work, with each interaction lasting between five to twenty minutes. Families and large school groups constitute a substantial component of the museum’s audience, providing an opportunity to engage with demographic groups from beyond my existing network of contemporary electronic arts audiences and peers.

Visitors to the exhibition were greeted by an exhibition attendant and provided with an A5 information card. This card described the work and provided some suggestions for how they could use it to explore contrasting psychophysiological response patterns using techniques involving sustained mental focus, breath-work and emotional recall.

The physical structure of the installation was similar in many respects to Cardiomorphologies v. 1, with individual participants observing a physiologically responsive video projection whilst seated in a semi-reclining chair, but the overall space was much more open to the rest of the museum. A new hand-held wireless heart rate sensing system enabled participants to conclude their interaction at any time by simply placing the sensors down on the stool in front of them, thus removing the sense of encumbrance and improving the overall reliability of sensor data that had been such
a problem in previous iterations of the work. The sound design was expanded to a quadraphonic speaker system, in which sounds moved around the participant according to the movement of their breathing and heart rate.

Cardio-respiratory data was visualized using the multi-layered halo and ray-system (see Figure 52), described in the previous chapter. The three principal elements of the visualisation (breath, heart rate, and HRV spectrum analysis) were introduced one at a time as a way of simplifying the process of induction and interface familiarization, and reinforcing the work’s dependence on the participant’s interaction. Breath sensor activity was used to control the overall size of the entire visualisation so that the breath related images would shrink when no breathing activity was detected. Heart rate changes were only visible when the work was receiving data from the heart sensors, and spectrum analysis visualisations appeared only after gathering a minimum of five minutes of heart rate data∗.

∗ The minimum amount of time required to analyse the very low frequencies being examined (refer to Chapter 4.1.1).
**Hardware**

- Vernier wireless heart rate sensor
- Vernier sensor input device for computer
- Custom-made breath sensors (stretch)
- CV-MIDI device (by Angelo Fraietta)
- PowerBook G4, 1Ghz processor (OS 10.4)
- Desktop G5, 1.5 Ghz processor (OS 10.4)
- Quadraphonic speaker system
- Data projector
- Reclining chair & foot stool

**Software**

- Max-MSP v.4.5 (Mac OSX)

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*Figure 52 Cardiomorphologies v.2 floor plan as installed at Beta_space gallery, Powerhouse Museum, Sydney*
Figure 53 Video stills from Cardiomorphologies v. 2 as exhibited at the Powerhouse Museum, Beta_space gallery, showing the halo-like visualisation developed from the Personas and Scenarios work with Lizzie Muller. Bottom image: Rays HRV spectrum analysis display, showing colour variations and their correlation to autonomically mediated and/or breath-related heart rate oscillations.
Figure 54 Top: installation view of Cardiomorphologies v. 2 as installed at the Powerhouse Museum Beta_space gallery, showing participant holding heart rate sensors, and the projected video feedback. Bottom: examples of the projected imagery showing different states, (the participant can be seen reflected on the surface of the screen) Photo by Greg Turner.
5.4.4 Interaction analysis and audience response

For our final analysis we wanted to evaluate the effectiveness of the new design and the extent to which we had succeeded in achieving the experiential objectives that I had articulated at the start of the project. *Video-cued-recall* was used once again, to record the experiences of eight participants. The following analysis of these interviews, prepared by Lizzie Muller (2006b), provides a number of valuable insights into the audience experience of this work, locating specific stages of identification and reflection arising from key design elements.

The experiences reported by the participants included intensely personal feelings and emotions that demonstrated the affective power of the visualisations. Their accounts revealed the extent to which the experiential objectives of engagement and reflection had been achieved, and also some important insights into the role of richness and ambiguity in this success. There was a great deal of evidence to suggest that the aims of *Quiet, Concentrated and Inwardly Attentive Focus*, and *Sensual and Kinaesthetic* were achieved. After a period of expectation at the start, all participants reported feeling relaxed and calm. The majority of participants reported that they were focused on their body and their breathing: ‘[I’m thinking] just about my heartbeat, I’m just thinking about the heart and breathing calmly, that was the focus, nothing else’.

Several participants reported an impression of the focusing and relaxing power of the image, for example: ‘My thoughts kept jumping to external thoughts but then I’d sort of get sucked back in and drawn back to the image, and then I just kept starting to relax more and more’.

Participants also indicated that the visuals felt like a mirroring or extension of their physiological and mental activities – for example at one point a participant was not sure whether they were causing the rings to move, or whether the rings were causing them to breathe in a certain way. Interestingly most participants reported that they noticed changes in the HRV power spectrum rays depending on their mental focus, even when they didn’t fully understand what information the rays were displaying, a point that is discussed further in the next section. From the responses it became clear that the relationship between the visuals and the body/mind led people to a feeling of engagement similar to the ‘somatic extension’ described by Edmonds et al (2004) for example:

*I’m feeling […] I don’t know if it’s the right word but integrated with the visual, because it’s kind of synchronised with how you’re thinking and breathing and moving and your heartbeat and everything all integrated together*

The majority of participants’ behaviour met the affective goal of *Explorative and Curious*. The opening sections participants’ reports tended to be characterised by
words such as curious, fascinated and intrigued. They explored the work in three ways; by experimenting with their breathing, with their thoughts or with trying to create certain patterns and shapes with the visuals. For most this process was described in positive terms, with one interesting exception. One participant describes a feeling of frustration at how little he could make the visuals do; ‘I thought oh, well I’ll try different things and see what I can make this thing do... I looked at the guy before me and I thought oh he’s not doing much maybe I can make it do all sorts of things but I couldn’t’. This coincides with a point made by Edmonds et al (2004) that physiological artworks challenge the notion of control. Edmonds suggests that it is more useful to think of the participant as influencing rather than controlling physiological systems, in which you are being rather than doing something in order to have an effect. It is an interesting challenge for the curatorial and interpretative aspects of such artworks to consider how audiences might be encouraged to adopt this different approach to interaction, so as to avoid frustration.

Most participants seemed more comfortable with this alternative kind of interaction and it facilitated a range of reflections about their body and their life through both negative and positive images and recognition of their physiological effect. There were two particularly interesting aspects to this; firstly that the participants all had only a very vague understanding of the kind of information being displayed by the spectral rays; and secondly that, nevertheless, the appearance of the rays prompted in most cases the recounting of very intimate and personally meaningful stories as a way of reflecting on the self.

Stories told by participants included thoughts of loved ones and of work, memories of holidays and experiences, and reflections on health and previous or current bodily states. There was evidence of a strongly perceived correlation between these thoughts (and their associated physical sensations) and the visualisations, for example one participant says:

*I tried to think of my girlfriend, who I haven’t seen for three weeks. And I remember the lights were really going out when I was thinking of her.*

*Another comments: [I] kept trying to think of myself as feeling really good about my body, [imagining myself] on the bike, and just cycling along, and I noticed that I could see the effect of that sort of calmness, um, that came from being on my bike...*

This evidence supports Gaver et al’s (2003) suggestions that ambiguity creates space for people to create meaning. The slight distance created by ambiguity encourages active reflection, and to interpret their experience, participants are required to build connections between their own physical and mental experiences and the information visualisations that they are being shown.
5.4.5 Evaluation

The development of *Cardiomorphologies v. 2* from prototype to final artwork, and the richness of the audiences experiences uncovered during its exhibition demonstrates the value of our research into audience experience as a process for the development of interactive artworks. Our final evaluation provides valuable insights into the nature of the interaction and specific qualities of engagement engendered by different interactive elements, revealing a productive tension between total absorption and more reflective and speculative forms of engagement facilitated through ambiguity.

The kinaesthetic intensity of the breath and heart rate visualisations were significantly improved through the use of multiple layers of visualisations to create cascading and rippling effects. The sense of flow and dynamism created by these elements suggests the importance of gestural traces such as trailing and ripple effects in the articulation and selective intensification of participant actions.

Together with a subsequent presentation of the work at Arnolfini contemporary art space (Bristol, UK) in February 2006, the overwhelming popularity of *Cardiomorphologies v. 2* with a broad range of audiences, from artists and curators to family groups and school children, suggests a more general hunger for interactive experiences that engage with aspects of our physiology and body-mind processes.
Presented within the context of busy public museums and art galleries, the unexpectedly social dimensions of the work, first hinted at during Cardiomorphologies v. 1 became even more striking: groups of up to twenty people at a time would gather around individual participants and become absorbed by the slowly changing patterns of the artwork. The attraction of the work in such settings was clearly linked to the sense that the work was offering some form of insight into the individual whose breathing and heart rate were driving it. In this sense the work has definitely fulfilled my original intentions to facilitate considerations of body-mind continuities, grounded in the reality of our moment-to-moment experience of our selves as physiologically embodied subjectivities.

Beyond the fulfilment of my primary aim to create a space where issues and experiences of body-mind interaction and representation could be explored at a general level, a more detailed form of interaction and learning of the kind I had encountered in my own experiences with somatic bodywork and biofeedback training remained elusive. The real potency of these forms, as discussed in Chapters 2.1 and 2.2 resides in their ability to enable participants to sense and eventually enact actual changes in their experience of themselves and the world around them through shifts in intention and physical organization (breath, posture, nervous system activity, muscle tonus, etc). This was accomplished to a limited extent in both Cardiomorphologies v. 1 and Cardiomorphologies v. 2, with participants generally reporting feelings of feeling relaxed and ‘spaced out’ on completing their interaction with the work. However, this remains a long way from the experience of voluntarily altering nervous system and heart rate activity, as can ideally be accomplished through clinical biofeedback and somatic bodywork.

Noise from surrounding exhibits and visitor traffic at the Powerhouse Museum significantly limited the extent to which participants could entrain increases in parasympathetic nervous system activity: the busy exhibition environment, the volume of the sound design (turned up to compete with the surrounding noise) and the novelty of the interactive experience itself, all combined to generate a strong sympathetic (flight-flight) nervous system response, which tended to inhibit the participant’s ability to entrain any significant increase in parasympathetic tone. The influence of such distractions highlights the need for a much tighter control over the participant’s greater perceptual field. The light and space works of James Turrell are notable in this regard: the power of his installations resides as much, if not more in what is removed from his installation spaces rather than what is contained within them.

Substantial improvements had been implemented to provide an increased sense of visual differentiation between the feedback and data visualisations generated by individual participants, but responses from participants suggested the need for an even greater degree of variation within and across individual interactions. A balance needs to be struck between richness and variability on the one hand, and simplicity of
interaction and ease of interpretation on the other – depth needs to be added, but not complication.

Breath sensing remained a problematic aspect of the work. The new stretch sensing hardware provided increased robustness and improved responsiveness compared to the previous piezo-electric design. Given the complexity of breath as both a recordable behaviour and as set of visceral sensations, it was clear that future developments would either have to embrace the restrictions presented by this essentially one-dimensional way of measuring breathing activity, or augment it with movement recorded from sources such as multiple points across the thorax, air flow in and out of the mouth or nose, or measurements of carbon dioxide levels.

The process of developing the work through the experience-centred research methods introduced by Lizzie have had a profound impact on my understanding of the work and its situation within the broader context of the conceptual framework and historical precedents outlined in Chapters 3 and 4. Whilst experience had been theorized as central to the works from the very beginning, the experience of making and evolving a work with these experience-focused tools and methods has transformed my appreciation of the issues surrounding my practice and the validity of practice-based research more generally. Our aim throughout this period was to develop a framework for testing and evaluating our respective questions and hypotheses, along the way we have uncovered some powerful tools for studying, documenting and thinking about the work that art does. Video-cued-recall emerges from this work as a powerful tool for documenting and archiving of interactive art as an experience, providing a basis for historical reflections on the work in-context (lived experience) that can too easily be overlooked with the passing of time. The development of these interview materials as an integral component of the artwork as a whole, had been tentatively explored during Cardiomorphologies v.1. In the wake of Cardiomorphologies v.2 my enthusiasm for the development of this method as a form of relational practice, such as introduced in Chapter 3.1.2 was tempered by Lizzie's concern for its continuing validity as research method, capable of soliciting direct responses unfettered by any pressure to perform to a wider public. This tension raised important questions around the use and impact of participation and story sharing in relational practice: how will a participant’s account of their experience be influenced by an awareness of their representation as a form of performance or artefact? Is this necessarily a bad thing—how might this influence be developed to support an artist’s aims? Whilst beyond the scope of this exegesis, these questions deserve further exploration – especially for artists and curators working in the area of participatory and relational aesthetics where social interactions between audience can play such a vital role.
Chapter 6  Conclusions

This chapter provides a summary of the developments that have taken place during the development of the four works documented in Chapter 5, followed by a consideration of four key findings relating to the development of these works and their implications for future works.

Chapter 5 outlined the development of four artworks that explore subjectivity as a physiologically embodied phenomenon, utilising breathing and heart rate patterns as an interface for biofeedback interactions. These interactions were designed to facilitate reflections and insights, grounded in the lived experience of the audience's participation and embodiment. Each of the works created a space where participants and observers alike became present to aspects of physiological embodiment outside of the context of pathology or elite sports training, in ways that are rarely supported in existing social contexts. Audience responses to these works have been studied as a way of evaluating the extent to which these interests have been realised through interaction. The purpose of researching the audience experience was not to create a work that simply pandered to audience tastes, but to find ways of facilitating a more intense form of engagement with the phenomenon and issues in question. Key differences between the works centre around the degree of fit between the participant’s own felt experience and the images and sounds reflected back to them through interactive sonification and visualisation.

res’onance-body [-box], created a sense of place for this type of engagement and bodily focus, and introduced co-experience as an unintended but rewarding new element to my conception of the work. The relationship between the artwork and the participant’s actions was not for the most part explicit, instead reflecting longer-term trends in breath-rate as revealed through slowly cross-fading drone textures and environmental recordings.

Cardiomorphologies v. 1 used improved data analysis algorithms and sensor hardware to establish a closer connection between breathing and heart rate behaviours. Breath-related movements were sonified and visualised in a way that provided a much
stronger sense of identification between the participant and the artwork. Heart rate-variability biofeedback was developed as a tool for examining emotionally mediated changes in physiology using FFT based spectrum analysis techniques. Where *res’onance-body [*-box], created an intensely immersive environment through the use of slowly shifting ambient soundscapes and (non-interactive) architectural lighting, *Cardiomorphologies v. 1* explored a deliberately diagrammatic and laboratory style aesthetic as a way of facilitating a more reflective and physiologically focused interaction.

The concept of the artwork as an instrument for listening and observing (in contrast to the more popular notion of interactive artworks as instruments for personal expression) was pursued through the use of pared-back geometric data visualisations and numeric displays of breathing and heart rate data. Interviews recorded with participants after their interaction with the work were introduced as a way of stimulating reflections and discussions that could be accessed by other visitors via headphone listening stations within the exhibition itself. Feedback gathered from these interviews was then used to evaluate the effectiveness of the various biofeedback elements as interfaces for learning to sense and regulate aspects of breathing and heart rate function.

An important finding from these interviews was the issue of information overload: the information that I presented to participants regarding the nature of observed behaviours was simply too complicated for general understanding. Interpretation and learning was fundamental to my interest in biofeedback and somatic bodywork, and highlighted the need for a re-examination of the way in which information was presented. Another recurring issue for participants was the desire for uniqueness: participants wanted the work to respond to their presence in a way that enabled them to differentiate their interaction from the interactions of others. This desire for differentiation seemed peripheral to my own concerns for the work at the time, but would later emerge as a vital component in my understanding of the work and its realization through audience experience.

