Choreographic cognition

The time-course and phenomenology of creating a dance*

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The process of inception, development and refinement during the creation of a new dance work is described and explored. The account is based on annotated video of the professional choreographer and dancers as they create and sequence new movement material, as well as weekly journal entries made by one of the dancers. A 24-week chronology is reported. We analyse the choreographic process using the Geneplore model of creative cognition as an organising framework and identify generative and exploratory processes including problem finding and problem solving, metaphorical thinking, nonlinear composition, and multi-modal imagery. An analytical tool adapted from the discipline of music analysis is used to explore relationships between recurring themes and visual, visceral, spatial and tactile images. Ideas for experimental work relating to choreographic cognition are discussed.

1. Introduction

1.1 Background

The psychological investigation of creativity is inherently problematic because the underlying cognitive processes are hidden and rapid, capturing acts of creativity in a controlled experimental setting is difficult, and a creative idea or solution may only be recognized as creative after the act has taken place. However, if the study of creativity is within a large-scale context and over an extended period of time such as the development of a work of art, then, as will be shown, these problematic aspects become more open to investigation.

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During 1999 and 2000 a collaborative research team in Australia involving the Victorian College of the Arts, dance industry partners (Australian Dance Council, The Choreographic Centre), and researchers from MARCS Auditory Laboratories at the University of Western Sydney, captured on video the evolution of new dance works by two elite choreographers. The large amount of video material as well as journal notes document a nine-month project led by choreographer Anna Smith and eight highly experienced professional dancers.[1] This video and written data present a rare glimpse of artists at work as they conceive, develop, reject and refine movement material for a new work, *Red Rain*. The interactive nature of choreographer and dancers working together to develop a work ensured the recording of discussions and the sharing of ideas both in words and movement.

This paper concentrates on the weekly log entries made by one of the dancers and the annotations of the video footage made by the choreographer. Our aim is to describe and investigate this particular creative journey. We identify aspects of the choreographic process that conform to current theories of creativity. Relationships between recurring ideas and themes in the evolving work are explored using an analytical tool borrowed from the discipline of music analysis. Dance, and contemporary dance in particular, has been largely neglected by cognitive psychology (although there are exceptions: see Foley et al. 1991; Hanrahan, Tétrau and Sarrazin 1995; Smyth and Pendleton 1990, 1994; Solso and Dallob 1995). Following this first and necessary step in documenting the creation of a dance, ideas for future experimentation are proposed.

1.2 Defining contemporary dance

In contemporary dance the major medium is movement, deliberately and systematically cultivated for its own sake, with the aim of achieving a work of art. It is communicative and expressive; it is visual, spatial, temporal, kinaesthetic, sensual, evocative, affective, dynamic, and rhythmic. Recording and describing the creation and composition of such a complex, multi-modal form of artistic behaviour can offer new insights into human cognitive processes. In studying the conception and choreographic realisation of a dance work we can expect to observe the generative and exploratory processes of creative thinking such as problem finding and solving (Goldsmith 1985; Kay 1994; Wakefield 1994); metaphorical thinking (Boden 1996; Finke, Ward and Smith 1996; Martindale 1990); juxtaposition of contradictory ideas (Anderson and Helstrup 1993; Koestler 1964; Rothenberg 1994); and imagery (Finke 1993; Isaksen,

Dorval and Kaufmann 1991/2; Kaufmann and Helstrup 1993; Reed 1993; Rieber 1995; Simonton 1994). Rehearsal and performance of new and complex movement material requires memory for material that is visual, spatial, kinaesthetic, motoric, temporal (Hanrahan et al. 1995; Overby 1990; Smith 1990; Smyth and Pendleton 1990, 1994; Solso and Dallob 1995; Starkes et al. 1987, 1990). Thus contemporary dance can be seen as a highly complex instantiation of human cognitive processes — short- and long-term memory, multimodal imagination, learning, performance, and expressive communication.

2. Method

2.1 Participants

The project involved choreographer Anna Smith working closely with eight highly experienced professional dancers. All dancers were female; ages ranged from 21 to 26 years. The dancers who collaborated in the creation of *Red Rain* also performed it in its inaugural season in 1999 when the work won the prestigious Green Room Award for original choreography. The dancers were graduates of the Victorian College of the Arts (VCA), an affiliate of the University of Melbourne and Australia's premier arts training institution. Auditionees for the School of Dance at the VCA must demonstrate considerable expertise in ballet and contemporary dance and have significant potential for succeeding in a demanding profession both nationally and internationally. Top dance graduates of the VCA have both highly honed dance techniques developed over many years of study and at least three years of dance composition. Four of the dancers who took part in the creation of *Red Rain* were previously employed as professional dancers for Anna Smith's contemporary dance company, *co.motion*, in 1998–99, as well as in other funded dance projects.

