

*Choreographic Cognition: Composing Time and Space*

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In the creation, performance and appreciation of contemporary dance we find a microcosm of cognition. Contemporary dance is communicative and expressive; it is visual, spatial, temporal, kinaesthetic; it is sensual, affective, evocative, dynamic, and rhythmic. The aim of this paper is to examine the degree to which contemporary psychological theory can explain the complex processes that mediate creation and performance of contemporary dance. These perceptual, cognitive and emotional processes are termed collectively for the first time *choreographic cognition*. A review of literature and experimental studies finds that psychological investigations have dealt with dance as discrete movements or steps, and questions of memory and imagery have been unnecessarily confined to codes that are verbal or visual. We propose there is much more. Movement through space is continuous, it flows, transitions are the conveyors of information and form. In an effort to capture the temporal and spatial characteristics, we outline a new theoretical approach that conceptualises choreographic cognition as a dynamical system and propose that the underlying code is neither visual nor verbal but an abstraction of time and movement represented in brain-based rhythms or oscillations. We also pose new research questions and suggest ways that these may begin to be addressed.

Contemporary dance is defined here as a work in which the major medium is movement, deliberately and systematically cultivated for its own sake, with the aim of achieving a work of art. It shares with other art forms the possibility of being viewed either as non-representational/non-symbolic (typically termed “formalist” in aesthetic theory), or of being representational or symbolic in some sense. Regardless of the approach that is adopted, time, space and motion are the media for choreographic cognition.

*Creating Contemporary Dance – The Choreographer*

An obvious branch of cognitive psychology that may provide some insight into choreographic cognition involves theories of creativity and attempts to explain processes and circumstances that give rise to innovative thought. Creativity is almost universally defined in terms of novelty: a creative act, idea, solution, artistic form, or product, is novel and original, and incorporates substantial new ideas not easily derived from earlier work (Johnson-Laird, 1988; Wales & Thornton, 1994). Simonton (1994) suggests that creativity is marked by an unending search for the new. Boden (1996) alludes to the apparent difficulties inherent in studying the creative process, and refers to the perceived mystery that surrounds it: “how could science possibly explain fundamental novelties?” (p. 75). This almost mystical aura that surrounds the concept of creativity can be said to exist in the absence of a complete theoretical explanation of the phenomenon (Finke, Ward & Smith, 1996). However, Boden suggests that creativity may be no more mysterious than other unconscious processes and systems, such as vision, language, and commonsense reasoning (p. 75). The essence of the novelty in artistic creativity may be metaphorical thinking. All humans are likely to use such thinking, and perhaps people who are creative, such as artists and scientists,

simply use it more often or to more focussed purposes (McKechnie, 1996). Alongside novelty, unconscious processes and metaphor, another element common to a number of accounts of creative thinking is the juxtaposition of two seemingly contradictory ideas. Rothenberg (1994) refers to this as a Janusian process: the ability to hold two competing, contradictory ideas, images or concepts in mind simultaneously. He proposes that creativity is the synthesis or coalescence of these. Koestler (1964) pointed to useful distinctions between creativity as it appears in humour (the collision of matrices or planes of thought), in science (integration), and in art (analogy). More recent accounts of creativity emphasize processes of problem solving and problem finding (Kay, 1994; Wakefield, 1994). Putting these notions together, Boden argues that a theory that considers unexpected combinations, together with a psychological explanation of analogy, may suffice as a theory of creativity.

### *Creativity in Choreographic Cognition*

By nature contemporary dance is difficult to study as it is ephemeral and, unlike a musical score, painting or sculpture, there are few notes of the development of the work or even good records of all aspects of the performance. Fortunately, since early 1999 a collaborative research team involving the Victorian College of the Arts, dance industry partners, and researchers in Australia has captured on digital video the inception and development of new dance works by two elite choreographers. We draw on this video and journal documentation seeking examples of problem finding and problem solving, metaphorical thinking, and evidence of the synthesis of competing ideas.