The two *Drawing Breath* works were conceived as a more light-hearted and playful alternative to the intense demands of the previous works. They were designed to be suitable for presentation in a conventional group exhibition or small art gallery setting, without the need for a dedicated operator to induct participants into and out of the work. The work’s enticing three-dimensional graphics, designed in collaboration with John Tonkin, created an intensely kinaesthetic visualisation of the participants’ breathing, as recorded by the stretch sensors fitted to their chest or abdomen. Despite the work’s strong immediate appeal and ease of presentation, *Drawing Breath*...
presented a relatively limited form of interaction compared to the quality of engagement afforded by works like *Cardiomorphologies v. 1* and *resonance-body [-box]*, and in this sense helped strengthen my resolve to continue working with these more intensive and demanding forms. At a purely technical level, *Drawing Breath* served as the basis for the development of my own breath-sensing hardware, and led to significant insights into sensor reliability and robustness.

Although structurally very similar to its previous iteration, *Cardiomorphologies v. 2* represented a major transformation in my understanding of interactive design processes. Working with approaches to interactive design and user experience adapted from HCI and human-centred design, I was able to re-evaluate my goals for the work. The strict, diagrammatic and instrumentally focussed visualisations explored in *Cardiomorphologies v. 1* gave way to a more sensual and evocative approach using a halo-like glowing structure. Audience experiences recorded using *video-cued-recall* and peer discussion (refer to 5.4.3.2) enabled me to refine my intentions for the work and address many of the issues regarding information overload and interpretation that emerged during *Cardiomorphologies v. 1*. The process of explaining to participants how they could learn to interact with the work (i.e. alter heart rate patterns through intentional focus or breathing) was radically simplified, with an emphasis on the idea of learning by doing rather than a lengthy and technical presentation. Heart rate variability spectral analysis techniques introduced in *Cardiomorphologies v. 1* as a simple bar graph, were now integrated as an array of ray-like emanations projecting from the centre of the main halo-like visualisation. Participants were told that increases in the length of the green bars correlated to influence of stress, novelty, rumination and general environmental engagement on their cardio-respiratory functioning, while an increase in the length of red-magenta bars correlated to a calmer and more inwardly focussed orientation, associated with slower, more effortless breathing and an absence of stress, rumination or external distractions.

Interviews recorded during *Cardiomorphologies v. 2* using *video-cued-recall* revealed that the work successfully engaged participants in an experience that was both intensely absorbing (immersive) and reflective; stimulating associations and reflections on wider issues relating to their life experiences. However, participants were also frustrated by the relative sameness of the interface within and across different participant’s interactions, despite improvements in this area since *Cardiomorphologies v. 1*. Ambiguity and complexity were found to play an important role in the facilitation of more reflective forms of engagement. Where these qualities had been problematic in *Cardiomorphologies v. 1*, the staged introduction of the various visualization elements in *Cardiomorphologies v. 2* provided a clearer sense of connection to the work from which these ambiguities could be explored. Despite the fact that the interviewees had only the vaguest understanding of the meaning of the ray-shaped HRV spectral display,
its appearance prompted, in most cases, the recounting of very intimate and personally meaningful stories as a way of reflecting on the self (Muller et al., 2006b).

The co-experiential dimensions of this body of work, evident from the beginning in res'onance-body (-box), have assumed a greater importance with each exhibition. In a subsequent presentation of Cardiomorphologies v. 2 at Arnolfini contemporary art space in Bristol (UK, 2006) it became clear to me that the work was functioning as both a form of social practice that enabled friends, families and total strangers to be present to each other through quiet attendance, and also as an intimate display of psychophysiology rarely afforded in established social conventions. The early dialogical aspects of the work, realised through interactions between the audience, the artwork and myself, was now extended to a room of up to twenty people at time. Viewed in this light, the work successfully realised my original aim to create experiences that facilitate new ways of knowing and representing both the body and our subjectivity as an embodied phenomenon. Whilst the overall sonic and visual aesthetics will continue to evolve, the developments and explorations documented in this exegesis have laid the foundations for an appreciation of the deeper issues and functions at the heart of this form of interactive art practice.

The research carried out during this Doctorate of Creative Arts has led me to an understanding of three key imperatives for the development of biofeedback interactions as vehicles for enquiry. They are as follows:

- Unlike many other forms of interactive art, biofeedback interactions describe and facilitate internal actions and processes. Instead of representing our body from an objective third-person perspective, biofeedback interaction represents the body from a first-person somatic perspective, mediated through a combination of externally presented signals and the participant’s immediate felt experience of themselves;

- The works facilitate enquiry through interaction design, providing participants with a framework for the exploration of progressively higher and more complex levels of psychophysiological differentiation, analysis and reflection. These processes are embodied within the design of the interaction itself, together with the various interpretive and promotional materials framing the audience’s entry into the work, thus shifting responsibility for critical engagement and accountability from the professional critic-theorist to individual participants and witnessing audiences; and,

- Co-experience plays an important but largely overlooked role in the experience and critical interpretation of interactive artworks by audiences and individual participants. Most audiences visit exhibitions with other people,
and engage with interactive artworks in situations that are intensely social and involve the presence and/or participation of friends, associates and complete strangers. Interactive artworks support or frustrate these behaviours to varying degrees through the conditions of use that they provide to their audiences.

### 6.1 An Internally Focused Interaction

Unlike many other forms of interactive art, biofeedback interactions describe and facilitate *inwardly* directed actions. Instead of representing our body from an objective third-person perspective, biofeedback represents the body from a first-person *somatic* perspective, mediated through a combination of externally presented signals and the participant’s immediate felt experience of themselves. The work’s *external* appearance is designed to reframe, intensify and extend this *internal* experience in such a way as to enable participants to gain a clearer understanding of their own embodiment and the choices it affords them. It is important that the works be evaluated on this basis — and not simply in terms of their appearance as conventional, externally focused audio-visual artworks.

An artwork whose form and behaviour is dependant on the subject’s own processes of being will be perceived by that subject in a manner categorically different to an object that exists and behaves separately from these processes. We experience our own body and actions as distinct from other objects and events in the world: this experience is never just that of another object or event in the world in general; it describes who and how we are in the world at any given moment in time. Embodiment is a process of separating out, between self and other, and of learning about one’s relationship to the world and the extent of one’s agency within it: i.e. ‘this is the end of me; this is the beginning of something else’ (Bainbridge-Cohen, 1995). Interaction with these works consists of a movement from the known and perceived aspects of the participant’s being (i.e. voluntary coordination of breathing actions) towards aspects of their being that are near or beneath existing thresholds of perception and conscious influence.

Because the perspective provided by the work is a primarily first-person somatic perspective, the participant’s own felt experience and actions form the primary point of reference to which the various audio visual displays are then compared. The participant’s experience in these systems is never reducible to the sensor data alone – such a reduction would imply a break in the feedback loop at the heart of biofeedback interaction. The centrality of the participant’s own felt experience in these works requires a sensitivity – on the part of the designer – to details of experience that will often extend beyond the limits of what can be recorded by available sensing devices.
The function of these sensor devices and the design of the work in general is to extend the participant’s own perceptual abilities, not to replace them.

One significant implication to arise from this insight relates to the quality of physical contact that these sensing devices provide their wearers – how these devices feel as objects against the participant’s body and the (passive) haptic information this contact provides them. Instead of ignoring these aspects of the work’s contact with participants, further explorations of these forms of (passive) physical contact could be used to help clarify and reframe the participant’s experience. Recalling the strategies and implication of somatic bodywork described in Chapter 2.1.3, it is clear that the nature and quality of contact provided by a somatic bodyworker has a determining influence on the quality of the client’s experience and self-insight. While human factors such as the practitioner’s own posture, intent, and quality of attentiveness are obviously beyond the reach of a human-computer interaction, there are still many ways in which human-machine contact on a purely physical and haptic level can influence the participant’s experience. In Cardiomorphologies v. 1, heart rate data was collected using surface electrodes attached by wires to the participant’s arms and wrist in a connection that created a sense of encumbrance as well as invoking notions of medical treatment (i.e. things being done to the body). By contrast, the wireless hand-held heart rate sensors used in Cardiomorphologies v. 2 provided participants with a much greater sense of control in regard to their involvement with the work. The action of holding a sensor in each hand suggested a more careful and intimate quality of contact, and participants knew that they could conclude their interaction simply by letting go of the sensors.

These examples illustrate how simple, non-reactive tactile contact can have an influence on the quality of the participant’s experience, and their sense of agency within it. Tactile contact was explored extensively in the experiential works of Brazilian artist Lygia Clark (refer to Chapter 3.2.2), especially in her later works involving the placement of her Relational Objects onto the participant’s body as a form of healing ritual. Clark’s exploration of contact suggests a range of possible approaches to the use of tactile framing devices and (active, electro-mechanical) haptic feedback in the development of future works exploring body experience and interaction.

6.2 Facilitating Enquiry Through Interaction

The works documented in Chapter 5 facilitated forms of enquiry and reflection through interaction. In this way, biofeedback learning becomes a vehicle for contemplating the wider implications of our embodiment and embeds the act of enquiry within the process of interaction.

Enquiry assumes special significance within the traditions of contemporary Western art, enabling distinctions to be made between works that are said to be merely
pleasing or fun, and works of a more critical or contemplative nature. Where the former present experiences enjoyed for their own sake, the latter draw the subject into a consideration of matters beyond the artwork’s immediate physical properties and towards a reflection of the larger meanings and values invoked by the work (Hansen, 2005). Playfulness itself can be a focus of critical enquiry to the extent that the artwork provides a framework for reflecting on what play can mean or contribute to our experience. Artworks afford enquiry by creating problematic situations involving certain ideas, experiences and conditions. The art experience becomes an ongoing process of making-sense of, or reconciling, the problematic nature of the situation encountered. Meanings derived from this process of making sense enable the art experience to play a role in the formation of subsequent life experiences (Fiore et al., 2005).

While much has been said on the problematizing and questioning function of contemporary art practices, it is not clear to what extent the problems presented by these works compel their audiences towards an actual process of reflection and enquiry. When does questioning cease to be a catalyst for actual individual reflection and simply an untested assumption on the part of artists, curators and critics? In placing the process of enquiry at the centre of the interactions documented in Chapter 5, I have sought to transfer the primary responsibility for critical engagement from the artist/curator/critic to the participating audience member. Asking questions is important, but so is searching for answers. Regardless of the fact that these answers can only ever be provisional accounts based on the subject’s present situation, it is through this action of making sense and forming an account of one’s own experience – through interaction with the work and in sharing these experiences with other audience members – that artworks facilitate the development of insights, understandings and values surrounding our experiences and actions as embodied subjects.

As an artist, I am interested in the processes by which we evolve meanings, values and identities through sensation, interaction, and enquiry. So, as makers and critics of interactive artworks, the question is how do we develop and evaluate an artwork’s ability to afford such forms of enquiry on the part of our audiences? Audience experience is hard to define, and actual audience experiences are usually assumed to be too individual to summarise in any artistically useful or meaningful way. Approaches to the study of audience experience in HCI and experience-centred design research introduced in Chapter 2.5 and Chapter 5.4.3 reveals aspects of experience and reflection in interaction that can be clearly identified across many users, in ways that allow us to see how enquiry and reflection is shaped by the design of the work and the interpretive frameworks surrounding them. In Cardiomorphologies v. 2 (see Chapter 5.4), these methods and frameworks were used to develop and evaluate audience experiences of the work in relation to these aims. The key findings arising from this process of
evaluation will now be considered in terms of their broader implications for works exploring biofeedback interaction as a medium for enquiry.

6.2.1 Immersion, reflection, ambiguity and enquiry

Muller’s (2006) analysis of interview transcripts recorded with Cardiomorphologies v.2 participants highlighted the importance of immersion and ambiguity in the development of enquiry through interaction. After an initial phase of familiarisation, participants became immersed in the movement of the breathing and feedback, literally zoning out and reporting that, “[I’m thinking] …just about my heartbeat, I’m just thinking about the heart and breathing calmly, that was the focus, nothing else”. Several participants reported the focusing and relaxing power of the image, for example: “My thoughts kept jumping to external thoughts, but then I’d sort of get sucked back in and drawn back to the image, and then I just kept starting to relax more and more”.

As changes in the slower timeframe data (such as breath and heart rate trends and low frequency heart rate oscillations) began to reveal themselves through gradual changes in the colour of various graphic elements; ambiguities regarding the precise cause of these changes initiated a series of momentary disengagements from this state of immersion, as audiences evaluated the status of these signals as a reflection of their action and presence within the work. As already noted in Chapter 5.4.4, despite the fact that participants had only a very vague understanding of the kind of information being displayed by the HRV spectral display, changes in the appearance of this display prompted in most cases the recounting of very intimate and personally meaningful stories as a way of reflecting on the self (Muller et al., 2006b).

It is clear from these experiences that immersion in itself is not enough to facilitate enquiry. It was only when participants became aware of other changes not immediately identifiable as their own (e.g. changes in the overall colour of the display, or in the length of the HRV spectrum display) that the process of reflection and enquiry came into play. This explains the limited appeal of an otherwise more immersive work like Drawing Breath whose appearance and behaviour, although intensely absorbing, remained relatively unchanged over time. As mentioned previously, embodiment describes a process of becoming and identification: i.e. *this is me, and this is the beginning of something else* (Bainbridge-Cohen, 1995). A work such as Cardiomorphologies v. 2 provides a multiplicity of levels through which participants can learn to identify aspects of their own being. These levels unfold over timeframes beyond our conventional press-and-play attention spans, extending from changes taking place over a few seconds (heart rate) to changes unfolding over the space of a few minutes (HRV spectrum analysis). The process of embodiment in these
interactions involves an extension of the participant’s sense of being into progressively longer timeframes, from the obvious to the apparently elusive and ambiguous. The task of design is to stage and prioritise the order in which these layers of information become revealed to the participant in a manner that is compelling but also coherent: too much ambiguity leads to a sense of alienation and indifference, whilst too much clarity leads to a sense of predicability and boredom. Both extremes foreshorten the extent of the participant’s involvement with the work.

6.2.2 Ambiguity and audience agency

Another important aspect of ambiguity in interaction is the way in which it enables individual audience members to direct the nature and extent of their enquiry. In their paper *Ambiguity as a Resource for Design*, Gaver et al (2003) describe how ambiguity can be developed as an asset rather than a problem in human-computer interactions that seek to engage participants in imaginative meaning-making activities:

> Ambiguous situations require people to participate in making meaning. This can involve the integration of previously disconnected discourses, the projection of meaning onto an unspecified situation, or the resolution of an ethical dilemma. In each case, the artifact or situation sets the scene for meaning making, but doesn’t prescribe the result. Instead, the work of making an ambiguous situation comprehensible belongs to the person, and this can be both inherently pleasurable and lead to a deep conceptual appropriation of the artifact.

They distinguish three principal categories of ambiguity that can be developed through interaction-design: 1) ambiguity of information, 2) ambiguity of context and 3) ambiguity of relationship. An artwork like *Cardiomorphologies* embodies all three of these categories to varying extents, and a closer examination of how these qualities are embodied with the design of the work demonstrates how audience experience can be influenced by the design of the work and its presentation.

*Ambiguity of information* invites participants to project their expectations onto an interpretation of incomplete information. Many of the physiological processes examined in *Cardiomorphologies* v. 2 were unfamiliar to participants, and participants took some time before they could begin to get a sense for how the variables related to their own presence within the work. As already noted, the design of the work negotiated a delicate and dynamic balance between clarity and ambiguity of interpretation, thus interaction becomes a process of mapping progressively subtler dimensions of perception and action.
Ambiguity of context requires an integration of seemingly incompatible frames of reference. Presenting biofeedback interactions in art galleries and museums requires audiences to negotiate seemingly incompatible ways of experiencing the body. Our experience of objects and events is strongly determined by the context in which these experiences take place: we experience our physiology differently in a doctor’s surgery than we would in an art gallery. Although some audiences find this kind of ambiguity intolerable (e.g. ‘it’s just not art’), for other visitors this ambiguity allows them to engage with their physiology in new and interesting ways. Marcel Duchamp’s notorious Fountain, a urinal placed on a plinth in an art gallery, is an extreme example of the provocative power of this type of ambiguity.

