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Trans-disciplinary Approaches to Research into Creation, Performance, and Appreciation of Contemporary Dance

Catherine Stevens

Introduction

The many layers and dimensions of creating, performing, and appreciating contemporary dance make its analysis from a psychological perspective compelling and challenging. Movement material that is created, performed or observed engages motor and kinaesthetic processes and leads to cognitive and affective reactions. Rich in gesture, expression and affect, contemporary dance is a heightened form of non-verbal communication. The aim of this chapter is to demonstrate the need for new and diverse methods to investigate and explain the complex psychological processes that underpin creation, performance and appreciation of contemporary dance.

Earlier psychological investigations have often dealt with dance as discrete movement or steps, and questions of memory and imagery have been unnecessarily confined to codes that are verbal or visual. We argue there is more. Movement through space and time is continuous and its effects cumulative. Ideas that generate movement may be verbal or non-verbal, and may be expressed as movement or metaphor. Empathy and understanding may emanate from the

unconscious neural level of ' mirror neurons' (Decety & Chaminade, 2003) through to conscious recognition of shared circumstances and states (Sloboda, 1998). Communication is achieved through inter-relations and integration of physical, cognitive and emotional forms of knowing.

The first part of this chapter consists of a summary of the approaches we have used to date to examine choreographic thought, creativity, and audience response to contemporary dance in an effort to capture the temporal, spatial, visceral and affective characteristics of human creativity, action, and movement-perception. The second part of the chapter is prospective and describes new interdisciplinary methods for analysis of these domains.

Choreographic Cognition

As part of the Unspoken Knowledges and Conceiving Connections projects, we observed and documented the in-studio conception and evolution of a number of new dance works. These included *Red Rain* (choreographer Anna Smith), *Not Entirely Human* (Sue Healey, Michelle Heaven), parts of *Fine Line Terrain* (Sue Healey), and *Incarna* (Neil Adams). In 1999, as we observed choreographer Anna Smith and her dedicated team of dancers create, experiment with and refine movement material for what was to become *Red Rain,* we coined the term 'choreographic cognition' (Stevens, McKechnie, Malloch & Petocz, 2000).

Choreographic cognition refers to the cognitive and mental processes involved in constructing and refining movement-material with the intention of creating a work of art.

From the point of view of experimental cognitive psychology, choreographic cognition is a complex and problematic phenomenon because the underlying processes are hidden, rapid, multimodal, and non-verbal. These latter qualities bring into relief the paucity of many psychological theories in explaining human creative behaviour. Specifically, the majority of theories in cognitive psychology assume that human memory and cognition involve verbal and/or visual representation (for example, Anderson, Budiu & Reder, 2001; Collins & Loftus, 1975; Raajimakers & Shiffrin, 1981).

In comparison, creativity in contemporary dance is movement-based and material evolves from experimentation and exploration in

the medium itself (Foster, 1976; Gardner, 1993; Hanna, 1979; Healey, this volume; Humphrey, 1959; Limon, 1955; Vaughan, 1990). The source of an idea in a new work may be drawn from any modality—visual image or space; heard or felt rhythm, beat, texture; visual, auditory, muscular, or psychological tension; emotion; sound; word; concept (Foster, 1986; Stevens, Malloch & McKechnie, 2001; Stevens, Malloch, McKechnie & Stevens, 2003). The idea is then expressed through movement, tension, and stillness. Second, most theories of cognition derive from studies of static items and objects such as words or pictures. Generating, performing, or observing contemporary dance defies this, too—movement-production and perception-processes being visual, spatial, temporal, and kinaesthetic.

Borrowed Models

One way to proceed is to borrow and adapt methods from domains that share features with contemporary dance. For example, methods to study movement may be taken from sports psychology (as in, Hanrahan, Tétreau & Sarrazin, 1995; Overby, Hall & Haslam, 1997; Starkes, *et al.*, 1990). However, theories of human movement that have been developed in the context of sport do not explain the underpinnings of movement generated to be novel, expressive, and interpreted by both expert and novice observers. As an alternative, models of creativity developed in the context of creative or performing arts, such as music or the visual arts, may be adopted, but they rarely consider the temporal, spatial, and non-verbal qualities of creating new phrases of movement.