An important characteristic of creativity in contemporary choreographic cognition is that dancers and choreographers increasingly work together exploring, selecting, and developing dance material. Australian choreographer Anna Smith developed new dance material working closely with eight experienced and professional dancers over a period of six months. The dance materials were generated from improvisations of the whole group. At one stage, spoken cues were given to the dancers such as 'Right elbow behind back, shoulders tilting, left hand reaching' and each dancer interpreted the cue. Individual solutions were found and the group gradually selected and developed the interpretations made by one or more of the dancers. Importantly, the choreographer was not in control of the material thus generated but the choreographic process took place through interactive dance-making to which everyone contributed (McKechnie & Grove, 2000). An explanation of creativity in choreography must therefore address the complex of dynamics and interactions among dancers and choreographer in this community of creative minds. In addition to motivation, memory, and personality factors that underpin the individuals' thoughts and behaviour, there are dyads and triads within the group and concomitant ideas, tensions, conflicts, attractions and defences. Thus the social and cognitive psychologist searching for a fresh domain to test current theoretical assumptions will be pleased with the uncharted territory offered by choreographer and dancer interactions.

Instances of problem finding and problem solving in choreographic cognition are easily found. The development of movement as art brings with it challenges of the limits of the human body and best use and negotiation of the dimensions, space and time. Although difficult to capture in writing, video footage of Smith and her team demonstrates the cognitive complexity of a segment that involved rapid and continuous whole body movement from all dancers with each performing a different series of complex transitions. As well as the motor and spatial complexity of each transition, the dancers were to carry out their individual movements while the group traced a DNA-like double helix. Before the sequence could be performed a logistical analysis to determine a way in which it could work spatially was carried out. Finally, movement of the complex spatial configuration of parts (dancers) and whole (group forming the helix) was realized using colour-coded paper trails of the path of each dancer. Thus the spatial and temporal configuration was

modelled with concrete materials and after much analysis and trial and error it was achieved in real time and space.

In another example, McKechnie describes creation of a work commissioned for a very small dance space. The space elicited ideas and images related to the use of simple forms in small spaces. Pondering this problem led to images of Ikebana, to the similar asymmetry of human lives lived in close contact in small rooms, to the alienation of separate lives closely entwined spatially but separated by emotional chasms. The source of the solution to the problem lay in synthesis between the imagery of confined spaces and the experience of contained tensions. A final example involves synthesis of real and imagined time in the perceptions of observers. *Amplification*, choreographed in 1999 by Phillip Adams reflects an interest in the contemporary cult of the pornography of car crashes. The choreographer faced a problem of how to represent a distorted experience of time in dance terms. The seemingly endless expansion of time experienced by car crash victims during the few seconds of a violent accident became the source of a central image. 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 tempo verging on the perilous, a feat accessible only to highly trained contemporary dancers. The presence of imagery is evident in these two examples and in most accounts of creativity. The examples also demonstrate that imagery can occur in all sensory modalities and in contemporary dance, unlike other artforms, the creative search is embodied in the human form.

#### *Memory and Imagery in Rehearsal and Performance of Contemporary Dance – The Performer*

Although choreography and contemporary dance have only rarely captured the interest of experimental psychologists, classical ballet versus contemporary dance have been used as tools to examine coding in human short- and long-term memory. Results include the observation that memory for complex movements is more kinaesthetic than verbal (Starkes, Caicco, Boutilier & Sevsek, 1990). Anecdotal accounts suggest that recall is often multi-modal such that activity in one mode triggers knowledge or recall in another. Smyth and Pendleton (1994) used an interference paradigm and measured effects of articulatory and movement suppression. Dancers' spans were longer than those of non-dancers for both classical ballet and modern movement and both articulatory and movement suppression decreased the dancer's spans. This implies that material is coded at least in the short-term in both verbal and kinaesthetic form. Long-term memory for dance material has been examined by Solso and Dallob (1995). They propose that a class of movements is represented abstractly in memory in the form of a prototype. Solso & Dallob conclude that there is an underlying scheme that governs the formation of body actions in general and dance routines in particular and that it may be possible to determine basic laws of motor performance and transformation as part of a comprehensive theory of dance 'grammar' and general kinaesthetic 'grammar'.