Ambiguity of relationship is similar in many ways to ambiguity of context, but where the latter provides a setting for behaviours and interpretations, the former describes the relations (real or imagined) that unfold within these settings. In Cardiomorphologies this was most evident in the nature of contact between individual participants and myself as the work’s operator. The attachment and adjustment of the various sensor devices and the processes of explaining the feedback signals and responding to participant’s questions, combined with the negotiation of safety and consent issues in the Information and Consent forms, established a quality of intimacy and attentiveness that is unusual in museum and gallery contexts. The involvement of these aspects in the work as a subject of the interaction requires a re-evaluation of their own status within the work.

6.2.3 Forlizzi and Battarbee’s Model of Experience in Interaction

Forlizzi and Battarbee’s (2004) model of audience experience in interaction, introduced in Chapter 2.5.1, provides a more complex appreciation of the varieties of experience at work in an interactive situation. Meanings and experiences unfold through a process of rhythmic alternations between four categories of engagement; fluent, cognitive, expressive and co-experiential. The usefulness of this model lies in the way that it allows designers to assess how each of these categories of experience in interaction is supported or frustrated through the design of the work and the interpretive frameworks that surround it, e.g. through the labels used to describe the work in the gallery, in promotional materials, and in the curatorial agendas informing the works presentation.

In Cardiomorphologies, biofeedback technologies are used to shift the usually fluent or subconscious experiences of breathing, heart rate and nervous system activity to a level of cognitive awareness and reflection in which participants learn to identify, sense and eventually coordinate the physiological behaviours being monitored (Schwartz and Olsen, 1995). At certain stages during their interaction participants achieve a degree of fluency with the behaviour of certain (biofeedback) interface
elements to the extent that they can begin to experiment with *expressive* interactions (i.e. deliberately causing their heart rate to speed up or slow down in order to make certain make shapes larger or smaller, etc.). The competency required in order to undertake these more expressive and playful forms of interaction indicates a transition from a *cognitive* (learning) stage of interaction to a *fluent* (learnt) interaction. *Cognitive* stages can be characterised not only by alternating between processes of immersion and reflection, but also by complex movements between *fluent* and *expressive* interactions where participants engage in playful forms of exploration regarding the work’s ability to accurately reflect their presence within the system.

*Expressive* interactions also describe processes in which participants develop a sense of identification and individuality through their representation in the artwork: *i.e.* *that is me, that is my heart, this is me being angry.* One of the perceived shortcomings of *Cardiomorphologies*, revealed during the *video-cued-recall* interviews and feedback from previous iterations of the work, was the relative sameness of the look and sound of the work from one participant to another – audiences indicated a strong desire for their interaction to reflect their particular sense of uniqueness and individuality. Forlizzi and Battarbee’s model reinforces the importance of this kind of *expressive* interaction in the production of meanings and values, and suggests the need for a re-consideration of the role of expression in my conception of the work. Interestingly, throughout the development of *Cardiomorphologies* I consistently avoided the idea of the work as an instrument for expressive (i.e. musical) performance, favouring instead the concept of the instrument as a tool for sensing and locating otherwise hidden details of our being. My reluctance to frame the interaction in terms of expression stemmed from concern that audiences might become fixated on the notion of expression and lose sight of the work’s primary goal as a system for sensing and reflecting on their own (physiologically) embodied subjectivity. Expression in Forlizzi’s scheme provides users with a basis for establishing their identity within the interaction, and as a basis for co-experience in relation to other users. In *Cardiomorphologies* this notion of expression includes the discussions and informal comparisons taking place between participants and observers. Differences between the work’s response to individual participants helps intensify their experience of themselves within the system, and becomes a starting point for *(co-experiential)* discussions between visitors and participants about the work and their own psychophysiology.
6.3 Acknowledging The Role of Co-experience

Co-experience is acknowledged in Forlizzi and Battarbee’s framework as a crucial component of audience experience in the generation of meaning and value. Where experience refers to continual flow of perception and action in waking life and an experience describes that which can be described and named, co-experience reveals how the experiences we have — and the interpretations we build from them — are influenced by the actions and understandings of others (Forlizzi and Battarbee, 2004). Co-experience plays a fundamental but largely unexamined role in the experience and interpretation of interactive artworks by audiences and individual participants (Graham, 1997, Heath and Lehn, 2002).

Experience-centred approaches to the design of interactive artworks focus on the artwork as a system for supporting specific kinds of audience behaviour and experience in which the artist, artwork, audience, and presentation setting comprise a matrix through which experiences and understandings evolve (Cornock and Edmonds, 1973). The deliberate inclusion and manipulation of co-experience within this matrix gives rise to various forms of dialogical practices such as those introduced in Chapter 3 allowing us to experience and reflect on ways in which meanings and values emerge and evolve through the sharing of stories and interpretations.

Co-experience has been an important and unavoidable element of my work with biofeedback interactivity from the outset. The processes of attaching the heart and breath sensors and inducting participants into and out of Cardiomorphologies necessitates a close and trusting relationship between the participant and the installation operator (usually myself). Enabling non-participating observers to also access the work opens it up to a much larger audience than would otherwise be available for a work that can only respond to one person at a time, with sessions lasting between ten and thirty minutes. As the work has evolved through various iterations, notions of co-experience, dialogue and conviviality have become increasingly important to my concept of what this kind of interactive artwork is and what it does. Cardiomorphologies creates a social space that allows friends and strangers to be present to each other in ways seldom afforded by normal social conditions: creating a space where people interact with the work individually but where they also participating through group observation. This experience of observing someone else interacting with a work via their feeling and breath was not something that I had anticipated audiences to find very interesting at all. However, in practice it created a surprisingly intimate and caring atmosphere, as observers bore witness to the normally hidden processes of the participant’s embodiment – i.e. listen to me, this is me being calm, this is me being sad, etc. While a few participants found the presence of observers disconcerting, the majority of audiences seem to appreciate the space this group focus created, taking turns to observe and compare each other’s signals. In many
instances it is likely that the presence of observers intensified the quality of the participant’s engagement with the work and the processes explored through it.

The framing of audience experience through formalised research methods such as the recording of post-experience interviews and *video-cued-recall* adds a further dimension of co-experience to the audiences’ overall experience of the work (Khut and Muller, 2005). Although problematic from a conventional social research perspective, the development of research-focused dialogues between artist/researcher and audience as an integral part of the work is an area of great interest to me as a practitioner, especially when considered in relation to theories of relational or dialogical aesthetics articulated by writers such a Nicolas Bourriaud (Bourriaud, 1998) and Eduardo Kac (2005). While ethnographic materials (i.e. interview transcripts and personal histories) generated through these methods suggest interesting potential as art materials in their own right (i.e. documentaries or database driven artworks) their primary attraction for me at this stage of the work’s development is as a useful device for shaping the participant experience itself – intensifying the experience of the participants through the range of expectations and behaviours that audiences bring to the experience of these research methods (i.e. ‘scientific’ experiments, focus groups, audience surveys) as relational structures.

Figure 56 Visitors observing a young participant in Cardiomorphologies v.2, Arnolfini gallery, Bristol, UK, 2006.
Chapter 7 Future Directions

The works documented in this exegesis have laid the foundations for an approach to the development of biofeedback interactions as vehicles for embodied enquiry and aesthetic appreciation. Biofeedback interactions enable us to re-imagine our subjectivity as a deeply embodied and instrumental phenomena.

Throughout this exegesis much attention has been paid to the way in which particular interfaces support specific qualities of engagement, and considerable energy has been invested in the exploration of breath-sensing technologies. The overwhelming tendency of these sensors to draw participants into exaggerated and forceful breathing patterns has provided an important catalyst for my re-conceptualisation of biofeedback as a vehicle for exploring subjectivity and the concept of *non-action* in particular. By contrast, heart rate variability spectrum analysis has emerged as a powerful tool for the creation of highly individualised and richly detailed interactive artworks. The potential of this modality for the creation of subjectively responsive artworks is rich with possibilities for future development.

Under suitable conditions, HRV spectrum analysis can provide compelling demonstrations of the close links between mental activity, emotion and autonomically mediated variations in heart rate. By differentiating contrasting forms of subjective engagement according to their associated HRV spectral profiles, the participant's subjectivity is represented as a fundamentally active process of orientation. The quality of engagement is of critical importance here: HRV spectral analysis can enable participants to differentiate contrasting forms of mental effort and engagement. The artwork's appearance can thus be made contingent on the quality of the *participant's* engagement. *Non-action,* (defined as a decrease in mental effort and non-judgemental engagement) can thus be developed as a form of gestural interaction, and has emerged from the process of exploration documented in this exegesis as key priority in the development of future works exploring biofeedback interaction.


7.1 **Beyond Research and Development**

Having established a working understanding of principals of HRV Spectrum analysis and biofeedback design through the four works documented in this exegesis, it is clear that the next stage of the work’s development will need to focus on the implementation of a more dynamic and individualized visualisation and sonification system, and a reconsideration of the project’s overall communications strategy. Based on the experience-centred approaches explored in this exegesis, each aspect of the work’s presentation will need to be reconsidered in terms of the cues they provide to the visiting audience. By re-examining the experience as a whole, in terms of the different stages and qualities of engagement involved, certain aspects of the work that have hitherto proved too complicated or confusing (i.e. ‘what is heart rate variability?’ and ‘what does this tell me about the state of my body?’) can be addressed in ways that preserve the integrity of the main interaction while providing interested audiences with pathways for more theoretical explorations of the psychophysiological processes at the heart of the work. Video recordings of each interaction with the work could also be provided to participants as a memento of their experience, extending the reach of the work into the domain of their ongoing life experiences.

Whilst not explored in this exegesis, time-series representations and comparisons represent another area of development rich in possibilities; enabling participants to compare in retrospect changes in physiology taking place within individual interactions and across multiple users. Other forms of long-term statistical analysis and representation could be developed to reflect the overall flavour of interactions recorded by the work over several days, or as an accumulation of individually deposited layers of information; creating a symbolic record of the exhibition as an accumulation of private reveries, ruminations and experiments.

The use of ethnographic methods for documenting and representing audience experience, and the possibilities for the development of these processes as performative elements of interest in their own right has already been noted. Considered within the context of the relational and dialogical art practices documented in Chapter 3.1 the possibilities presented by such methods deserve further exploration, and will likely provide the basis for new research beyond my current work with biofeedback and body-mind representation.

7.2 **Consolidating Methods and Tools**

One critical element for future work in this area concerns how the conditions of production influence the quality of the completed product. In Chapter 5.4.2.2, the process of play was identified as a crucial element in the development of experientially satisfying art works. The means by which such a work is created can have a determining
influence on the quality of experience provided by the completed artwork. Greg Turner’s data manipulation ‘toys’ highlight the importance of play in the creation of aesthetically engaging data-mappings schemes. Through the process of extended play, artists establish a sense of familiarity and rapport with the dynamics of the data to be mapped and the responsiveness of the various visualisation and sonification systems. This rapport constitutes a form of embodiment through which the artist articulates the various intensities and channels of flow that characterise the form and quality of the completed design. Future work with experientially focussed data-mapping systems, such as those documented in Chapter 5 would benefit from closer examination of the role of technology and compositional method in support of the creative process. An interactive model of the data to be mapped (i.e. a realistic and fully adjustable simulation of autonomically mediated heart rate variations) would greatly assist with the testing and evaluation of new sonification and visualisation schemes, and could be programmed to emulate a wide range of real world behaviours. Such a model could also serve as a starting point for the development of interactive interpretive displays that could be used to explain the principals of HRV spectrum analysis to interested audience members.

7.3 Wider Applications

Interactive art experiences, as explored by the works documented in Chapter 3 and Chapter 5, provide a compelling medium for critical explorations of self as a complex phenomenon embodied within multiple dimensions of influence i.e. cognitive, physiological, ecological and sociological.

This exegesis has concentrated primarily on an exploration of our physiological embodiment, but throughout the development of these works I have often wondered to what extent the principals of interaction and feedback explored in this exegesis might be extended to broader explorations of our social and/or ecological situation. Recent developments in areas such as community media (Garcia, 2003), global positioning systems (Adams et al., 2006) and telecommunication networks (Tuters and Varnelis, 2006, Mobilegaze, 2005) are supporting a growing body of artworks, community development and various media interventions engaging with this very issue, inviting us to imagine and reflect critically on the wider implications of our actions.

Central to many of these approaches is a concern for the development of the “artwork as public research laboratory”, a phase coined by Rokeby (1998) to describe the critical and participatory nature of his own practice-based research. This notion has been explored intensely through each of the works discussed in Chapter 5 and 6 and provides a compelling model for future research into other dimensions of embodiment and social practice.
7.3.1 Art and Health

One area of particular relevance to the artworks documented in this exegesis is the relatively recent field of ‘arts and health’ and health promotion. As a field, arts and health is far ranging and diverse in its approaches and outcomes, ranging from arts therapies and the display of curated exhibitions in hospitals, to community cultural development projects focussed on broader community health, overall wellbeing and wider sustainability concerns (Putland, 2003).

Given the proliferation of electronic sensing devices in contemporary health care, it is surprising that so little work with interaction and biofeedback has been undertaken in this field, and this gap in existing arts-and-health practice can only strengthen the case for potential residencies, exhibitions and associated research and development work. Presented within the context of health promotion and education programs in hospitals, museums and educational institutions, works like Cardiomorphologies have real potential to introduce audiences to a more considered and inspirational appreciation of personal wellbeing, not simply as the absence of illness and pain, but as a source of pleasure and a vehicle for deeper self understanding and personal growth.
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Appendices
Appendix A

DVD Documentation – Exhibited Works

Disc #1

Portfolio of exhibited works, 2003–2005

Track 1

1. Introduction: background & context
2. res’onance-body [-box],
3. Attaching the sensors
4. Installation view
5. Installation view continued

6. Cardiomorphologies v. 1
7. Attaching the sensors
8. Installation views
9. Sample of screen footage: weeks 1 & 2
10. Sample Screen footage: spectrum analysis display

11. Drawing Breath v.2
12. Attaching the sensors
13. Installation views
14. Sample of screen footage

15. Cardiomorphologies v. 2
16. Attaching the sensors
17. Installation views
18. Detail of Beta_space visualization
19. Detail of Arnolfini visualisation

Track 2

Previous works (1997–2003)
Appendix B  DVD Documentation – Interviews

Disc 2  Video-Cued retrospective reports collected by Lizzie Muller

Track 1  Prototyping workshop, Performance Space, May, 2005*
1. Respondent #H
2. Respondent #K
3. Respondent #I

Track 2  Cardiomorphologies v. 2
Beta_space, September, 2005**
1. Respondent #2
2. Respondent #6
3. Respondent #5
4. Respondent #3

* Refer to Chapter 5.4.3.1 for more information about these interviews and the video-cued recall method.