2.2 Equipment

Dance studios were used at the VCA and the Australian Choreographic Centre, Canberra. Sessions where movement material was created, developed, modified, and selected were recorded on digital video (Sony DCR-TRV900E). This technology provided good quality images and enabled dancers to view easily a sequence recorded in that or an earlier session.

2.3 Materials

A summary of the 24-week choreographic process follows. The unabridged chronology of the process including entries from a 14-week logbook written by one of the dancers, Nicole Steven, journal notes, and video annotations made by choreographer Anna Smith, may be downloaded from the website: http://sites.uws.edu.au/research/marcs/. A major impetus for the choreographer's ideas came from images associated with birth and death and the spilling of human blood.

Weeks 1–4. The choreographer began by asking the dancers to think about, and respond to, ideas and images associated with the colour red. Sharing of ideas, associations, images on red and the blood-filled interior of the human body took the dancers into the beginnings of movement. Early experimentation investigated what choreographer Anna Smith labelled "through-lines". The aim was to find a "pathway out of the body" from the pelvis and out through another part of the body. Dancer Nicole Steven documented the through-lines or pathways she developed: "My second through-line: At the tip of sacrum; Around to iliac crest; Head of femur; Spiral through thigh; Drops out knee cap" (Steven 1999, Week 1). These written notes were used to prompt the dancers' own memories and facilitate explanation to other dancers. By the end of the first week the choreographer introduced an idea for the work based on a paper sculpture relating to the inside of a vein or artery. The dancers discussed and explored movement suggested by veins, pulsing, breathing, blood pressure, blood flow.

In the second week, the body through-lines were scrutinized and sequenced. Nicole described in her journal how difficult it was for the movement to be remembered. The choreographer asked the dancers to bring something red to rehearsal and discussion of the objects and their inherent versus secondary "redness" ensued. Some of the objects were used as a basis for new movement; for example, red kidney beans were studied and their feel, sound, textural qualities, observed. The dancers attempted to use the beans while producing their individual through-lines. In the final work, the beans were poured in streams from bowls and from folds held against the dancers' bodies, or were pushed against a prostrate dancer leaving the trace of her form on the floor as she rolled away (Figures 1–3). The red kidney beans became a central metaphor for the idea of blood throughout the work. In another experiment in Week 2 the dancers took turns in having red wax dripped onto their skin (Figure 4). Nicole noted: "We discovered a rather strange sensation

as the hot liquid wax cooled to become a stiff and rigid, almost suffocating, second skin, only to crack and peel cleanly away from the skin as soon as movement was introduced".

Figure 1. Beans are pooled or trickled. In the closing moments of the work they are poured in a torrent of 'red rain'. The sound recalls rain on an iron roof. Photo: Anna Smith.

Figrure 2. Red kidney beans were used to outline the shape of a prone body. Photo: Anna Smith.

Figure 3. The line of the body left behind suggested traces written in blood. Photo: Anna Smith.

Figure 4. In the studio, the dancers experimented with the wax of a red candle dripped on skin – the wax evoking sensual images of fragility, blood. Photo: Anna Smith.

In Week 3 large squares of paper with one side red and the other side blue were used in the studio. One experiment with the paper resulted in "a beautiful sculpture which resembled some kind of a nest around K. as she lay on the floor. The paper was scrolled and curled…it was frail yet seemed to protect her. It also enveloped around her; the red interior, revealing occasional slithers of

blue from the other side of the paper seemed very life giving, like a nest or womb" (Steven 1999, Week 3).

Figure 5 illustrates the paper nest. During this week the choreographer introduced the idea of a lack of oxygen in the blood or body and the dancers were asked to consider what effect this would have on movement.

Figure 5. The ensemble referred to this image as the 'nested child'. Thickly textured paper curls in folds around the body of the dancer. To the choreographer, the red and blue colours of the paper suggest both life-giving and life-draining qualities. Photo: Anna Smith.

Another paper sculpture was introduced in Week 4. Created by sculptor Elizabeth Boyce, it consisted of several small rectangles of white paper joined by a thread that ran through the centre of each rectangle. The choreographer hung the length of rectangles and asked for the dancers' responses to the sculpture (Figure 6). For Nicole, the sculpture was reminiscent of the human spine with each piece of paper a vertebra — the thread like a spinal cord. The group spoke of possibilities of using red ink — to symbolise blood — to write their histories along the paper spine. Around this time, the choreographer recorded in her journal: "Shapes fashioned from handmade paper transform the space: it is laid on the ground and curls around a body like a nest. A paper wall, made from vertical strands can be interpreted in a number of ways. Each is, perhaps, a book. The cotton that holds them together, a spine of a book, or a body" (Smith 1999).