Of the experimental studies of memory for dance most have used classical ballet in which a sequence of prescribed steps is drawn from an established repertoire of labelled formal movements. By contrast, contemporary dance frequently consists of idiosyncratic movement derived from the theme being explored and is less easily reduced to verbal description. At one point in developing *Red Rain* the dancers commented on the extraordinary amount of information they needed to retain while working with new and demanding movement material. On another occasion a dancer watched herself perform a slow and intricate move on video but had little recollection of performing the movement or how she made her body move in a particular way. Such observations have implications for memory in choreographic cognition. One testable hypothesis is that verbal labels or cues for single movements (such as 'Deirdre's wrist; Kathleen's sitting bones; Nicole's no. 3') are used initially. Over time, longer and more complex movements are sequenced, rehearsed, and chunked in long-term memory. With repetition, the entire sequence becomes part of kinaesthetic

memory. A crucial question that arises is to ask what is the nature of the representation in memory that stores and integrates visual, auditory, propositional, spatial, temporal, and kinaesthetic features?

Imagery is used extensively in dance because “an arsenal of images has the ability to find a concise way of describing a movement” (Smith, 1990, p. 17). Using psychometric tools, Overby (1990) showed that experienced dancers differed significantly from novice dancers on three of four imagery ability measures, namely body image, cognitive imagery and spatial ability. Interpreting results on the Individual Differences Questionnaire (IDQ), Overby suggested that, while novice dancers prefer a visual mode of thought, experienced dancers were equally inclined to verbal and visual modes of thinking. She speculated that dance experience may be related to a tendency to process visual and verbal information on equal terms. Foley, Bouffard, Raag & DiSanto-Rose (1991) demonstrated that subjects who performed movements or imagined themselves performing them were better at recognizing the movements than those who observed or imagined another performing. This self-performed task effect was evident only for “uncommon” movements (modern dance and ballet). Visualising movement and movement patterns is now common in sport and in systems of training in kinesiology (Sweigard, 1974). Foley et al. concluded that further research is needed to establish whether imagery abilities differ in general or specific ways across expert and novice dancers. The ideas of Damasio (1999) and improved methods of investigation using new scanning technology are likely to contribute to our understanding of imagery and movement.

In his analysis of *Red Rain* development footage, Grove (1999) noted that, as the dancers explored movement triggered by a verbal cue, they appeared to intellectualise their task. Paradoxically, “the movement became more internal, establishing its own pathways through the body, internal realizations, instead of relying on a picture or mirror-image of what the spectators see”. For Grove, “it was as if the piece was being created from the inside out”. There is imagery indeed behind the movement created and explored by the eight dancers but the way in which experimental studies have considered imagery seems to fall short of the processes involved in an actual creative act. Experiments have dichotomised memory codes as either propositions or non-verbal structural descriptions and images. However, categorisation of movement in terms of what it is not, i.e. non-verbal, is uninformative and simply reflects the lingua-centric bias of cognitive psychology. In its stead, Grove refers to dance-making as “an utterance of the body”. The artist, whether poet or choreographer, does not necessarily start out with words or a visual image, but instead material may come from a pulse or a rhythm. A challenge for the experimental study of choreographic cognition is to divest itself of reference to verbal versus non-verbal features and turn to the seemingly simple notion of a generative pulse or rhythm. A dynamical view is based on this simple but powerful assumption.

As the medium of contemporary dance is time we propose that the artistry of movement is in trajectories, transitions, and in the temporal and spatial configurations in which moves, limbs, bodies, relate to one another. Choreographic cognition can be conceived as a dynamical system wherein change to a single component can affect the entire interacting network of elements. In a dynamical system, time is not simply a dimension in which cognition and behaviour occur but time, or more correctly *dynamical changes in time*, are the very basis of cognition.