** Refer to Chapter 5.4.4 for an evaluation of these video-cued recollections gathered during the Beta_space exhibition.
Appendix C  Curriculum Vitae: George Poonkhin Khut

Born 1969, Adelaide, lives and works in Sydney, Australia

EDUCATION
2002-2006 Doctorate of Creative Arts (candidate), University of Western Sydney
1993-1989 Bachelor of Fine Arts, University of Tasmania, Centre for Arts, Hobart

SELECTED SOLO EXHIBITIONS AND COLLABORATIONS
2005 Cardiomorphologies v.2 with Lizzie Muller and Greg Turner, Powerhouse Museum, Sydney
2004 Cardiomorphologies v.1 artist residency and exhibition, Performance Space, Sydney, Australia
2003 res’onance-body (-box) with Julia Charles & Karina Clarke, Gallery Barry Keldoulis, Sydney
2003 Nightshift with Wendy McPhee, Perth Institute of Contemporary Art
2002 Nightshift with Wendy McPhee, Artspace, Sydney
2002 Nightshift with Wendy McPhee, Tasmanian Museum and Art Gallery, Hobart
2001 Chinoiserie Gallery 4A, Asia Australia Arts Center, Sydney
2001 New Work (Nightshift beta version) with W. McPhee, Performance Space, Sydney
2000 Pillow Songs 24HR ART, Darwin
1999 Pillow Songs Gallery 4A, Sydney and Temple Studios, Melbourne
1999 Snare CAST Gallery, Hobart and RAW Nerve, Sydney
1999 Pillow Songs Sidespace Gallery, Salamanca Arts Centre, Hobart

GROUP EXHIBITIONS
2006 Cardiomorphologies v.2 Inbetween Time Festival of Live Art & Intrigue, Amolfini, Bristol, UK
2004 Asian Traffic: phase four six-part group exhibition, Gallery 4A, Sydney, Australia,
2003 Nightshift with Wendy McPhee, Inbetween Time Festival of Live Art & Intrigue, Amolfini, Bristol, UK
2001 Suspended First Draft Gallery, Sydney, Australia
2001 Close Encounters First Draft Gallery, Sydney, Australia
1996 Mutiny on the Docks Customs House Building, Tasmanian Museum and Art Gallery as part of Hobart Summer Festival

COMMISSIONED WORKS 2001 – 1994
Girt by Sea sound design, Urban Theatre Projects youth ensemble, Sydney
Censored sound design, performance by W. McPhee, director D. Pollard, Backspace Theatre, Hobart
Immersed sound design, installation by John Utans, University Art Museum, University of Queensland
Panopticon sound design, Salamanca Theatre Company, directed by D. Pollard, Hobart
To Eat Flower & Walk on Glass sound design, Salamanca Theatre Co., directed by D. Pollard,
Living In/Living Out sound design, collaborative project with Martin Walch and Miranda Morris, Tasmanian Trades Labour Council with Royal Derwent Hospital, New Norfolk
New Music Tasmania Festival Club, interior design, Peacock Theatre, Salamanca Arts Centre, Hobart
New music for Piano and Electronics, designer and co-director with Gabriella Smart with Yumi Umiumare,
Studio Theatre, University of Tasmania Hobart
MIKROVION in Concert video artist, IHOS Opera, Elizabeth Pier, Hobart

GRANTS & AWARDS
Australia Council, New Media Arts Board, New Work, for Drawing Breath v.3
Australian Postgraduate Research Award 2002–2005 (Doctorate of Create Arts, Research)
Australia Council, New Media Arts Board, New Work, for Nightshift
Australia Council, New Media Arts Board, Arts Development (with W. McPhee)
Arts Tasmania, Artists Development, for Snare exhibition tour
CAST Touring, Exhibition Touring Fund, for Pillow Songs
Australia Council, New Media Arts Fund, Presentation & Promotion for Pillow Songs
Australia Council, New Media Arts Fund, New Work, for Pillow Songs
Arts Tasmania and Australia Council, Theatre Board, producer and presenter, for Butoh Master Classes with Yumi Umiumare
res’onance-bod’y (-box)

a interactive installation by Julia Charles, Karina Clarke, George Khut and Luiz Pampolha

Gallery Barry Kedoulis (GBK) Client Viewing Room
1/42-44 Macquarie Street, Chippendale, NSW, Australia

November 28th to November 30th
Opening preview Thursday 27th of November, 5:30 – 8pm.

Exhibition continues for three days only:
Friday 28th November, 12 noon to 4pm, then 6pm till 8pm
Saturday 29th November, 12 – 4pm, then 6pm –8pm.
Sunday 30th November, 12 noon to 6pm.

Through the use of biofeedback sensors that monitor the participants breath and pulse rate, individual audience members participate in the unfolding of an immersive sound environment, based on their awareness and interaction of their own breathing and heart beat patterns. By extending these primary body functions into the space of the installation, the work creates a space for a gentle but sustained meditation on these vital but often overlooked physical functions and their contribution to the quality of our being in the world.

Profiles

Karina Clarke
Karina has an MFA in Furniture Design from the University of Tasmania and a BA Int Des (Hons) from RMIT. She is currently a lecturer in Design at UNSW, College of Fine Art. She has worked commercially in design studios, furniture manufacturing and retail establishments. As a highly qualified designer with traditional design and craft skills, Karina Clarke has gained a reputation for her work in the furniture industry as well as her individual contemporary designs for exhibition. She has been the recipient of a number of awards including the Rosamond McCulloch Studio Cité Internationale des Arts in Paris, Arts Tasmania and FIAA Australian Furniture Exhibition awards.

Julia Charles
Julia has been working as a Design/Maker in Sydney for the last eight years. She works on individual commissions for architects, interior designers and proveat clients and cultural institutions. Her design training began at RMIT in Landscape Architecture in Melbourne. Following a passion she retrained in 1995 at the Sturt School of Wood and subsequently co-founded the Splinter Workshop with two other graduates from Sturt. Over the past three years she has been teaching in the School of Design at COFA, UNSW. Her work has been selected for an exhibition of Contemporary Australian Design which will travel to Berlin in 2004.

George Poonkhin Khut
George is an electronic media artist working for the most part in the area of immersive installation environments. His sound installations have been presented throughout Australia, and he has worked on numerous commissioned works for theatre and dance, as well as community cultural development projects. In 2002, Khut commenced a Doctorate of Creative Arts at the University of Western Sydney, where he is researching the use of biofeedback training technologies to create interactive sound and video environments.

Luiz Pampolha
Luiz Pampolha arrived in Australia, after living in Rio de Janeiro. In Brazil he worked as a lighting designer for seven years before he decided to come to Sydney. Luiz’ work includes lighting design for major international events and artists such as Top Cat Blues Festival, Fre Jazz Festival, Rio Design Exhibition, Stanley Jordan, Tony Bennett, and Betty Carter.
sponsorship acknowledgements

This event is presented as part of Sydney Esquisse 2003 <www.sydneyesquisse.org>, and has been generously supported by Gallery Barry Keldoulis, Xenian Living Light, Interface Services, GVA Global Ventures Australia and John’s Pineboard.

Xenian, architectural color changing lighting

Xenian are the exclusive NSW distributors for ColorKinetics range of colour changing digitally controlled LED lights, including the ‘Cove 12’ color changing lights used in this installation.

Interface: modular carpet supply & installation

Interface and Interface Services are one of Australia’s leading suppliers and Installers of Modular carpet. The Interface Group of companies is recognised as one of the world leaders in the area of sustainability, with a goal to become a totally sustainable organisation by the year 2020. Our journey towards sustainability began in 1994 with our founder and then CEO Ray Anderson. His vision has been a major part of our move towards sustainability and our ongoing commitment to this goal. All our carpet has a minimum 50% post industrial recycled yarn content.

Global Ventures Australia, GVA

GVA is the Agent and Importer of Eco-Core FSC and E1 timber panels, FSC Certified Poplar Blockboard and Multiply Multiflex Siding Ply (E1) European White Birch Multiply (E1) European White Birch Formply (E1) European White Birch Paint Grade Plywood (E1) SVL - Structural Veneer Lumber
INFORMATION, TERMS & CONDITIONS FOR BIOFEEDBACK INTERACTION

Dear audience member,

Thank you for your interest in my research into biofeedback controlled interactive art works. I value the unique contribution that you can make to my study and am welcome the possibility of your participation in it.

This interactive sound installation (the “Work”) is part of my Doctorate of Creative Arts research project being undertaken at the School of Contemporary Arts, University of Western Sydney, Australia. The Work uses biofeedback-training technologies (the “Equipment”) to enable individual participants to interact with aspects of their own heart-rate-variability and breathing patterns. It aims to provide a safe environment for participants to explore biofeedback-assisted exploration of their own heart and breathing patterns.

Please read through the important Health & Safety Precautions and Potential side effects outlined on the following page, to make sure that your interaction with the Work will be safe. If you do not want to interact with the work, you can still observe other people interacting with the work.

During your interaction with the work, you will be focusing on slowing your breathing down to a rate of approximately six breaths per minute (equal to breathing in for four seconds, then breathing out over six seconds) and changing aspects of your heart rate patterns. Your heart rate goes up and down with your breathing. When you breathe in, your heart rate tends to go up. When you breathe out, your heart rate tends to go down. These breath-related changes in your heart rate are called “Respiratory Sinus Arrhythmia,” or RSA. RSA triggers reflexes in the body that help it to control the whole autonomic nervous system (including your heart rate, blood pressure, and breathing).

During your interaction with the artwork, you will be learning to increase the size of these RSA heart rate changes. As your RSA increases you will be able to observe this increase on the video display before you, and you will hear a corresponding increase in the volume of a particular sound texture. You will use this information, to teach yourself to increase your RSA. You are invited to consider how it feels when you increase this RSA pattern in your heart rate.

As a part of your interaction with the artwork, you are invited to experiment with how certain mental imagery, thoughts or memories of experiences of love, appreciation, peacefulness or an imagined sensation of gentle warmth in your heart area can gradually increase your RSA signal. These experiments are voluntary, and are designed to help you explore some of the ways your body and thought processes interact with each other. You do not have to do these experiments if you do not wish to.

Please remember that your participation in this art work/event is a purely artistic and imaginative exploration of biofeedback interaction, and is in no way intended as a form of therapy. Biofeedback training as a therapeutic practice is conducted by skilled health care professionals, involves precise diagnostic procedures and takes place over many sessions. The artist makes no claim that interaction with this work will lead to any positive health benefits.

If you feel dizzy or light-headed at any stage during your interaction with the work, you are probably breathing too deeply—you are hyperventilating. Try to breathe more shallowly and naturally. Breathe easily and comfortably. Do not try too hard or too deeply. Watch out for hyperventilation symptoms—they are not a part of the work, and can be potentially harmful to your health.

During and immediately after your interaction with the Work, remember to avoid any sudden changes in posture such as standing up abruptly or sudden upper body movements, as this can lead to dizziness and even fainting.

After your interaction with the work, you are invited to take part in a short (5 minute maximum) interview, in which you will be asked to describe aspects of your experience during and after the work—you do not have participate in this interview process if you do not wish to. Your interview will be used to record descriptions of your feelings and associations in response to the work. My Doctoral research and thesis may incorporate comments made by you during your interview.

Appendices

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IMPORTANT HEALTH & SAFETY PRECAUTIONS:
SOME REASONS WHY YOU MIGHT NOT WANT TO INTERACT WITH THIS WORK

Biofeedback heart-rate-variability and breath-rate training are generally considered very safe, educational and relaxing learning procedures that commonly lead to a sense of wellbeing and inner calm. Most people using these procedures do so without problems.

However there are a few rare circumstances where adverse reactions have been reported.

A few people do experience uncomfortable reactions and other problems with these procedures. Potential problems may occur with the following:

- Persons with severe psychiatric disorders,
- Persons using medications including insulin, oral hypoglycaemic, thyroid replacement, anticonvulsants and antihypertensive medications

If any of these conditions apply to you, you MUST seek your doctor/health care specialist’s approval to interact with this work.

For your own safety we cannot allow you to interact with this work IF your doctor/health care specialist has advised against it.

POTENTIAL EFFECTS YOUR INTERACTION MAY LEAD TO:

Biofeedback assisted relaxation and breath awareness training involves a gradual slowing of heart rate, and lowering of tension and nervous arousal. In some rare instances these exercises may generate unfamiliar physical or emotional states that some individuals may feel uncomfortable with. It is also possible that as a result of your relaxation, confusing or unpleasant memories may come to your attention. The most common is feeling faint during a session and/or feeling dizzy when you are getting up at the end of your interaction with the Work. This is due to decreases in blood pressure, which can accompany deep relaxation. These changes are usually related to temporary changes in blood pressure or other systems in the body. They are very rare and are virtually never dangerous if taken care of.

If you do start to feel uncomfortable or unsure about what you are feeling or doing it is VERY important that you ask for the interaction to be stopped or at least paused for a moment while you adjust. You are in control of your interaction at all time, nothing is being ‘done to you’.

Persons using anti-seizure medication, vasodilators, antidepressants, diuretics or any other medication with a potential side effect of postural hypotension should avoid any sudden changes in posture such as standing up abruptly from a sitting or lying down position during your interaction.


NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel. 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
BIOFEEDBACK PARTICIPATION CONSENT & RELEASE AGREEMENT

First Name: ____________________________________________

Telephone: ______________________ E-mail: __________________________

Postal Address: ____________________________________________

In consideration of my being accepted to experience the Work, I release George Poonkhin KHUT (the Artist), The University of Western Sydney, and <<insert name of host gallery/venue/festival here>> and all other organizers and sponsors, their employees and agents, from any claim for damages or injury suffered by me as a result of my experiencing the Work. I give this release for my heirs, executors, administrators and assigns.

I have read and understood the range of possible physical and psychological outcomes that may result from my interaction with the artwork as outlined in the INFORMATION, TERMS & CONDITIONS FOR BIOFEEDBACK INTERACTION sheet, and that I wish to experience the Work at my own risk.

I UNDERSTAND THAT:

- my participation is entirely voluntary, and that I am free to determine the duration of my interaction with the biofeedback art work, up to a maximum of thirty (30) minutes. I understand the purpose of this experience as a form of artistic and imaginative exploration, and that it is not intended as a form of therapy.

- interacting with George Poonkhin Khut’s biofeedback heart rate and breath based artwork could, in some rare circumstances, result in physical or mental discomfort or injury and that I should seek medical advice if I am uncertain of the risk to my personal health.

- during my interaction, I will be learning to voluntarily modify aspects of my heart rate, breathing patterns and autonomic nervous arousal.

- in the event that I should begin to feel uncomfortable about any aspect of my interaction with the work, I will indicate to the operator of the installation to pause or terminate my interaction with the work.

- I understand that in the event that I should fall asleep, I will be woken with a gentle shaking of my forearm. If this kind of physical contact is inappropriate, I will negotiate with the artist/operator for an alternative way of being woken from sleep (list appropriate contact negotiated in space below)

CONSENT FOR POSSIBLE VIDEO-RECORDING OF YOUR INTERACTION Please tick the appropriate box:

☐ I agree to being videorecorded during my interaction with the work, and give my consent to this video footage to be used only purposes outlined in the INFORMATION, TERMS & CONDITIONS FOR BIOFEEDBACK INTERACTION sheet.

☐ I DO NOT wish to be videorecorded during my interaction with the work.

MEDICAL DECLARATION Please tick the appropriate box:

☐ I DO NOT have a recent or long-standing history of one or more of the following conditions: heart problems, seizures, fainting, epilepsy, or psychiatric illness/severe depression.

☐ I DO have a recent or long-standing history of one or more of the following conditions: heart problems, seizures, fainting, epilepsy, or psychiatric illness/severe depression, and HAVE CONSULTED WITH MY DOCTOR/RELEVANT HEALTH CARE SPECIALIST, and they have determined that my interaction with the work will be safe, according to the terms outlined in the attached INFORMATION, TERMS & CONDITIONS FOR BIOFEEDBACK INTERACTION sheet.