Dancers responded individually to a single paper strand and later demonstrated their improvisation or movement response to the other dancers. The nature of the vertical strand presented a challenge for the kind of movement material that could be used. Dancer K. produced a successful phrase — its

appeal lying in the "subtle, beautiful way the paper reacted to the slightest movement from her body" (Steven 1999, Week 4). Dancers and choreographer discussed using an entire wall of the hanging spines in performance. Nicole noted that sharing their ideas about the paper led to a satisfying insight about the large, two-toned squares of paper and its relation to blood in the body — the red and the blue suggesting oxygenated and de-oxygenated blood.

Figure 6. The paper spines become doorways, corridors and portals. In the performance of *Red Rain* they are lit to suggest a mysterious curtain that both conceals and reveals. Photo: Anna Smith.

Weeks 5–7. A change in the quality of movement material occurred in Week 5. The initial through-lines were flowing in character and they maintained a stream of motion through a certain pathway in the body. To find a new awareness of each section of their bodies, the choreographer asked the dancers to construct movement that truncated the through-lines already established. Nicole noted the difficulty of this "changing dynamic" and the choreographer taught the dancers what was intended through demonstration. As before, the group learned phrases developed by individual dancers. An improvisation task was constructed as a way to help the dancers "break up the habitual flowing awareness [that] already [existed] in our body as trained dancers" (Steven 1999, Week 5). An effective method was to have someone else dictate the parts of the body where movement would be initiated. After pilot testing the task, the dancers added certain descriptions of quality and dynamic to the body part instructions. Thus, each dancer responded to verbal instructions given by other dancers. For example, "Right elbow behind back, shoulders tilting, left hand reaching" with each dancer

interpreting the cue. Sessions involved individual improvisation and then selection of particular phrases of movement. As each unit originated with a single dancer, the units were labelled with a dancer's name. The dancers viewed the video and the choreographer selected portions of each dancer's movement material. Each dancer then learned all of the selected improvisations. Nicole commented on the experience of re-creating her own improvisation that had been captured on video:

> I can say that largely I could remember the feeling associated with that particular movement. Yet actually re-creating it was difficult in that I was now looking at the image on the screen rather than being given a prompt which would initiate the movement…D. had a rather different experience with one particular movement of her own. She could not recall the moment when she had improvised that movement (Steven 1999, Week 5).

In Week 6 the series of paper spines forming a wall or curtain was used and further improvisations recorded. Nicole was struck by the relation of the dancers to the paper wall: "The unfolding paper spines as the dancer moved away from the sculpture appeared almost as though the spine was being removed from the dancer's internal body" (Steven 1999, Week 6). Week 7 involved a revision and consolidation of the movement material created previously. Nicole observed: "The material was starting to sit in my body more comfortably… Finally, the strain of remembering was fading and I could begin to really inhabit the movement" (Steven 1999, Week 7). The choreographer began to sequence phrases and structure them in time.

Weeks 8–14. The dancers supplemented their own ideas and imagery with library research on the symbolism of red, particularly in other cultures. The dancers reported their findings back to the group and observed the universality of many of the ideas, symbols and rituals. In the ninth week the choreographer taught the dancers a phrase of her own movement material. It picked up the idea of through-lines, blood-related imagery and linked in with earlier movement. It occupied a larger area of space than the dancers had used up to this point. This phrase was concatenated with another and structured around the wall of paper spines. Nicole noted that integration of this material was difficult. The still, linear hanging paper was juxtaposed with frantic, erratic truncated movement. Larger phrases began to be loosely sequenced.

In Week 10 the group returned to texts found from their library research and the book *Juice of Life* (Camporesi 1995) was the focus for inspiration. As a fresh alternative, the dancers split up and spent a day in personal rehearsal. Each dancer improvised an individually chosen passage from *Juice of Life*. The

dancers re-grouped in Week 11 and shared their ideas and phrases of movement material. The choreographer selected sections. Most of the movement was tense and dramatic. Phrases created by H. were different. She had chosen a section of text that referred to the cyclical nature of life and the circulatory system. Nicole described the phrase as consisting "of a repeating pattern which appeared to circle back and forth around itself. It was really beautiful, and had a persistent lulling rhythm" (Steven 1999, Week 11). Sections of all the phrases were learnt and H's phrase was learnt in its entirety. The remainder of the week was spent piecing these movements together and recording them on video.