While dance shares much with other art forms, it is also unique. Like architecture and sculpture, it manipulates volumes of space for aesthetic and expressive purposes, but unlike architecture and sculpture its product does not stand frozen in time. Like painting and drawing, dance for the observer is a visual experience, but, unlike these, it is not a static object. Like music and poetry, dance takes place via movement through time, but unlike these it is for the observer a manifestly visual experience. Like all other art forms, dance is expressive and emotionally communicative (giving rise to the 'aesthetic experience').

Unlike all other art forms, however, dance is literally embodied in the moving human form. Thus time, space, motion, and the human

body are the media for choreographic cognition (Stevens, McKechnie, Malloch & Petocz, 2000). In light of the ephemeral, temporal, and spatial qualities of dance, we took an approach that did not rely on a single method to study choreographic cognition, but used converging operations to address issues in different and complementary ways.

Analysing Creative Processes in Choreographic Cognition

As detailed in the Epilogue, our first method to study choreographic cognition used the case-study paradigm. The case-study method enabled the tracking and analysis of behavioural markers of creative processes. Data for the case study included studio video-footage and journal notes made by the choreographer and one of the dancers. A 24-week chronology of making *Red Rain* was compiled. An analysis of the main themes of the work using a method of description and analysis borrowed from musicology (Schenker, 1979) was provided. The creative work of the choreographer and dancers was described using the Geneplore model of creative cognition (Finke, Ward & Smith, 1996).

The case study brought to light a cycle of generative and exploratory processes of problem-finding, problem-solving and metaphorical thinking. More specifically, and guided by the Geneplore model, we identified generative phases or pre-inventive structures with properties that promote discovery (Finke *et al.*, 1996). Cognitive processes and examples of pre-inventive structures from *Red Rain* included: retrieval (red images—tomatoes, blood, red earth, red wax, red kidney beans); association (concept of blood led to associated concepts of life, veins, arteries, spine, death, ritual); synthesis (blend breathing, blood with red/blue paper); and analogical transfer (paper sculpture as spine or personal history, helix analogy to DNA). Pre-inventive properties in creative cognition of which evidence was found in the development of *Red Rain* included novelty, ambiguity, meaningfulness, emergence, incongruity, and divergence. Exploratory phases and examples included: attribute-finding (red/blue paper as a womb, nest); conceptual interpretation (beans as blood-flow, or aurally as rainfall); functional inference (book/spine paper sculpture); and hypothesis testing (helix pattern problem and solution).

In keeping with the scientific or hypothetico-deductive method on which experimental psychology is based, future investigations are

needed to document the evolution of other new works by different choreographers and dancers. The content is likely to differ radically from *Red Rain*. However, if the Geneplore model has psychological validity for contemporary dance, then commonalities in the processes and stages should be observed across a range of works, contexts, and choreographers.

Recording Audience Response to Dance

The term 'choreographic cognition' may also be applied to the cognitive processes of members of an audience as they watch, interpret, and respond to contemporary dance. Renee Glass's research (chapter 8) with the Audience Response Tool (ART) records and compares cognitive, aesthetic, and affective responses of audience members who have attended a pre-performance information session with those who have not. The effect of dance experience and/or training on cognitive and affective reactions has also been manipulated and analysed (see chapter 10). Our methods converged in that movement-motifs, features, and themes of *Red Rain* described in the case study were echoed in interpretations of the work provided by audience members using ART.

Analyses of choreographic processes using a case study approach, and perceptual and cognitive responses of audience members using psychometrics methods, revealed contemporary dance to be a rich behavioural phenomenon deserving of attention from cognitive, social and developmental psychologists. Our investigations revealed that creation of contemporary dance is a generative process that may be applied to a pulse, rhythm or gesture abstracted from visual, auditory, kinaesthetic or tactile modalities. The artistry of choreographer and dancer is to express these ideas in bodily form.

Cognition in dance is quite literally embodied knowledge. By embodied knowledge we mean procedural memory for sequences and movements (Solso & Dallob, 1995; Smyth, Pearson & Pendleton, 1988; Smyth & Pendleton, 1990, 1994; Starkes *et al.*, 1990), 'embodied' in the sense of the body as a medium whose movements carry information, for performer and observer, about physical, conceptual, and psychological aspects of the world (Ayres, 1973; Iyer, 2002; Sloboda, 1998; Thelen, 1995).