Signed: (Participant's signature): ________________________________ Date: ________________________________

Parent or guardian's signature (if participant is over the age of 12 but under the age of 18):

______________________________________________________________
 TERMS & CONDITIONS FOR RECORDING & PUBLICATION OF INTERVIEW MATERIAL

Thank you for your participation George Poonkhin Khut’s biofeedback interactive art work.

As part of his Doctorate of Creative Arts research at the School of Contemporary Arts, University of Western Sydney, Australia, George is recording short interviews with people who have interacted with his biofeedback interactive art work (the “Work”). The interview will take between 5 to 15 minutes of your time. Through your participation in this interview, George hopes to gain a deeper understanding of the work as it is revealed in your experiences during and after interaction with it. He is seeking vivid, accurate and comprehensive portrayals of what this experience was like for you: the various thoughts, feelings and images that came to mind during and after your interaction with the work.

The interview will focus on your immediate experience of the Work. To insure your privacy we would like to avoid discussing any aspects of your personal life history that you do not wish to share with members of the general public.

During the interview you will be asked the following questions about your experience of the work:

- What was the most interesting aspect of your experience?
- What connections between your body and the sounds and visuals did you find the most interesting?
- Where there any aspects of the Work that you did not enjoy? If so could you briefly describe them...
- Please describe how you think you were able to increase your “RSA” heart-rate pattern? Were there any particular images, thoughts or feelings you used to increase your RSA? If so, please describe them...

Extracts from your interview may be used in future presentations of this research project, including art exhibitions, public broadcasts, multimedia publications, published journal articles and conference presentations.

Interview transcripts and analysis will be shared with my supervision team, and other members of the University of Western Sydney research community.

In any instance where your comments are attributed to you, you will be only be identified by the following four details:

- Your preferred first name
  (you can choose to use a false name if you do not want to be identified)
- Gender
- Usual Occupation
- Date and time of your interaction with the work

Your participation in this interview process is entirely voluntary. You have the right to withdraw from the research at any time, up until the 25th of March 2005. At this point I will be in the final stages of completing the report, and will not be able to remove any quotations.

I value your participation and thank you for your commitment of time, energy and effort. If you have any further questions I can be contacted by telephone on 0417 566 425 or by e-mail at george@georgekhut.com

Yours sincerely

George Poonkhin Khut, Doctorate of Creative Arts Candidate
University of Western Sydney, School of Contemporary Arts

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
INTERVIEW CONSENT & RELEASE AGREEMENT

Name: ..............................................................................................................................................

Preferred name for use in edited transcripts: ................................................................................

Gender: ...................... Usual Occupation ..................................................................................

Address: ........................................................................................................................................

City: ............................... Postcode/ZIP: .......... Country: ....................................................

Telephone and / or e-mail address: ................................................................................................

I agree to participate in an electronically recorded interview about my experience of
George Poonkhin Khut's interactive artwork.

I have read and understood the terms and conditions of this interview process as outlined in the
TERMS & CONDITIONS FOR RECORDING & PUBLICATION OF INTERVIEW MATERIAL
information sheet.

I grant permission for the data collected during my interview, to be used in the process of completing
George Khut's University of Western Sydney, Doctorate of Creative Arts (DCA) degree, including his
dissertation and any other future publications, including audio-visual artworks and publications,
exhibition programs and promotional materials relating to the Artists biofeedback Works.

I understand that each participant, including myself, will be identified in these publications by the
following basic details:

• My nominated first name (I can use a name that is not my real name if I do not want to be
  recognised)

• Gender

• Usual Occupation

• Date and time of my interaction with the Work

I grant permission for the above personal information to be used for the purposed outlined in the
TERMS & CONDITIONS FOR RECORDING & PUBLICATION OF INTERVIEW MATERIAL
information sheet.

Signed: (Participant's signature): ................................................. Date: ..............................

Parent's or guardian's signature (if participant is over the age of 12 but under the age of 18):

..................................................................................................................................................
Note: Alex White is credited in this promotional flyer for his contribution to a sound design component that was not implemented in this showing of the work.
Cardiomorphologies v.2 interpretive materials developed by Lizzie Muller in consultation with George Poonkhin Khut. These cards were provided to visitors on entry into the installation.
INFORMATION, TERMS & CONDITIONS
FOR BIOFEEDBACK INTERACTION WITH CARDIOMORPHOLOGIES

Thank you for your participation in my research into biofeedback controlled interactive art works.

This installation is part of a research project being undertaken at the School of Contemporary Arts, University of Western Sydney, Australia. The work uses biofeedback-training technologies to enable individual participants to interact with aspects of their own heart-rate-variability and breathing patterns. It aims to provide a safe environment for participants to explore biofeedback-assisted exploration of with their own heart and breathing patterns.

To interact with the Work you will be fitted with a stretch sensor around your abdomen and given a wireless heart rate monitor to hold in both hands. These sensors will feed information about your breath and heart rate to the computer which will control patterns projected on the screen in front of you and sounds surrounding you.

During your interaction with the work, you will be focusing on slowing your breathing down and changing aspects of your heart rate patterns. Your heart rate goes up and down with your breathing. When you breathe in, your heart rate tends to go up. When you breathe out, your heart rate tends to go down. These breath-related changes in your heart rate are called “Respiratory Sinus Arrhythmia,” or RSA. RSA triggers reflexes in the body that help it to control the whole autonomic nervous system (including your heart rate, blood pressure, and breathing).

During your interaction the artist may suggest you modify your breathing in different ways, or experiment with how certain mental imagery, thoughts or memories affect your interaction. These experiments are completely voluntary. You do not have to do these experiments if you do not wish to.

Please remember that your participation in this art work/event is a purely artistic and imaginative exploration of biofeedback interaction, and is in no way intended as a form of therapy.

Interactions last for approximately 10 minutes, you may ask for it to last longer if you wish and it will continue at the artist’s discretion. If at any point you wish to stop the experience you may drop the heart rate monitor (which will immediately stop some aspects of the Work) and request the artist to stop all other aspects.

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Cardiomorphologies Release Form

Biofeedback heart-rate-variability and breath-rate training are generally considered very safe, educational and relaxing learning procedures. Most people using these procedures do so without problems.

Potential effects your interaction may lead to:

Biofeedback assisted relaxation and breath awareness involves a gradual slowing of heart rate, and lowering of tension and nervous arousal. In some rare instances these exercises may generate unfamiliar physical or emotional states that some individuals may feel uncomfortable with. It is also possible that as a result of your relaxation, confusing or unpleasant memories may come to your attention. The most common is feeling faint during a session and/or feeling dizzy when you are getting up at the end of your interaction with the work. This is due to decreases in blood pressure, which can accompany deep relaxation. They are very rare.

Acceptance of Risks, Release and Medical Declaration

I hereby recognise that experiencing Cardiomorphologies ("the Work") could, in some circumstances, result in physical or mental injury and that I should seek medical advice if I am uncertain of the risk to my personal health. I declare that I have read and understood the material contained in this form, I am aware that I can seek further information from George Khu ("the Artist"), and that I wish to experience the Work at my own risk.

In consideration of my being accepted to experience the Work, I release the Artist, the Powerhouse Museum and all other organizers and sponsors, their employees and agents, from any claim for damages or injury suffered by me as a result of my experiencing the Work.

I certify that I am in proper physical condition to experience the Work and that I am over the age of 18. I understand that there is a risk of injury to me from experiencing the Work, and that I should not take part in the Work if I have any of the following conditions:

- heart problems,
- severe psychiatric disorders,
- proneness to convulsions or fainting,
- epilepsy (even if controlled by medication)
- conditions that require the use of medications including insulin, oral hypoglycaemic, thyroid replacement, anticonvulsants and antihypertensive medications,
- any other medical condition which could be aggravated by experiencing the Work.

Name: ..............................................................................................................................

Phone: ................................................... Email: ...................................................

Address: ..............................................................................................................................

Signed: (Participant’s signature): .................................................. Date:
Appendix O  Cardiomorphologies v. 2 Interview Release Form (UTS HREC)

UTS:IT:CREATIVITY & COGNITION STUDIOS
CARDIOMORPHOLOGIES HUMAN CENTRED DESIGN PROCESS: UTS HREC 2004-011P

CONSENT FORM - STUDENT RESEARCH

I ___________________________ (participant's name) agree to participate in the research project “Cardiomorphologies human-centred design process” (CCESS:Ethics-0502) being conducted by Lizzie Muller of the Creativity and Cognition Studios at the University of Technology, Sydney.

I understand that my participation in this research will involve reporting on my experience of Cardiomorphologies which will take approximately 20-30 minutes of my time. I agree that my experience of Cardiomorphologies and my report may be recorded on video and audio.

I understand that the purpose of this research procedure is to record my experience of the interactive art work. I also understand that the record of my experience and my views as expressed in the interview may be quoted or referred to by the researchers within their PHD theses and/or in a published journal article or conference paper.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way. I understand that the data will be stored securely and confidentially at UTS for at least 5 years.

I am aware that I can contact the researchers or their supervisor Prof. Ernest Edmonds if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason.

I agree that the researchers have answered all my questions fully and clearly.

_________________________________________  __/__/__
Signed by

_________________________________________  __/__/__
Witnessed by

NOTE: This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Louise Abrams (ph: +61 2 9514 4965, Louise.Abrams@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.
Appendix P  Cardiomorphologies v. 2 Video-Cued Recall Interview Transcripts

**Video-cued recollections: Beta_space exhibition, September 2005**

**Respondent #1, participant interview recorded by Lizzie Muller**

**Respondent #1**: Do you want me to start commenting?

Interviewer:  Yep, be good.

Respondent #1: Okay, well this time I knew, okay, it was the expansion and contraction of the lungs and the heart rate, that’s all I knew and, um, I didn’t really know at that time whether I should try different things or put my feet up, relax so... when I was standing watching the chap before me I thought “oh, looks pretty basic” uh, I thought “oh, well, I’ll try different things and see what I can make this thing do”... The expander was quite sensitive, I thought it was almost going to slip and he adjusted (inaudible-too fast) twice... (pause). I thought it would do more than it did.

Interviewer:  What are you thinking at this point?

Respondent #1: I was more listening to what he was saying, and I wasn’t... I didn’t focus on the screen until he walked away. So I thought “okay heartbeat, you know”, and then he came... that’s right, he came to adjust it again... I wasn’t sure whether I was making those hub-huh sounds or whether that was generated or amplified or whatever...

Interviewer:  Why are you laughing?

Respondent #1: All I was doing at the moment was just relaxing and, um, seeing what would happen if I breathed normally and tried to remain calm. (Pause). It was there I wondered if this was an amplification of me going “huh-huh”; I think that’s where he was explaining the different colours to me.

Interviewer:  And what were you thinking?

Respondent #1: So I thought different colours would mean different states of calmness or agitation, I knew the diameter of the circle was consistent with exhaling or inhaling, um, I didn’t really understand what the definite rings were for. (Pause). There is where one... the first time I tried to breath in and out a bit faster and see what would happen. (Pause).

Interviewer:  What were you feeling at that point? What were you feeling at that point?

Respondent #1: Um, I was trying to make my heart rate go faster by breathing faster. I don’t know that I was feeling much at all; I was thinking that if I, you know, that if you could get up and run on the spot it might be interesting or ride a bike or something; um, I was thinking that it wasn’t as responsive as I thought it might have been. I think this is where he explained the green circles to me about really relaxed and I thought “well, I’ll see if I can really relax”, but the heart rate didn’t change that much... colours are interesting but I didn’t really understand them that much... I stopped breathing a couple of times to see what would happen and all it did was make my heart pump faster. So all I’m talking about is physical things so I wasn’t... I didn’t have any great feelings at the time, I was more concentrating on trying to make that thing go work differently and trying to do it from a physical sense. Yeah, a couple of times I thought, “I wonder how long this is going to go for”, because it wasn’t, it wasn’t doing as much as maybe I thought it might have done. Um, I looked at the guy before me and I thought “oh, he’s not doing much maybe I can make it do all sorts of things” but I couldn’t, other than what it was doing, and, um,
this is when I was trying to breath out and in faster to see if I could get it to do different things... from what I knew about the colours and the patterns and the changes, um, yeah, I was getting a bit bored with it. Maybe if I understood it a bit more about the exact colours or the phase, the changes between one colour and another or what the concentric rings meant, maybe I might have tried different things but I didn’t understand what they were for, it really didn’t become evident during that time... and I, I don’t know, I felt, gee, maybe they should have said, well, think of three things in order, maybe think of a time when you were really happy or a time when you were scared or a time when you were sad, you know what I mean, to try and mentally focus on it to do something, but I mean these are thoughts that just occurred to me, not necessarily right here and now while I’m speaking at this time but... I suppose if that went for seven minutes, it was interesting for about three; I was testing it for a couple and then probably for a couple it was ‘I wonder when this is going to be over’. Is... the other fellow said it wasn’t going to make any difference how much pressure I put on the handles, but I gave them a squeeze every now and then just for the heck of it. I reckon it would be interesting if you got people to do a task and not watch the screen and then if you could show them later on, they could see the colour differences and the pattern differences, you know, the cognitive things with colours or shapes or numbers or something, but as something for a disco, yeah, it needs more work.
Video-cued recollections: Beta_space exhibition, September, 2005
Respondent #2, participant interview recorded by Lizzie Muller