#### *Meaning and Communication in Contemporary Dance – The Observer*

The power of movement and dance to evoke memories has been identified as an important factor in the communication achieved via contemporary dance. Hanna (1979) suggests that affective and cognitive communication in dance are intertwined and she gives a broad account of the way in which emotion is communicated. For example, physical movements associated with affect may stimulate or sublimate a range of feelings and may be elicited for pleasure or coping with problematic aspects of social involvement. Adults may find succour and release cathexis in

culturally permissible motor behaviour; this may be reminiscent of nurturance and protection of prenatal and infancy stages and imitates satisfaction of childhood behaviour. Dance may communicate a kind of excitement; may also provide a healthy fatigue or distraction that may abate temporary crises. Examples of the intoxication that occurs with rapid movement abound. Such therapeutic matters are unlikely to be of concern to the choreographer. However, such responses on the part of the observer constitute communication and will reinforce pursuit of dance as art or entertainment. The psychological issue that remains is to explain the *mechanism* that underpins release and cathexis. Sympathetic kinaesthesia is one possible explanation.

Conversations with elite choreographers and dancers suggest the presence of intriguing somatic and kinaesthetic processes when they observe dance performance and this leads to many possibilities for research into communication via kinaesthetic perception. Anecdotal reports suggest that expert observers actually *feel* the movement or feel as if they are performing the movement; a kind of sympathetic kinaesthesia. One way to examine this would be to take detailed physiological recordings of changes in tension, galvanic skin response, muscle response, heart rate, and blood pressure, as an observer watches a performance. We can examine the effects of differing levels of experience and performance expertise. We can also assess the way the presence of music might moderate physiological change. Finally, we can ask whether there is evidence of comparable physiological change in other performance artists such as elite musicians as they observe a virtuosic performance on their instrument. Is observation for all elite artists a virtual performance? Indeed, one could imagine that if such muscular and physiological changes occur during mere observation then styles of dance do not evolve or change from simply *watching* seminal works but aspects of the performance may literally be *stamped in* to the choreographer's kinaesthetic memory: a kind of virtual plagiarism!

Interestingly, recent neurophysiological findings suggest a mechanism that may underpin sympathetic kinaesthesia. Neurons have been identified in both monkeys and humans that fire according to particular actions of the hands and mouth, rather than with the individual movements that form them. Furthermore, a class of these same neurons fire when the action is *observed* being performed by an other (Di Pellegrino, Fadiga, Fogassi, Gallese & Rizzolatti, 1992; Fadiga, Fogassi, Pavesi & Rizzolatti, 1995). Rizzolatti and Arbib (1998) suggest that the mirror system *represents* in an observer the actions of an other. If this is so, then as we observe a dance performance particular neurons are firing that represent particular dance actions in us.

#### *A Dynamical Systems View of Choreographic Cognition*

Time is the glue, the medium of choreography and contemporary dance and, for this reason, contemporary dance lends itself to analysis in terms of dynamical systems theory. In this theory complex wholes and forms emerge from simple elements and in self-organising dynamical systems structures emerge from chaos. It is possible to apply the dynamical view to identify pulses, rhythms, patterns that spark an idea that is utterable in movement. The pulse or rhythm can occur in any modality but, for the creative choreographer, will be expressible as a composition of movement in space and time. Ultimately, we can apply the notion of dynamical systems to better understand, possibly to model, the movements and form of a single body, or many bodies, in space and time.

Another artform – music – has been described as a dynamical system (Burrows, 1997; Sloboda, 1998) and Sloboda's account in particular is relevant to dance. Sloboda argues that meaning in music comes from the way it embodies the physical world in motion. Human understanding of music comes from our capacity for analogical thinking. If contemporary dance too embodies the physical world in motion it may be doubly powerful in that it can be understood both by analogy and by direct perception. That is, the trajectory of objects in motion, through time, is the

very stuff of dance – real objects moving in real space and real time. Adams' *Amplification* is a good example of a contemporary dance work that can be understood both directly *and* by analogy.