Framed this way, choreographic cognition provides a litmus test for psychological theories that purport to explain human memory,

creativity, communication, and language. Much work remains to develop psychological theory that can explain the parallel, multidimensional, and ineffable processes at work in choreographic cognition. Work may also proceed to develop methods for capturing responses of audience members in real time as a performance unfolds.

New Methods to Investigate Contemporary Dance

There are at least three aspects of choreographic cognition—as it relates to choreographer, dancer or observer—that warrant scrutiny and that elude most empirical investigations. First, the dynamic and temporal nature of contemporary dance requires the recording of cognitive, affective, aesthetic and physiological reactions through time, as creation, performance, or observation of movement unfolds. Second, it may be informative to record and analyse the underlying neural activity of observers as they watch contemporary dance. The moderating effect of specialist movement-expertise could also be examined if continuous recording methods are developed that capture cognitive, affective, and physiological reactions. Neural activity and behavioural (continuous response) data could then be compared and correlated. Third, the impact of dance exposure and training on development from the perspective of social processes, personality, self-esteem, memory and spatial abilities could shed light on developmental processes across the lifespan, from new and emerging artists, to established artists and those late in their careers.

New methods are needed to capture these three dimensions of choreographic cognition. Concomitantly, innovative theories are needed to interpret and correlate the resulting time-series data, and to examine and explain the intimate conceptual link between choreographer, dancer and observer. Suggestions for potential methods and theories will now be outlined.

Recording On-Line, Continuous Responses to Dance

The Audience Response Tool (ART), as we have seen, provides comprehensive recording of open-ended and discrete (rating-scale) responses. However, ART is retrospective, and the reliance on human memory is problematic. Encoding and retrieval of information from human memory is known to be a constructive and reconstructive

process (Bartlett, 1932; Cowan, 1995; Loftus, 1979). Introspective or retrospective accounts of a dance performance will always be tainted by the act of retrieval. That is, initial perceptions, responses and reactions will combine with existing knowledge and be influenced by expectations. Responses gathered after a performance may differ from initial reactions as a result of omissions, rationalisation, and interpretation.

A method that captures cognitive and/or affective responses in real time eliminates the problem. Accordingly, we are developing an on-line, continuous-measurement device that can be programmed to record cognitive or affective responses along one or two dimensions while a work is performed. The hardware for such a system consists of a hand-held computer with an external input device such as a joystick to allow input with a twice-per-second sampling rate.

Recording continuous cognitive and affective responses

Schubert (2001) and Cowie, Douglas-Cowie, Savvidou, McMahon, Sawey and Schroeder, (2000) have used continuous-sampling methods to record emotional two-dimensional responses to affective stimuli such as music and faces (see Figure 1, overleaf). For example, Schubert's (2001) Two-Dimension Emotion Space (2-DES) consists of a computer screen that depicts emotional labels in 2-D space with one dimension referring to valence and the other to arousal. As a musical piece plays, participants use a computer mouse to move the cursor around the four quadrants to indicate either the emotion they recognise is being expressed by the music, or the emotion they feel in response to the music.

The data gathered using this method is in the form of a time-series. A trajectory through the 2-D/four-quadrant emotion-space is derived, and emotional reactions can be related to the structure of the musical piece. Methods gleaned from time-series analysis are available to gauge the lag between significant structural, melodic, rhythmic, dynamic or harmonic points in the music, and listeners' points of change in emotional response (Schubert, 2001; 2004).

A similar procedure may be adapted to record continuous responses to contemporary dance. Observers may respond using a single dimension from low to high that represents grades of qualities such as happiness or enjoyment, or judgments of complexity or