Respondent #2: Oh, this is, um... it feels quite strange in the gloomy room, um, watching, um, the light on the screen; felt a bit odd, wondered what my head was going to be doing, but sort of interesting as well. I was interested in the, um, the actual piece of equipment, that it was just measuring the expansion of my chest and then relating back to the picture image on the screen, couldn’t get it to fit, perhaps a bit tight for a start, could see that it was tight and it wasn’t moving or it was really stretched out, and then the buckle popped out when I was trying to tighten that and then I got it finally almost right I think. I was fascinated by the, um, changing light on the screen, just getting down, wanted to feel comfortable on the chair; deciding whether I should put my feet up or not and listening to the instructions about the heart monitor... Um, yeah, still thinking about were my feet comfortable, um, just trying to listen and then being aware of the heartbeat noise, it was quite scary; spooky more than anything yeah. I was adjusting the chair making sure I felt okay; I felt like perhaps I needed to wipe the, um, hair from my forehead, which I think I did, so I wouldn’t be distracted by it during the process. Um, you can probably see that the strap was still a bit tight, yeah, it was... yeah just trying to make sure I felt let out (?) making sure I wasn’t going to get tickly and scratchy nose, itchy nose; so I could be prepared and just enjoy the ride. That’s the point I was explained that the red heartbeat was the slower heartbeat and when it was yellow it was going faster, so then I immediately start to think about the, um, sort of understanding what was happening, I was trying to think about what I was doing, what I might do during the process, but at this stage I think I was just trying it out, seeing what it did, um, you know, probably feeling like, um, just, um... it’s been quite a relaxing day so far so just sit back and enjoy it. Um, I don’t quite know what I was thinking here, first I think I started to, um, just try and sort of breathe regularly and slowly and then I thought, oh - I’m not sure if it’s at this point - but at some point I thought “oh, I’ll try and think of something sort of exciting”, and I’m looking forward to seeing my husband tonight and started to think about when I get home, and started to think about sex actually, I thought that would be something fun to play with and be with him and sort of, yeah, seeing him naked and just being intimate together with... I could see the reaction; I don’t know if it’s at this point or not and then I thought more about just being with him as opposed to just being comfortable with him and being together and, um, that was a nice, you know, a nice feeling... um, yeah, I don’t quite know what point I am here but I noticed a change from when I was in the sort of thinking about the sex thing and then just thinking about just being comfortable and quite together, there was a change and the breathing patterns sort of slowed down but there was still some just sort of excitement there, um... Then I think I tried to just quieten my breathing and really started to breathe long, um, long deep breaths again. I’m not sure if the timing reflects that, I still seem to be breathing quite fast here, but just calming and quieting down really just looking at the image and focusing on my breathing, and then I know I... yeah, here just really slow it down and I almost started counting, I’m not sure what that reaction there was; notice the yellow lines, wondered what they were, where they came from, what they were, um, just really trying to think, not really think about anything but focus on my breathing, trying to think about how my body felt in the chair; trying to make it all slow down and draw the breaths out, and sometimes I would get to the end of breathing out and I’d quickly want to breath in again because I was a bit short of breath, um, this is being explained about the lines, that they’re about sort of excitement or stress I and I thought “oh, that’s interesting, I’ve got something going on there” and was described that the red lines were about, um, I didn’t quite understand that; just being, um, the sort of more bodily functions or something quietening down or taking over. So that’s just... I can’t think that I was thinking about anything particular at this
point except probably focusing on my breathing um, I was trying to think of images like being near water. Um, I’ve recently been in holidays in the Solomon Islands and this lovely lagoon and beautiful wilderness spot and thinking about what it felt like there, um, getting up in the morning and going for a swim first thing in the lagoon; it’s just very peaceful, not so much the swimming but the environment where it was just really peaceful and, um, yeah, interesting. Um, then I was thinking about, I can’t quite remember the sequence but perhaps just being walking by the water, near the water and, um, I was thinking about... I wasn’t really conscious of the heartbeat sound at this point but I was conscious of the sound like the waves and I was thinking about the waves as they break and a rocky shore and walking and just being in this place where there’s, um, lovely water. I always feel good when I’m near water; feel, um, calm and calm and energised at the same time, um, so it’s possibly here... or and another thing I thought about was riding my bike around the road that goes around by the coast in Wellington, and I love to ride, and when I get on the bike I love that feel... that sensation of motion just pedalling and moving along, and I always find that really relaxing as well, and then being by the water. And, um, I was trying to think about it being a really nice, um... a nice warm day for biking, not a windy or cold day, so feeling my body felt comfortable that I felt that I was a little bit slimmer than I am now that I was feeling... kept trying to think of myself as feeling really good about my body on the bike as well, um, and just cycling along, and I noticed that I could see the effect of that sort of calmness, um, that came from being in my bike, probably more so than being, um, walking... um, um... I don’t know, sort of can’t, can’t remember what I was thinking of at this point. I know at one point I sort of thought about my work a little bit, but that was sort of briefly and then I went back off that, still trying to think about, um, just sort of the breathing, seeing if... I think I could just again slow it down; slow down the heartbeat and my breathing. Just really enjoying the visual images, not really conscious of the heartbeat, um, and, um, intrigued by the continued yellow lines in there; they didn’t seem to reduce much, but at times I noticed the red lines increasing. Yeah, particularly when I did manage to slow right down, switch off, um... No, I can’t think what I was thinking about at this time, I think it was nothing significant going through my mind, um, just observing myself and my breathing I think, um... Yeah, just watching, just breathing more readily I think, not so much the deep breaths but, um... just trying to be kind of calm, quiet; wondering. I know at the end I was sort of wondering... it was sort of fading away and changing so I was just absorbed, observing that, mm, there we go... oh, what’s happening maybe this is the end. Sometimes during the process I could hear noise in the background, say like children or something like that, but most of the time I didn’t hear much.
Respondent #3: Oh, um, no not really much of anything at this point other than, um... I've done some biofeedbacks with stuff before and I'm just thinking... I'm wondering how this is going to compare with other things I've done in the past, and I was thinking, “wow, my heartbeat’s really loud”. (Pause). Mostly I was just focusing on feeling relaxed and calm, and I changed that in a few areas in the hope that I will see those and can probably point that out, but most of the time I just wanted to feel calm and relaxed as much as possible. (Pause).

Interviewer: (Inaudible-mumbling).

Respondent #3: Again, I think that maybe I’m just focusing on feeling calm and relaxed, that’s why it’s pulsating like that. (Pause). Now that, that right there, at some point I tried to exaggerate the tension and said, “oh, my goodness, this is a really a terrible experience” - just try to think that to exaggerate that, I think it was about this time, or maybe it flashed like that. (Pause).

Interviewer: So George is explaining things to you here.

Respondent 3: He’s explaining to me what, what those lines were about - and I’ve already forgotten his explanation all about what these lines meant - one set meant one thing and the other meant another. (Pause). Maybe that’s when I tried to exaggerate the tension; at some point, I’m thinking maybe that was it. (Pause).

Interviewer: Do you remember how you were thinking or feeling at this point?

Respondent 3: Um... I’m having a hard time remembering. I remember, like I said, one time I tried to exaggerate the tension, um; the other thing I tried to do was, uh, count a series of numbers to see how that would affect it - you know, two, four, six, eight, sixteen, thirty two, sixty four, one twenty eight, two fifty six, five twelve, you know, um, one the… I just tried to do that, you know, til it got really difficult. (Pause). Then I think near the end, around this time, I tried to think about my girlfriend who I haven’t seen I three weeks. (Pause). And I remember the lights were really going out when I was thinking of her, after that I just focused on relaxing and... (Pause). I think the last minute I was ’okay, I’m done now’. (Pause). Yeah, I think that’s maybe when I’m trying to think of my girlfriend right then. Yeah, right there. (Pause). Now I think I’m just back to feeling calm, telling myself to feel calm and relaxed, and focus on breathing calm and relaxed and nothing else. (Pause). Again, just calm and relaxed steady breathing, that’s what I’m telling myself.

Interviewer: Were you thinking about anything in particular?

Respondent 3: Nothing at all, just I’m thinking about my heartbeat, I’m just thinking about the heart and breathing calmly, that was the focus, nothing... nothing else... I used, uh, I’ve used, like I said, I’ve used this stuff, uh, professionally to help with pain management and relaxation and I wasn’t in any pain so I was just focusing in on relaxation...

Interviewer: It’s fading out now, were you aware that was the end?

Respondent 3: Yeah.

Interviewer: And George came to take you out. So were you ready for it to finish at that point?
Respondent #3: Sorry?

Interviewer: Were you ready for it to finish at that point?

Respondent: Oh, yeah, I was very ready. Oh, yeah, like the last... it was pretty close, like the last minute I was starting to feel a little like 'okay, let’s get it over with’.

Interviewer: Let’s wind it up.

Respondent #3: Let’s wind it up... and like, it wasn’t more than a minute that it actually did wind up.
Video-cued recollections: Beta_space exhibition, September, 2005
Respondent #4, participant interview recorded by Lizzie Muller

Respondent #4: Um, after I listened to his instructions I think I tried to concentrate on something that was relaxing, so I think I was thinking of somebody I met a few weeks ago, um, so I guess this is what I probably was thinking about at the beginning. (Pause).

Then I... I think I was, um, quite erratic when I was thinking actually; I was jumping from all different sort of elements in my life. Um, I started thinking about work actually, which is probably quite, um, a different kind of a feeling that I have towards it, um, and thinking about things that I haven’t completed yet or I’m in the middle of working on that I need to finish off. Um, and I know at one stage I started thinking about my... like I’m actually in the middle of re-applying for my position, so I know that’s sort of been something that’s been nagging in my mind for the last week, so that’s probably what I was also thinking about at some stage um... (Pause).

I think I kept, um, going back to thinking about this person, particular person, that I was having a conversation with a few weeks ago, um... and then I was trying to think about things that have been stressful in the past couple of weeks, um, which are all work related. And then I think at one stage I just sort of stopped thinking all together and just sort of focused on looking at the colours and the patterns. (Pause).

And looking at the changes between the pink and yellow. (Pause).

I think I did that for quite a while actually, just didn’t really think about anything. (Pause).

I just remember wondering what the lines meant, and I think George actually came over and explained that to me at this point... (Pause).

And I think after he explained that I focused more on the patterns the lines were making, and I think the more I stared at the patterns it made me stop thinking about anything external and I was just quite focused on the shapes and the forms that were coming up in front of me. (Pause).

And I think I... after he told me that there was a two-minute delay in the actual, um, you move to (inaudible-mumbling) I kind of think. I kept thinking back to what I was thinking about previously to try and see if there was any difference between what I was seeing and, um, what I was thinking previously. (Pause).

I think my thoughts kept jumping back to, like external thoughts, um, related to my life, but then I think I'd start thinking about that but then I’d sort of get sucked back in and drawn back to the image, and then I think I just kept, um, starting to relax more and more. Um, I don‘t think I could really concentrate on thinking on anything outside. (Pause).

I don’t think I really paid much attention to my heart rate actually; I was much more focused on the visual. (Pause).

I remember thinking that my breathing was very, um, sort of slow and consistent and was very normal, and I wasn’t really paying attention to how the pattern of my breathing actually...
Video-cued recollections: Beta_space exhibition, September, 2005
Respondent #5, participant interview recorded by Lizzie Muller

Respondent #5: Okay. Well, um, here I’m getting strapped in; um, just excited about what is about to take place, and I’m a little bit curious about, um, the experiment and the experience, um, here. I was just fascinated by how the circles, the rings and the light just, um, reacting to, um, how I’m breathing and, um, a little intrigued by how, um, the ring is expanding as I breath in; and, um, I can feel, um, a little bit – uh – like, um, manipulating my breath just to see the reaction of the rings, um, for some reason feeling a little suffocating for a few seconds because, um, trying to see if the rings can, um, stand(?) expanded or when I breath out try to restrain the ring from moving, um... (Pause).

Here, um... I think here is when, um, I’m trying not to like, kind of holding my breath a little bit, um, I don’t know, out of nervousness or whatever, um... (Pause).

And here I was explained that, um, I could hear my heartbeat and with the, um, holding the, the heart rate monitor um... (Pause).

Here’s the beginning of the, um, experience... It’s the, I’m a little bit excited here, um, about seeing the refracts, the reaction of the visual to, um, what I... from what my understanding with, um, reacting to - uh - what’s internal to me and, and... um, in the first few minutes I actually got a little bit emotional, um, because, um, just seeing the beautiful light and colours and sounds, and it projected out from the internal... (Pause).

And I think here I was thinking about, um, when I – uh – when I was born the doctors actually said I had a heart condition and, um, I had a hole in my heart that needed to be sewn, um, but.... Um, they can’t operate on infants so they said to come back when I was five, um, but my parents never took me back and so I was thinking that it’s such an amazing thing to see your heart kind of beating and here I’m learning about what the rays extending from the circle centre meant and... I think he was explaining that the green one’s especially represent like your, um, nerves, and like, um, neurals and stuff like that; and I just notice that things, um, seem longer and wondering at that moment if I was particularly nervous or, um, tense... and, um... um, I couldn’t really capture what he was talking about; the red, the shorter, the shorter red thing, um... and, um, I think after he explained all that I noticed, um, like a lot of background noise from outside, um, like there was like other exhibits or installations going on, and there are children and just a lot of noise, just suddenly like for a little bit taken out of the, um, train of thought that I was on. Um, so my mind kind of wandered off for a little bit here and, um, and so I was trying to experimenting to recollect my thoughts and, um, enlisting a little bit of sort of meditation techniques that I learned from like yoga or something. So I was trying to, um, slow down my breathing and, and so like I think, um, here I was just trying to manipulate my breathing to make it steady and consistent... and then, um, maybe for a few minutes I sort of just tuned out, just looking at the light and was trying not to think and just, um, staring at the light... (Pause).

Mm... Yeah, pretty much through the rest of the experiment I think I was just looking in the centre, it’s kind of, um, it’s hypnotic a little bit, um, feeling like, um, I guess, I don’t know if it’s the right word but integrated a little bit with the visual, um, because it’s kind of like synchronised with how you’re you know thinking and breathing and moving and your heartbeat and everything like all integrated together... Yep... Here I’m probably thinking I can do this all day... (Pause).

Oh, here I’m thinking... I think, um, when the beams start rotating, um, I kind of wonder about what that meant; if it’s something that, um, I’m feeling that’s making it rotate or if it’s just part of, um, you know, what it naturally does; and, um, here I was thinking, because the rays are... all
of them are really long I was thinking if I was really, really stressed out at this point, um... yeah, actually here I think I, I sort of felt that, um, that it wasn’t, like I feel like my breathing wasn’t as synchronised as... with the with the image anymore, so I don’t know if like I was breathing irregularly or if it’s and now I’ve started (?), so I (inaudible-laughing) had a feeling it was coming to an end of the... of the experience and I sort of, um... Because the visual is changing, that it’s shrinking, that I felt actually there was... almost trying to hold my breath a little bit to, like almost the visual become the way I’m breathing and, um, at the shrink (?) down I feel like myself sort of, um, holding my breath and my breath shrinking down with the visual...(Pause).

And here I was just staring at the centre until it disappeared... sort of... Here I was wondering like how long that whole thing took because it... I don’t know if it was really long or really short.
Respondent #6: Okay, I’m meant to be speaking. Okay, I think at this point I was just trying to read the basic things on the card and see what I’m meant to be doing, so I was getting a bit familiar with the instrument attached to me. Um, I was curious about (inaudible-background noise) and the outer circles and whether that was connected to, um, an (inaudible-background noise) - being strapped in wasn’t a particular problem. I wondered if it was some kind of magnet because I got a bit of a tingle off the hand bit thing. (Inaudible-background noise). Um, okay. I was concentrating probably at this point on just keeping the breathing steady, not too slow but steady, and... and I was really impressed with what happened to the colours and whether... oh, that’s right, this guy came on and I was asking him about the colours and what their significance were; whether they had any particular significance to something I was doing or not doing, I trying to think about (inaudible-background noise) outer colour was more about the noises that were coming (inaudible-background noise). Um, I didn’t quite get the bit about the (inaudible-background noise) individual colours in the middle, I thought it looked like an arm(?) and you can see an extension (inaudible-background noise / children)... and again here he’s just obviously engaging and giving me some more information about what it is (inaudible-background noise) again I was just concentrating on my (inaudible-background noise) um, (inaudible-background noise)... um again this is the bit where you see (inaudible-background noise)... yep again I was focusing on what you’re seeing can’t remember what I was actually seeing at this point and (inaudible-background noise) around me, I think at this point I’m trying to concentrate on slowing my breathing down and reading some instructions from the card and trying to see what the rhythm was happening... um and again I’m focused on (inaudible-background noise) and think of (inaudible-background noise) to um (inaudible-background noise) concentrating on what (inaudible-background noise) um yeah I’m thinking around that (inaudible-background noise) they ask you to breath, they ask you to (inaudible-background noise) rather than breath from the various (?), I wasn’t sure what then I was thinking about (inaudible-background noise)... um, probably slightly distracted shortly because my husband’s (?) looking for my daughter and I don’t know if it was that point (inaudible-background noise)... okay I think I was probably curious about why some of the lines in the middle moved from one side to the next side (inaudible-background noise) lines and then they’re I think (inaudible-background noise) I’m thinking (inaudible-background noise) if anything oh there’s only one there (?) I think I was trying to reflect on whether the colour sequence is significant or whether, oh yeah that’s where I got distracted so I was saying to my daughter so the thinking here was just about (inaudible-background noise) trying to join me okay, so I’m focusing back in again and then again thinking about why there was more lines that time, central lines. I was also listening, yep probably again (inaudible-background noise) distract me, I think there’s a (inaudible-background noise) the pulse and the heartbeat and whether that was actually mine so I was um, I don’t know at this point but maybe slightly shorter to what (inaudible-mumbling) I was checking out my own pulse just to see whether it was in rhythm with the pulse thing (inaudible-accent)... I don’t know what at that point I was thinking but the whooshing sounds sounded very much like the sea, the beach... and too just because I guess I think (inaudible-accent) I’m interested in why people are drawn to specific colours and for me I’m drawn to everything blue so everything in my house ends up being blue and I guess that’s, I wondered whether there was a (inaudible-mumbling) thinking around that way about these things and oh yeah, I think it’s at this point, yeah I can see myself moving here, I think it’s at this point that I’m checking out whether the pulse, the heart rate noise that I’d heard was linked to the speed of my pulse, I was um just checking it out and it seemed to be in rhythm, I was just curious so there was a bit of concentration at this point really
and otherwise I didn’t, alright yeah and (inaudible-mumbling) more lines, I wasn’t sure whether that was just a visual thing or if that was connected to anything I was doing and again the focus on me trying to work out whether the heart thing um... again I was interesting, and at some point and I think it was earlier, I can’t remember, it might come after, I’m not very good at remembering but at some point I was holding my breath just to see whether there were any changes and um at that time it didn’t seem to (inaudible-mumbling) but this one time it seemed still... again um reflection from me around this time was on colour and um, I suppose it looked a bit like an eye, (inaudible-mumbling) and the colours and yeah it’s really quite soothing (inaudible-mumbling) bright appealed to me but I guess that’s what generally appeals to me anyway... and I guess there was some spots on the trough (?) that um the whole idea that being around some kind of art and visual and some kind of (inaudible-mumbling) feedback mechanism which I’ve heard of use in the park for people with possibly some behavioural problems so I’m thinking around some of that stuff too (inaudible-mumbling) so I stretched um the wall was kind of relaxing (inaudible-mumbling) again focus on the colour, it was, allowed for me some reflection on whether this was a bit hypnotic or not (inaudible-mumbling).
Video-cued recollections: Performance Space, prototyping workshop
Respondent #I, interview recorded by Lizzie Muller

Interviewer: [Inaudible]...
Respondent #I: Very excited.