Another prompt to develop new movement came from a text read aloud by the choreographer that captured the images of blood and the opposing ideas of life and death:

> At the ends of the universe is a blood red cord that ties life to death, man to woman, will to destiny. Let the knot of that red sash, which cradles the hips of the goddess, bind in me the ends of life and dream ("Awakening Osiris"; in Ellis 1998: 180).

Nicole noted that this technique was new to the process and that it seemed to "add texture and value to the movement" (Steven 1999, Week 12). Ideas for the beginning of the piece began to emerge at this time incorporating earlier improvisations produced in response to dripping blood, the wax sequence, movement from peeling wax, paper, text, truncated sequences, and dripping wax.

The dancers and choreographer discussed the intricacy of pathways of blood in the body and one of the dancers mentioned the double helix from molecular biology. The choreographer then introduced the idea of an unfolding helix or plait-like pattern made up of five dancers in constant motion. The helix would require rapid and continuous whole body movement from all dancers with each taking a different path while performing complex, individual transitions. Work on the helix consumed hours of discussion, experimentation and spatial and temporal planning. Nicole wrote:

> … we began with the three strand pattern. We memorised our individual pathways, (one person per strand) and simply walked them in the space, imagining they were lines traced onto the floor. This was easy enough, however we had to decide who would cross in front at each intersection. Anna wanted to experiment using her truncated movement phrase. The process that was about to begin was a rather tedious and complex one. We all set about altering the material so that it could be travelled along the winding pathways of the strand we had been allocated…joining the others on the inter-linking pattern posed some problems. Due to the different shape of each person's pathway the movement

> took up different amounts of space and different lengths of time. Time and space were both problematic elements of this task (Steven 1999, Week 13).

The video shows choreographer and dancers drawing the pattern and coding the path of each dancer in colour (Figure 7). The dancers walked through the pattern, perfecting their path and speed to avoid collision with each other. Coloured tape was used to mark out different strands on the studio floor. Finally, additional movement was added and the use of imagery encouraged. In Week 14 the new task was to find a solution to the helix-movement such that a circular phrase developed by H. might link two or more dancers in an arcing pattern.

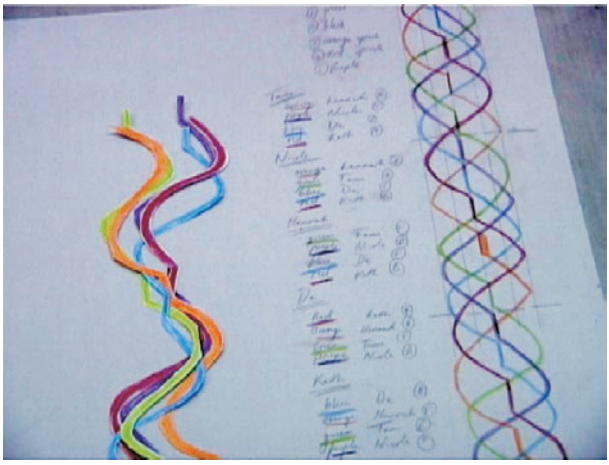

Figure 7. Colour-coded braid pattern or helix in *Red Rain*. Individual coloured strands represent the floor path of a dancer. Each dancer performed a sequence of idiosyncratic and complex movement transitions as they travelled along their path. On the video, the dancers discuss their perceptions of this process and its spatio-temporal complexities. Photo: Anna Smith.

Weeks 15–24. During the latter months the images and ideas from Week 1 recurred, continuing to inspire and frame movement: visual, rhythmic and visceral images such as blood rushing, pulsing in and out. The choreographer noted these ideas in her journal:

> Soaking the high air scarlet; blood silently burning; blood knotted to life and death. For me, these words engender imagery which is textural, sensuous, provocative; there is also pain and loss…Many ideas are giving birth to the movement material and the qualities I attach to it: a visceral relationship with images and objects. Blood and life; a torrent flows (Smith 1999).

Props continued to impel movement or enhance newly-emerging sequences. Four months into the project there were distinct and identifiable sections to the work: Section 1 merged with Section 2. The process of sequencing seemed to be an emergent one. Anna's journal captures the mystery and frustration of not always being fully aware of the final work:

> On Friday I had a great rehearsal; I think I passed through a difficult stage. I always feel as though I am over-anxious to know the work; what it is. But it is not alive yet so how can I possibly expect to know what it is? It has to breathe its own existence, and I have to be patient, to allow it to evolve itself. The work is an organism which creates its own body, so to speak. Does this make sense? Perhaps I understand the dilemma much better now (Smith 1999: 22/7).