A dynamical systems view of choreographic cognition holds that behaviour is continuous and each component acts and interacts with others in the system. Each state of the system determines the next state so that a structure or form evolves. Change occurs at many time scales and change at one scale shapes and is shaped by change at others. The process is one of self organization where solutions emerge to problems defined by particular constraints of the immediate situation (Thelen, 1995). In the context of movement there will be a number of physical constraints that will influence and determine the evolving form. Constraints might include mass, limb structure, size, weight, flexibility, space limitations, and so on. Within the set of constraints there will only be a certain number of possibilities so that the evolving movement is determined by what has come before and the context in which the movement is set. Importantly though, the movement is flowing, continuous, transitional – it is motion rather than simply 'moves' or 'steps'.

### *Constructing and Testing a Dynamical Theory of Choreographic Cognition*

One of the first tasks for the development and evaluation of a dynamical theory of choreographic cognition is to specify the constraints and features/variables of the system. Such information may be procured from detailed three-dimensional analysis of (initially) simple movements/transitions. Even a five-second sample of a transition in a modern dance piece will generate a multitude of possible features. The simplest starting point would be to identify a feature as a single oscillator and demonstrate entrainment and coupling to a relatively simple motion task. Thelen (1995), Saltzman (1995) and Large and Jones (1999) provide examples of the way in which single- and dual-degree of freedom oscillatory models lead to testable predictions of human timing behaviour. Although a single oscillator is unlikely to capture the richness of the creation and performance of modern dance, an investigation of a single oscillator model of dance-like movement or body transition would provide the needed existence proof of the viability of the dynamical approach.

At a higher level of complexity, detailed analysis of dances (in Adshead, 1988) and the movement notation system of Laban (1975) are fertile ground for identifying the key features and movement variables in contemporary dance. The three broad categories in Laban Movement Analysis are use of the body, use of space, and use of dynamic energy. Adshead expands on these concepts to include analysis of relationships between the parts and the whole, and of interpretation and evaluation. Precise elements are then defined within each of the categories. To take an example, movement may leave straight lines as vapour trails, an action may result in curved and arc-like trails, and other motions leave behind complex three-dimensional loops, twists, and spirals. These so-called trace-forms can then be analysed in more detail: linear trace forms may be accomplished simply with flexion and extension of various joints; curved trace-forms require abduction/adduction and sometimes rotation. Technology now provides us with motion capture systems via digital video and computer imaging which is able to reveal the most subtle and complex movement pathways. To scrutinize samples of outstanding contemporary dance works with the tools of dynamical systems theory and digital technology would be a fascinating and informative exercise.

A dynamical view of choreographic cognition has great explanatory power in that it is relevant to the three key actors we have described – choreographer, performer and observer. Our dynamical view proposes that the basis for an idea in movement can come from a pulse, beat, rhythm, or action. The task and artistry of the choreographer is to notice such a pulse and to express it in bodily form. The germ of an idea may multiply and develop so that from a single movement other variations, approximations, caricatures, inversions, emerge. (At some later stage the movement may be described using verbal language or visual images – but this is not necessarily its

original form). In dynamical terms, there may be structure and order, perhaps self-similarity, that emerges from apparent chaos. Complexity increases when choreographer and dancers interact and dancers perform – transitions, explorations continue to be conceived as a state space of many dimensions. Finally, for the observer, there is understanding from recognition, perhaps via analogy, of objects, organisms, moving in space and time and experiencing the conflicts, tensions, resolutions of a biological object negotiating the world, a world of time, space, and others. Within the dynamical scheme, a dance work consists of transitions of elements in high-dimensional space. The meaning for choreographer, dancer and observer lies in the dynamics of these transitions and their embodiment of the physical and biological world.

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