Interviewer: [Inaudible – too low / background noise]...
Respondent #I: And your [inaudible – background noise] at this point.

Interviewer: [Inaudible - background noise]
Respondent #I: And your [inaudible – background noise] at this point. If you start feeling a bit dizzy or light-headed just...

Interviewer: [Inaudible] talk about, you know, [inaudible – background noise]... It’s completely up to you. If you start feeling a bit dizzy or light-headed just...

Respondent #I: I’m too excited.

Interviewer: [Inaudible – over speaking / too low]. Now, ah, [inaudible – background noise]...

[Break in Recording]
Interviewer(?): Okay, so when you’re looking at, um, the video [inaudible] does it worry you if you just remember exactly...

Respondent #I: Oh, yeah.

Interviewer(?): It is?
Respondent #I: Yeah, when I look at the bar I’m going in and out [inaudible]...

Interviewer: Really?
Respondent #I: Mm. I mean the... I think emotion comes but [inaudible]. I mean the physical experience...

Interviewer: Mm.
Respondent #I: Yeah, not...

Interviewer: Can you describe that physical experience?

Respondent #I: Ah, yeah. I think I was feeling excited like, you know, in the very beginning but the excitement turns into another level kind of excitement, do you know what I mean? The excitement of experiencing a body.

Interviewer: Uh-hum.

Respondent #I: So that... yeah. I mean, yeah, I guess we’re talking about different... The excitement is still there but the, you know, the front of... the side of it... it’s... still very engaged...

Interviewer: Uh-hum.

Respondent #I: ...by what’s going to happen.

Interviewer: So try and describe that while I watch – see if you can – try and describe...

Respondent #I: Okay.

Interviewer: ...that physical feeling. If you can.

Respondent #I: Okay.

[Background noise]
Respondent #1: Loud.

[Background ‘video’ noise]

Respondent #1: I’m very curious, you know. Like to go [inaudible]... I’m very interested in looking at what’s happening on the screen.

[Pause]

Respondent #1: I had no... I don’t have any like presumptions or any... because I don’t know where I’m going to with this piece. So I had a very open mind [inaudible – jump in recording]. I’m not thinking about a lot of things, I’m just thinking about the process, about what I’m doing.

[Pause]

Respondent #1: So at this point I’m still waiting for what’s going to happen. It’s just amazing to see how, um, your body reacts. I mean the internal life motion of your body getting represented on screen... It’s a bit spiritual really.

Interviewer: Is that what were you thinking at that point, or is that something [inaudible]...

Respondent #1: No, it was afterthought.

Interviewer: Try to stick to what you were thinking there and then.

[Pause]

Respondent #1: This part’s not very exciting – this is me talking – because I have exciting parts later on.

Interviewer: That’s okay. So at this point are you bored there?

Respondent #1: No, I’m just waiting for something...

Interviewer: You’re waiting.

Respondent #1: Yeah, I was just kind of...

Interviewer: Do you have anticipation or...

Respondent #1: I’m anticipating.

[Pause]

Interviewer: [Inaudible – background noise] more exciting.

Respondent #1: Yeah, yeah.

Interviewer: Because in this bit George finds out he can’t...

Respondent #1: Yeah. That’s boring.

Interviewer: Is that boring?

Respondent #1: Yeah.

Interviewer: Why?

Respondent #1: Because, you know, [inaudible]...

Interviewer: So how did you feel?

Respondent #1: A bit disappointing, but that’s okay because every... Like if [inaudible] so I was just thinking my hands are too swollen(?); they’re [inaudible] my output.

Interviewer: Any other memories you have about what you felt at that point?
Respondent #1: Um, I’m still very engaged in the whole state of body and mind.

Interviewer: Okay.

Respondent #1: Engrossed really.

[Pause]

Respondent #1: I want to say it’s when the rings come up.

Interviewer: Okay, we’ll get to that.

[Laughter]

Respondent #1: I hope I’m helpful.

Interviewer: Very helpful. There’s absolutely no way that you can’t be helpful so...

Respondent #1: Yeah.

[Laughter]

Interviewer: No matter how hard you try.

Respondent #1: I was just thinking at this point, ‘maybe we can change the colour of the screen, it’s boring’.

Interviewer: You started to get bored with the colours... with the colours?

Respondent #1: Yeah. And I was just thinking how nice if the colour changed. Mm.

[Pause]

Interviewer: [Inaudible] start. So you’re bored. You wish the colours would change?

Respondent #1: Yeah. I’m still engaged but I’m bored by the colours.

Interviewer: Mm.

Respondent #1: I wish it was my heartbeat the whole time through. I was quite disappointed by that really.

Interviewer: Uh-hum.

[Pause]

Respondent #1: It’s very peaceful. I was, um, quite [inaudible – background noise] a revelation(?) to see the red because it didn’t come back afterwards. It just never came back again.

[Pause]

Respondent #1: At this point I’m just looking at the circles. I have no idea what George is saying. I do try and pay attention but I’m more engaged by the circles. I think they’re amazing.

[Pause – background video]

Respondent #1: And I could... I was trying to experiment with my own breathing to see how... how much of the [inaudible] I can sustain, of different types of breathing patterns I could do myself. So I’m trying to create something with my breathing.

[Pause – video]

Respondent #1: It’s a very joyful experience. I mean I remember feeling very, very peaceful but very, very happy.
Respondent #1: Amazing.

[Pause]

Respondent #1: Elation. Elated.

[Pause]

Respondent #1: Overwhelmed, slightly. Kind of fla-(??) but in a nice way – which I suppose goes to revelation(??).

[Pause]

Respondent #1: Oh, that’s… that’s the part I like. It’s beautiful. I wish the colour would change, though.

[Pause]

Respondent #1: That is the part I like. I love that part because I had this sudden movement and I was so excited. And I tried to do it again but it never came back, so I was a bit disappointed I couldn’t recreate my pattern. That obviously is not my heartbeat so I wasn’t very interested but I was still interested because it’s very pretty to look at.

[Pause – video]

Respondent 8: I wish it were my heart.

[Pause – background noise]

Interviewer: [Inaudible]...

Respondent #1: Yeah, it’s not my heart.

Interviewer: It’s not your heart.

[Laughter]

[Inaudible – over speaking / too low]

Respondent #1: [Inaudible] other peoples’ heart look...

Interviewer: Right.

Respondent #1: I mean, you know, [inaudible] transcendental...

Interviewer: Mm.

Respondent #1: … electrical way.

Interviewer: You thought that was beautiful you felt at the time.

Respondent #1: Yeah.

Interviewer: [Inaudible – jumping in recording] circles. How did you feel when they came back?

Respondent #1: I like it when they come back. [Inaudible] really like it. Just something interesting about, um, circles. The matter(??) is a bit, yeah, experimental(??). I felt I was trying to be Spiderman. I was trying to make it – if I can balance on the web. I was doing a movement, [inaudible]. I was just interested at that point how far the works(?) will go – like how further away they can go.

Interviewer: Uh-hum.
Respondent #I: When I started [inaudible] I didn’t think it did anything at that point. Maybe the colours will change, at that point I was thinking...

Respondent #I: I was, um, paying attention to the noises that was happening.

Respondent #I: Like now.

Respondent #I: Like the noises sound very monotonous, but it’s not. I wish it was more obvious(?).

Respondent #I: I like it when I stopped breathing, because when I stopped breathing I could sustain a shape and just look at it. Then it doesn’t change for like ten seconds.

Respondent #I: Now I’m slowly thinking about how people in hospitals feel – like, you know, how clinical a hospital experience is, clinical and very clean and very emotionless, you know, and... like this is happening in hospitals every day, that’s what I’m thinking then, and how interesting it is to see a person’s physiological reaction when they’re just about to die. Very sad [inaudible].

Interviewer: Were you thinking that at that moment?

Respondent #I: Yeah, a little. Oh, yeah, I love that bit...

Respondent #I: It got to a point when I was... my lips were like trembling, but a very internal trembling...

Respondent #I: I’m creating (?) [inaudible] colours to change.

Respondent #I: See I keep trying to recreate that moment but it won’t [inaudible – background noise], you know, something else.

Respondent #I: [Inaudible], still. I think I never left that plateau of [inaudible] high.

Respondent #I: Anyway... there’s a lot of [inaudible – sirens] I mean there is [inaudible – sirens].

Interviewer: Toward the end.

Respondent #I: Yeah, because you [inaudible – jump in recording]...

Interviewer: This is when George takes away the circles [inaudible – phone ringing]...
Respondent #1:[Inaudible – jump in recording / ringing] with no circles. Yeah, I started concentrating on how small I could make my age(?); how small and how big I can go.

Interviewer: [Inaudible – too soft]...

Respondent #1: And...

[End of Recording]
Appendix Q  Interview with Kate Richards

RealTime, Issue 66, April-May 2005

Let the Body Navigate
Kate Richards talks to electronic artist George Khut

George Poonkhin Khut is an electronic media artist whose immersive sound installations have been exhibited in Australia and the UK. The acclaimed video installation, Nightshift, created with dancer Wendy McPhee was exhibited at Arnolfini (Bristol, UK) as part of the Breathing Space exchange program with Performance Space and PICA (see www.georgekhut.com). Khut is presently engaged in post-graduate research at the University of Western Sydney School of Contemporary Art, creating installations using biofeedback—the process of electronically measuring changes within the body and displaying these to the person being observed so they can learn to influence the behaviour being measured. Cardio-morphologies was installed at Performance Space, July 21-Aug 7, 2004.

Khut’s new biofeedback-based work, Drawing Breath, will be shown at Sydney’s Gallery 4A, April 14-May 14. Later this year it will be part of a touring concert program of the same title with The Song Company in a selection of motets, madrigals and contemporary songs, from Ockeghem to Oxygène—and the breathing rhythms of the audience.

Skin

George Khut: My father came here in the 60s from a Chinese family in Malaya. My mother’s family is Anglo-Celtic Australian, and it was through her that I gained most of my early exposure to contemporary art. [Dad’s] been practicing martial arts since childhood, so there’s been an awareness of mind-body interconnections via the various internal energy and self-cultivation approaches implicit in traditional martial arts techniques.

Kate Richards: He was actively practicing this during your childhood?

George Khut: Yes, and encouraging me to do so as well but I just didn’t have the fighting spirit! I went to Kung Fu classes every week, for many years. It’s only recently that I’ve started to get some glimpse into the significance of some of these techniques. There was also an understanding that meditation and related traditions of self-cultivation were a part of our East Asian cultural heritage and something to be proud of.

Our family culture was essentially atheist, though as time went on, it grew to include an element of ancestor worship. Although my sister and I were both educated in Christian schools, there was an open hostility towards traditional Western mythology–original sin, a God that answers your prayers, going to heaven or hell when you die, or bodily functions being somehow sinful. I think things like this really sowed the seeds for my present interest in how we represent and ‘practice’ our embodiment.

Breath

George Khut: I moved to Sydney [from Tasmania] in 2001 and intentionally immersed myself in a creative crisis. I thought ‘If I’m going to do this [art practice] it better be worth my time and energy!’ I wanted to work with very basic physical materials, in a very minimal way, being very inspired at the time by artists like Wolfgang Laib and James Turrell. But I was also deeply interested in the suggestive power of electronic sound: trance-like ritual practices and the altered states of consciousness they can induce. I was also reading about fringe media practices like accelerated learning techniques, subliminal advertising and brain-wave biofeedback—the various ‘back door’ approaches to subconscious exploration. Biofeedback interaction seemed to combine both these interests very neatly.

Kate Richards: How did you first start playing with biofeedback?

George Khut: I looked though a listing of biofeedback practitioners in New South Wales and sent out an email to all of them asking for help with learning about biofeedback! Dana Adam of the Active Learning Centre responded and enabled me to try a variety of biofeedback interactions at her clinic. I had initially proposed working with brainwave biofeedback but it’s hard to get psychologists and psychiatrists to say on record that it’s completely safe without appropriately qualified supervision. They recommended breath and heart rate biofeedback as a safer option, and one that sat well with my interest in more ‘whole of body’ approaches like breath-based meditation. There has already been a lot of art work developed from the 70s up to the present exploring brainwave biofeedback. The idea of breath and heart centred interactions seemed relatively unexplored, and I was interested in the contributions these functions make to our overall experience and self-image.
I realised that with my early work Pillow Songs (RT24, p46) I was very interested in how people respond when they are lying horizontally in a darkened space. Later I learned that just lying down will tend to increase parasympathetic nervous system arousal (our internal rest-relax-regenerate reflex). I’ve been interested in how various cultural practices intuitively involve this process of parasympathetic arousal. I’m thinking here about devotional practices such as prayer, chanting, meditation and trance-dancing, and the kinds of ritual architectures designed to accommodate these activities—the effect these practices have on your cardio-respiratory state, and the role of these unificatory experiences at a bio-social level.

Kate Richards: What are unificatory experiences?

George Khut: Experiencing your self as deeply connected to a larger reality, that ‘all of nature speaks to me’ feeling. It’s curious that these sorts of experiences are usually taboo in contemporary arts practice—we tend to annex them off to dance parties, yoga classes or chronic illness treatment programs.

The gist of my doctorate proposal to UWS was "how do you develop multimedia systems that in some way enable people to navigate through their bodily experience?" For me personally it was also a response to the disembowing qualities of a lot of popular virtual reality iconographies—this idea that we will download ourselves into a computer and do away with our bodies forever.