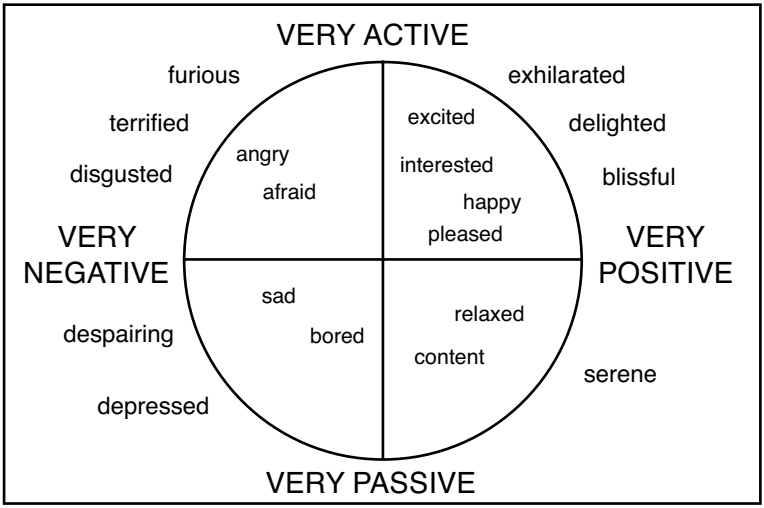

Figure 1: *An instrument for recording perceived emotion*
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predictability. A two-dimensional representation of emotion could also be used (Cowie *et al.*, 2000; Schubert, 2001). Sessions would commence with training and practice trials to ensure that participants are familiar with the recording device, and that the method does not distract attention or interfere with reaction to the work. The data can be analysed as a time- series, and compared with the sequence of events in the work. Consistency in type and intensity of response across audience members may also be deduced.

Recording physiological reactions to dance

Responses to dance by expert and novice observers often include visceral and somatic reactions (see chapter 8). It is well established that people entrain to a beat or rhythm (Jones, 1976; Large & Jones, 1999; Wing, 2002). For example, children and adults accurately synchronise a motor response such as finger-tapping to the pulse of auditory isochronous sequences, rhythmic sequences, and music (Drake, Jones & Baruch, 2000; Large, Fink & Kelso, 2002), and adults adapt their breathing according to actions they observe (Paccalin & Jeannerod, 2000). It should also be the case that observers of dance entrain to the various time-scales of movement in dance. Anecdotally, dancers

report that when they watch dance they have a sense of dancing themselves (for example, Marie Rambert in Foster, 1976, p.44; Hanna, 1979). To test this hypothesis empirically it is necessary to measure physiological responses, such as pulse or respiration, that may synchronise to music and movement, and that signal or correlate with emotional and/or somatic reactions.

It is now possible to record many channels of physiological data as individuals observe performance of a live dance work. Physiological indices that can be measured easily using a small cuff on the finger include pulse rate and galvanic skin-response. Electromyogram (EMG) or muscle activity may be measured using surface electrodes, and a belt worn around the diaphragm can be used to record respiration. These physiological responses may be related to level of arousal, startle response and attention, sympathetic muscle activity, and entrainment of respiration or pulse.

Research questions to be asked include: Do observers entrain to the pulse and rhythm of a dance work? Is there evidence of sympathetic muscle activity, particularly in those with extensive dance training? Are physiological responses correlated with cognitive or emotional responses recorded using the 2-DES apparatus?

The technology for recording and analysing multivariate time-series data is readily available. The challenge for this research is the development of testable theories that guide interpretation and explanation of interrelations between the affective, cognitive and physiological data, and the multiple time-scales to which individuals of differing levels of knowledge and expertise may entrain and respond.

Brain Activity During Movement-perception and Action

Psychologists have long speculated that perception and action are intimately linked—that *observing* an action involves the same repertoire of motor representations as is used to *produce* the action (Castiello, 2003; Chaminade, 2002; Decety, 2001; Liberman & Mattingly, 1985). One implication of this view is that the capacity to understand another's behaviour and to attribute intention or beliefs to others is rooted in a neural execution/observation mechanism (Grèzes & Decety, 2001). Recent findings in neurophysiology suggest that in monkey ventral premotor cortices there are neurons that code goal-directed motor acts such as grasping, holding, and manipulating

objects—a ' motor vocabulary' of actions related to prehension (Rizzolatti & Arbib, 1998). Notably, a percentage of F5 grasping neurons also fire during *observation* of specific 3-D objects even in the absence of any movement directed toward them (Murata *et al.*, 1997).