This [biofeedback] technology provides a point of entry into aspects of bodily experience in an age when so much of our body is being left out. I’m exploring some of the functionalities we see in Eastern traditions, in a way that feels authentic to me. Rather than importing some exotic taxonomy for mind-body inquiry and cultivation, could we attempt to develop cultural practices from our own personal and immediate experience of ourselves? Biofeedback is a tool that trains our ability to sense and respond physically to our experience of the world. As an artist, I have to ask ‘how do I connect these sensations and abilities to my existing mix of cultural histories and practices?’ I’ve recently been studying the Feldenkrais Method of sensory-motor education, and it’s had a significant impact on the direction of my work. These kinds of ‘somatic’ methodologies have developed very concrete ways of investigating mind-body organisation and the body, based on lived personal interactions.

Biofeedback enables us to work with categories of experience that aren’t easily accessed by representational or symbolic forms of communication. By consciously eschewing symbolic imagery and representation...artists can foreground the physical presence of the observer. The observer’s perceptual system becomes the figure against the void-like ground of the design of the work.

Immersion

George Khut: My interest in immersion relates to this process of foregrounding your own perceptual processes—processes that are usually taken for granted. Sure there’s the whole VR tradition where you immerse yourself in a panoramic imaginary landscape/narrative, but personally I’m more interested in the processes taking place inside the participant.

What I find challenging in a work like your Cardio-morphologies is that it takes some degree of training and commitment to move past the interface and achieve the full body immersion.

In terms of the interface design [by John Tonkin], you’re building an instrument and it does require some skill from the user. At the same time, I have been struggling with the idea that these works are instruments that people then express themselves through. I’m much more interested in people learning to listen to the voices of their own bodily experience, which is such a rare event in our culture.

My main expectation would be that the audience give the work some time—half an hour to 40 minutes is ideal. And a big part of what I’m doing in this work is saying there are experiences and forms of understanding that won’t unfold in 5 minutes, and there are forms of understanding and communication which can’t take place in a normal symbolic/language centred context. I want to make the learning phase [for Cardio-morphologies] shorter and let people feel confident to make correlations—which is pretty fundamental to effective biofeedback. It must be clear to the audience ‘oh that’s my heart, and that’s it changing’, and I have to manage that in terms of interface design.

Affect

Kate Richards: It’s very pure work in that way—it’s pure affect.

George Khut: People say ‘why is this art? Why not do it in a yoga studio?’ My response to this is that in presenting this work in an art gallery I’m placing that experience in a context that invites a
certain spirit of inquiry and speculation—I hope. My understanding of art is that it provides people with ideas about other ways they can ‘be in the world.’

Kate Richards: So your work is purely formalist in that it’s not about content or subject matter?

George Khut: No not really. I would say that its subject is not a subject that we are used to considering as ‘subject’—that is, ourselves and our own somatic being. And maybe it’s time we started to consider that as a subject. Part of the tradition of our Western mind-body split is the separation of subject from object whereas most contemporary philosophy and psychophysiology refutes this separation. So how do we start to acknowledge that in terms of our cultural practices and representations?

Kate Richards is a multimedia artist and producer based in Sydney.
Appendix S

Exhibition Information Sheet, *This Secret Location*, Arnolfini, 2006

**Introduction to the exhibition**

**This Secret Location**

1 - 12 February 2006

part of Inbetween Time Festival of Live Art and Intrigue

This Secret Location is an exhibition of extraordinary art works by national and international artists who occupy the gap between live and digital practice. Located in Bristol’s L-Shed and Arnolfini, This Secret Location combines digital installations and live performances.

In this technological era, the way we communicate and perceive the world has changed forever. So how do artists deal with this unsettling time of transition? This Secret Location navigates the fluid borders between the real and the virtual and begins to uncover ambiguous hybrids of the two.

Although all the works in This Secret Location employ innovative applications for technology, they are really much more about real physical environments and live human interactions. The artists have created works that are containers for our experience - it is us, the audience, that breathes life into their dormant heart. So as these artists contemplate our future possibilities they seem to affirm how much more urgent is the need for our flesh-on-flesh meetings. At the heart of each of these works is an aching need for contact with us, for warm connection with blood, skin and bone.

Lynette Wallworth

Still:Waiting2

*your presence changes everything*

Ground Floor, Gallery 1

Lynette Wallworth’s practice spans video installation, photography and short film. Her installations rely on subtle interactions with the audience, the interplay between participant, moving image, sound and space serving as a metaphor for our connectedness within a wider world. Wallworth describes her intention as “bringing together technological advances and ancient understandings, new media and old practices, electronics and the electricity of human touch.”

Still:Waiting2 is an immersive installation environment that is both unsettled and revealed by our very presence. Filmed on high-definition video in an eerie twilight, Still: Waiting2 directs visitors through a series of sensor regions Whilst a surround sound-scape amplifies the dramatic movement of large flocks of birds. Still:Waiting2 suggests that on first viewing much can be overlooked by the “newcomer”. It reflects on the reality that over eons all organisms that remain in direct contact with each other develop mutually beneficial systems of adaptation and interdependence, but that these specialisations may not at first have an apparent meaning to one who is new to the system. The work reflects on human immersion in a complex world and questions whether there may be ways of meeting across cultural distance that do not cause rupture. This is the first European presentation of Lynette Wallworth’s work.

Wallworth recently received a New Media Arts Fellowship with the Australia Council for the
Arts, enabling her to research and develop a new series of installations through residencies in Iran, Italy and the Lode Star Observatory in New Mexico. In February 2006, Wallworth will begin a three month long Arts Council England Fellowship at the National Glass Centre in Sunderland, UK.

Alex Bradley (a certain) SILENCE - version 001 (prototype)
Foyer, Ground Floor
(a certain) SILENCE is a research project and work in progress developed by Alex Bradley for Arnolfini’s We Live Here Associate Artists Programme.

Alex Bradley is a Bristol based interdisciplinary artist who uses sound, technology and performance to create works of subtle beauty and disorientation. Often collaborating across arts and industry contexts, Bradley’s work seeks an intimate, often live exchange with the audience.

(a certain) SILENCE begins with a question: Are we ever really silent?

Collaborating with product designer, Lee McCormack, Alex Bradley responds to the unique environment of a pod-like space, The Ocula. In this pod, one participant at a time is returned to darkness and ‘Silence’.

‘(a certain) SILENCE is my first piece for The Ocula, and my first step into new ways of making you, the audience, engage with me. So I am giving you my ‘internal soundtrack’. Not just the blood and skin and bone but the grey matter too. This work is about not ‘tuning in’. Switch off the normal filters that your ears and brain use. Do the opposite- let it all in. Then, I suppose, we can begin.’

In this ‘silence’ our ears tune to an internal soundtrack, the sound of our own survival. The pulse is seen briefly, surfacing just near the elbow, the heart is perceived by an indefinable synthesis of sound and touch. The body with its millions of receptors and sensors will, even in its most relaxed state, alert the brain to the exterior in a constant reminder of our own fragility. In this era of post-human experiments, abstract delivery systems such as hi-fi, television and public address, (a certain) SILENCE takes a specially designed and constructed space to take you back to your own body, your own sound.

George Poonkhin Khut
Cardiomorphologies
Gallery 2, First Floor
George Poonkhin Khut works in immersive and interactive installation environments. He is presently completing a Doctorate of Creative Arts at the University of Western Sydney, Australia, researching the incorporation of biofeedback training technologies into interactive music and sound environments.

Cardiomorphologies is an interactive installation that enables participants to explore aspects of their own psychophysiology with the aid of a custom designed biofeedback artwork. Audiences interact with Cardiomorphologies on an individual basis for periods of up to thirty minutes at a time. Breath and heart rate data collected by non-intrusive sensors are used to control a large video projection consisting of a series of halo-like concentric circles that pulsate and blush in time with their own breathing and heart rate patterns. Participants hear their breathing and heartbeats transformed into a gentle sound scape of wavelike noises and subsonic impulses.

“To take part in these installations is to enter into a matrix of dialogues; between you and the computer, between you and the artist, and ultimately and most potently, between you and yourself. Despite the complexity of this matrix the experience is one of absorbing clarity. Khut uses a simple, highly refined audiovisual style which serves to focus attention on the subtleties of the physiological changes driving the artwork. The result is an augmentation of the body in which the breath and heart are simultaneously seen, heard and felt.” Lizzie Muller, excerpt from forthcoming catalogue.
Cyborg dancing
Tim Atack inside George Khut’s Cardiomorphologies

George Poonkin Khut’s Cardiomorphologies is a multimedia work wherein the vital medium is the participant’s body. A pressure-sensitive strap is placed around your upper ribs to measure your breathing; your heart rate is converted into electronic pulses using sensors held in both hands. You sit in a comfortable chair and watch your personal bodysong writ large in throbbing circular pulses, projected before you. It’s described by the artist as a “quietly immersive” experience, and whilst that’s certainly true the act is also quietly invasive in the way that any vaguely medical procedure tends to be. A whole gallery wall is occupied by huge, unflinching multicoloured representations of your vital organs for all to view, unstoppable only in the sense that you can let go of the electrodes at any time. Simultaneously, sounds are generated from the rhythmic beat of your body data, and these are audible on headphones: a pair around your own head, and wireless sets for use by any interested parties around the gallery space. As a participant, it’s possible to use the experience several ways. One is to sit back and watch your body mechanism rendered as artwork in as passive or meditative a manner as possible—given the situation. Another is to play Cardiomorphologies like a musical instrument. The metabolic musician can use hyperventilation or deep breathing to form wider, more vibrant circular pulses on the screen, the thump of the heart increasing in volume, size and frequency, before perhaps making attempts to slow the tempo back down into a natural resting state.

Whatever approach you decide upon, Cardiomorphologies creates a very honest creative symbiosis between yourself and a cold, hard computer. There are many pieces at the Inbetween Time festival concerned with relationships—both real and imagined—between humans and technology, but Khut’s biological mimic is the only example where the machine can literally be said to have taken on human characteristics. However, the key facet of Cardiomorphologies’ ingenuity is the manner in which bodily data is transformed into highly abstract representations. True, it’s possible to imagine the piece presented with life-like or even photorealistic video images of heart and lungs up on that screen, but the effect would be to slam out a constant reminder to any participant of their own mortality, their entropic, finite qualities, the ones that make humans most resemble machines.... and let’s face it, a huge undulating mass of meat projected in this fashion would probably make people lose their lunch on a regular basis. With the far subtler approach chosen by Khut, a partnership develops between device and devisor. Given enough time in that chair, it’s almost possible to forget the mechanical-biological feed into the image, and to consider your cyborg interactions a sort of dance, a duet, a partnership of necessity. It’s hypnotic—almost literally—and reflecting upon the experience afterwards there’s enough interdependence in Cardiomorphologies to make you ponder the implications of Khut’s hardware freezing, or his software crashing. If you were sufficiently immersed in the process and the screen suddenly went blank, what sort of shock might that provoke and would your metabolism follow suit?

George Khut is a Sydney-based artist working in the area of sound and immersive installation environments.

George Poonkin Khut, Cardiomorphologies, Arnolfini, Feb 1-12

Tim Atack is a musician, performer and writer living and working in Bristol. His band angel tech can be found at www.angeltech.co.uk
Appendix U  Catalogue Essay for Strange Attractors exhibition

It’s all about you
Lizzie Muller

At the center of George Khut’s art is your body. Not an idea, a representation or a theory of a body, but your lived, sentient body. His artworks occur when you arrive – they are all about you.

Khut makes audiovisual installations that create sensory immersion. His recent works using biofeedback technologies, Drawing Breath and Cardiomorphologies, use the participant’s physiological data to animate their sonic and visual aspects. Drawing Breath translates the breath into an oscillating soundscape and a delicate animation of thread-like particles (designed by John Tonkin) which explode and converge with each inhalation. Cardiomorphologies senses both the heart and breath rate and reflects these in a series of audiovisual patterns based on shifting colours and tones. These installations are circuits in which the participant is a crucial element. It is impossible to make a clear distinction between the artwork and the person experiencing it.

To take part in these installations is to enter into a matrix of dialogues; between you and the computer, between you and the artist, and ultimately and most potently, between you and yourself. Despite the complexity of this matrix the experience is one of absorbing clarity. Khut uses a simple, highly refined audiovisual style which serves to focus attention on the subtleties of the physiological changes driving the artwork. The result is a kind of synaesthetic augmentation of the body in which the breath and heart are simultaneously seen, heard and felt.

This feedback loop encourages participants to experiment with their breathing, and move towards an awareness of the interconnection between their physical and psychological state. For Khut biofeedback technologies are tools for interpreting our “bodymind” which inhabits and knows the world through our physical presence, perception and action. His intention is to create art-works that allow participants to experience aspects of their embodied subjectivity and, particularly in the case of Cardiomorphologies, to learn to consciously influence aspects of the self that we may perceive as being beyond our control. For Khut, art is not an abstract disinterested activity; his art has work to do.

In this, Khut’s practice is clearly aligned with the field of Somaesthetics described by Richard Shusterman, which asserts the role of the body in the creation and appreciation of art. Shusterman’s project, which builds on a Pragmatist philosophical position, places embodied experience at the centre of philosophical understanding. As the locus and instrument of aesthetic experience he argues that the “cultivation of the body and its senses should be crucial to the aesthetic project” [1]. Shusterman puts forward four ways in which Somaesthetic practices contribute to the central aims of philosophy. First by refining our mechanisms of sensory perception and thereby improving our routes to knowledge, second developing self-knowledge by drawing attention to our physicality, third by developing our ability to enact our will through somatic efficacy (our bodies are notorious for betraying our will – just ask someone with a stiff neck or a tendency to sweaty palms), and lastly by increasing our ability to feel and appreciate pleasure. In this last aspect Khut’s artwork also corresponds to recent interest in the aesthetics of sensation. His artworks create a sensual appreciation of breath and other body processes which amounts to a pleasurable “intensification of the body” [2].

Khut’s biofeedback work is difficult to categorise. At recent exhibitions of his work, particularly outside artistic contexts, audiences have asked “is this art?”, “is this an experiment?”, “is this psychology?” Interestingly this confusion does not seem to diminish the audience’s desire or ability to engage with the experience. In fact it appears to free some participants up to experience the work in a way that they wouldn’t be able to if it was clearly marked “art”.

One way to understand Khut’s practice is as a series of correspondences between different cultural and intellectual traditions. He has been influenced by Eastern philosophies of embodiment and related practices of meditation and martial arts, though he rejects their tendency to fit the person to a mould. He has also been strongly influenced by Western somatic practices such as Feldenkrais (of which he is a student as is Shusterman). He is drawn to science as a system of enquiry that questions assumptions and leads to new understandings, but works against the objectified body produced by scientific discourse. His art is a meeting point of different ways of thinking about the body in the world.

Drawing Breath (Triptych), created for Strange Attractors, goes further by offering a meeting point for people at the exhibition. Influenced by the work of audience theorist Beryl Graham [3] which posits dialogue between people as a powerful aspect of contemporary interactive work, Khut has created a piece that brings participants into a body-mediated conversation. Three participants at a time can interact with the installation – creating new layers of sonic and visual complexity as their breathing rates converge. The work draws the audience members together through shared breath and collaborative attempts to sculpt their audiovisual environment. In this new piece Khut is experimenting with the social aspects of the bodymind in art, how one body
can communicate with and be influenced by another. Perhaps his work is no longer all about you – it’s now about us.

Lizzie Muller is a curator, writer and researcher in the field of art and technology. She is currently writing a PhD on the audience experience of interactive art and its implications for curatorial practice. She has collaborated with George Khut in the development and exhibition of the biofeedback installation Cardiomorphologies. lizzie@lizziemuller.com

Notes


2. In recent public lectures on “Chaos, Territory and Art” Elizabeth Grosz has placed sensation, affect and the “pleasure principle” at the heart of aesthetic experience, describing art as an “intensification of the body”.