It seems that representation of an action can be triggered either by presence of the object or by the *memory* of it. Gallese *et al.*, (1999) propose that 'mirror neurons' provide the neurophysiological basis for the capacity of primates to recognise different actions made by other individuals: the same motor pattern which characterises the observed action is evoked in the observer and activates its own motor repertoire. This matching mechanism offers the advantage of using a repertoire of coded actions in two ways at the same time: at the output side to act, and at the input side to analyse the visual percept. Such a matching system has now been demonstrated in humans. Transcranial Magnetic Stimulation (TMS) of the motor cortex of subjects *observing* hand actions made by the experimenter determined an enhancement of motor-evoked potentials in the same muscular groups that were used by the experimenter in *executing* those actions (Fadiga *et al.*, 1995). It appears that when we observe an action, we use the repertoire of motor representations used to produce the same action—it is a system of *sympathetic response.*

Live contemporary dance is a particularly rich context for real-world investigation of the role of so-called 'mirror neurons' in expression, communication and empathy through human movement. For example, contemporary dance may communicate not only through narrative and metaphor but also at the level of shared understanding of the dynamics and constraints of the physical and biological world. Sloboda (1998) argues that meaning in music comes from the way it embodies the physical world in motion, and that human understanding of music comes from our capacity for analogical thinking. Contemporary dance, too, embodies the physical world in motion and, it could be argued, may be doubly powerful in that it can be understood both by analogy and by direct perception.

As an example, *Amplification* by Phillip Adams takes as its subject matter the contemporary cult of the pornography of car crashes. Adams faced a problem of how to represent a distorted experience of time (a common experience during a car crash) in dance terms. The

problem of conveying the nature of the experience in real time was solved by breaking up movement-material into brief distorted and fractured components, and performing a long and complex sequence of them at a perilously fast tempo (see figure 2). The effect was of rapid, violent movement seemingly (and paradoxically) occurring in slow-motion. Adams' exploration of body and temporal distortions can be understood both directly *and* by analogy. Mirror neurons and the sympathetic neural and possibly muscular response activated as we observe dance is a candidate mechanism to explain communication through direct perception.

Figure 2: *Performers: Shona Erskine, Luke George, Geordie Browning, Stephanie Lake, in* Amplification*, 1999 Choreography © Phillip Adams*
Photo © Jeff Busby, design – 3 Deep

Corballis (2003) posits that language evolved from hand gestures rather than vocal calls. He theorises that in early bipedal hominids facial gestures increasingly supplemented hand ones, gradually accompanied by vocalisations. Eventually all gestures of mouth and tongue became distinguishable acoustically, and hand gestures became redundant. Corballis notes that gestures with the hand continue as an accompaniment to speech.

The theory proposed by Corballis explains the universality of human movement and gesture—heightened in dance—as a means of

communication. Dance in this theoretical context is an important medium in which accounts of communication through movement may be tested and evaluated. For example, cross-cultural investigations of the universal recognition of body gestures and alarms.

Research is currently under way in a number of laboratories around the world using brain-imaging techniques to capture neural activity as a person observes and/or enacts a particular movement (for example, Decety, Chaminade, Grèzes & Meltzoff, 2002). Conceptual frameworks for the research include the coupling of perception and action and the notion that perception of others' motion, such as the ability to identify, interpret and to predict the actions of others, plays a major adaptive role (Grèzes, Fonlupt, Bertenthal, Delon-Martin, Segebarth & Decety, 2001). For example, if the same representations are used for both reading others' actions and producing them, an important issue relates to the way we easily distinguish the actions we produce from those generated by others (Decety, *et al.*, 2002; Jeannerod, 2003).

In one brain-imaging study, Positron Emission Tomography (PET), scans indicated that the left inferior parietal cortex is involved in producing imitation, whereas the right homologous region is more activated when one's own actions are imitated by another person (Decety *et al.*, 2002). Examining the effect of expertise, and using functional Magnetic Resonance Imaging (fMRI), Lee, Kim and Woo (2001) demonstrated that novice observers perceive dance simply as movement.

By contrast, stronger activity in the left superior temporal sulcus and angular and fusiform gyri of professional choreographers suggests that they analyse movement with knowledge of choreography and the extraction of symbolic units that activate a semantic network associated with the meaning of particular gestures and actions. One explanation of this phenomenon may be the potential interplay and/or competition between procedural and declarative memory (Poldrack & Packard, 2003).

Our own research will use magneto-encephalography (MEG), a brain-imaging technique with good temporal and spatial resolution, to capture the flow of activity in the brain as participants synchronise or entrain to a beat presented visually and aurally. Behavioural, muscular and neural responses will be recorded and compared during

perception and action conditions. To test the hypothesis that movement-perception and neural simulation are constrained by an observer's motor competence, expertise and expectations (Chaminade, *et al.*, 2001; Jeannerod & Frak, 1999), movement expertise of the observer will also be manipulated.

While the technology is available to record the flow of activity in the entire brain as participants observe, image or enact movement, mathematical and analytical tools to describe and summarise the *dynamics* of human movement are required. Dynamical systems theory (Freeman, 1999; Gregson & Pressing, 2000; Mitchell, 1998; Port & van Gelder, 1995; Stevens, *et al.*, 2002) may be applied to analyse dynamical properties of the movement-stimulus, as well as the dynamics of associated neural activity and flow. Robust mathematical models of biological and human movement are needed to complete this story. Convincing animations of biological motion will herald the discovery of mathematical equations that describe human movement. Currently, models exist for walking and running based on equations for the motion of a pendulum (Alexander, 1984), for flapping movements based on equations for the motion of a mass spring (Thelen, 1995), and to generate variations of predefined motion-sequences (Bradley & Stuart, 1998). Other complex human movements await mathematical analysis, parameterisation, and synthesis (Camurri, *et al.*, 2000; Camurri, Lagerlöf & Volpe, 2003; Jalics, *et al.*, 1997; Ude, 1999).

Effects of Dance on Development, Identity and Memory

At the other extreme of the behavioural spectrum, the effect of participation in contemporary dance programmes on child and adolescent development, personal identity, and cognitive abilities, also warrants systematic investigation. Anecdotal reports of the personal and social benefits of active arts programmes exist, but there are few controlled longitudinal studies of the effects, or theories to explain possible underlying mechanisms.

A spin-off study from the Conceiving Connections research project is currently under way, examining self-concept, self-esteem, identity and personality attributes of adolescents participating in the Quantum Leap Youth Dance Program at the Australian Choreographic Centre. Scores on a range of social and personality scales (for example,

Marsh, 1999) will be measured at the beginning and end of the Quantum Leap programme. The intention is to capture development over the 12-month period, to document the programme and process and disseminate findings nationally and internationally so that similar programmes may be implemented elsewhere.

Given the wealth of non-verbal material in contemporary dance, it is surprising that only a few researchers have used dance as a medium for the examination of temporal, kinesthetic and spatial cognitive processes (Hanrahan, *et al.*, 1995; Smyth & Pendleton, 1994; Solso & Dallob, 1995; Starkes, *et al.*, 1987). A new project will investigate the nature and mechanisms of short-term and long-term memory for movement and spatial and temporal stimuli among new and expert dancers and choreographers. Whether movement-material is coded and/or transformed in verbal, spatial or kinaesthetic terms will also be investigated.

Conclusions

Psychological processes involved in contemporary dance from the vantage point of choreographer, observer, and dancer have been considered. This complex phenomenon has many facets, and its investigation and explanation require the use of theories and tools from many disciplines. For example, creative processes in choreography have been considered using tools from psychology and musicology.

Measurement and interpretation of audience-response has drawn on techniques from sports psychology, psychophysiology, and neuroscience. Memory and personality issues may be examined using experimental methods and psychometric tools gleaned from cognitive, social and developmental strands of psychology.

Three themes recur in the prospectus for research outlined in this chapter. First, work is needed to develop theories and testable hypotheses to drive investigations that make use of current technologies such as Peak Motus motion-capture, the mathematics of dynamical systems theory, and brain-imaging methods such as PET, fMRI and MEG. Second, as human movement is defined by its passage in time, tools for analysis of time-varying events and multiple time-scales are needed. Third, research questions relating to contemporary dance will only be answered by using the breadth and complementarity of an interdisciplinary approach. In many instances the technology and tools for

interdisciplinary studies are available, and we await specification of detailed and integrated theories from which precise, testable hypotheses may be derived. The descriptions and views offered in this volume may go some way to realising that goal.

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