At five months, there were five discernible sections to the piece. Much work had been invested in sequencing and developing transitions between movements and sections. The transitions functioned to link bodies in time and space while maintaining the tone and flow of the piece. Movement material was further combined either serially or in parallel — a by-product of the parallelism of the helix pattern as well as the choreographer encouraging duo-work with dancers practicing their sequences "against" others. The parallelism was a distinctive feature of the final work.

During the fifth and sixth months, props of paper, beans, wax continued to be used in the studio and these featured in the final work. By six months, the essence of the work was all but complete, the name of the work had been decided, and time was spent rehearsing and refining. *Red Rain* emerged as a title during the groups' residency at the Canberra Choreographic Centre (17/8/99) in response to the choreographer's closing image in the work.

2.4 Procedure

Dancers and choreographer worked four to five days per week (averaging 15 hours per week) over nine months creating, developing, sequencing and refining the movement material. As the movement material evolved and changed it was recorded on video by the choreographer whenever she felt a useful phrase had emerged or when any movement idea needed to be remembered for future reference or development. From the outset, movement material was generated in response to ideas, images and props provided by the choreographer, as well as from comments by the dancers. There was no fixed or explicit narrative. Gradually, certain material was selected, principally by the

choreographer, further improvised, learned and refined by the group. Video footage was checked and phrases of movement sequenced and re-sequenced. All movement material was developed without particular music in mind. However, music recordings were sometimes used to mask the music by Tchaikovsky coming from the piano in the next studio! Performances of *Red Rain* used a recording of *Ghost Opera* by Tan Dun performed by the Kronos Quartet as an accompanying soundscape (Nonesuch 79445–2, 1997); the choreographer chose the music. The final work premiered at Gasworks Theatre, Melbourne in November 1999.

3. Results

3.1 Description of the work

The final 40-minute work begins with the delicate sound of water dripping gently through a dancer's fingers into a hidden pool. It ends with a torrent of 'red rain' pouring over bodies and falling in huge droplets of sound. There is something archetypal about the complex of image and sound, an evocation of ancient memories, perhaps of sacrifice and renewal. Between these powerfully conceived images the work unfolds in finely wrought structures that suggest the cycles of experience in which rituals of birth and death, isolation and community, mark the passing of women's lives.

In a review of the premiere, Fairfax (1999) wrote that mountains of blood-red kidney beans cascade across the floor and pile up to snug into the contours of the dancer's bodies while blood-red light creates rectangular patterns across the floor, boxing up the dancers and isolating them singly, and in groups, so that sometimes as many as four or five different things are happening at once. Meanwhile, a Japanese paper sculpture, strung ribbon-like across the stage and suspended in a shaft of white light (Figure 6), becomes a place for refuge, a shuttered window with dancers flickering past, contemplative, wilful figures in an ordered and highly ordering world.

Dance critic Hilary Crampton (1999) noted that imagery in *Red Rain* is suggested, not explicit. The structures are complex — at times lingering single moments, at other times flooding the stage with a myriad of images that can be read in different ways. The use of props is integral to the work — thick scrolls of paper form a womb like nest, in which a diminutive figure curls, foetus like, overshadowed by a dancer, tall, poised, archaic, with angular gestures. The images recur, the context changed, so that they can be read as tenderness, hope, despair,

depending on the juxtaposition of figures and the dynamics of the movement. Crampton explains that the work has an inner tension and muscularity arising from the spine — movements coil and release into explosions of athletic energy. One is aware not only of the dancers, but also of the space behind them as limbs reach back, shoulder blades seem to take on life, like blossoming angel wings. It is as if the dancers are forever trying to bring the past with them (Figure 8).

Figure 8. The 'sail' image from a performance of *Red Rain*. Photo: Anna Smith.

As mentioned, the choreographer selected *Ghost Opera* by Chinese composer Tan Dun (1994), performed by the Kronos Quartet and Wu Man, as an accompanying soundscape. It is a work for string quartet and pipa, with water, metal, stone and paper. The composer was inspired by childhood memories of the shamanistic 'ghost operas' of the Chinese peasant culture. In this 4000 year-old tradition, humans and spirits of the future, the past, and nature, communicate with each other. The performer of 'ghost opera' has a dialogue with his past and future life — a dialogue between spirit and nature.

Tan Dun's *Ghost Opera* is notable for its contrasts in the alternation between human voice, the sounds of water, stone and paper and the interweaving passages of a string quartet. Although the movement vocabulary and large sections of the choreographic structure of *Red Rain* were established before the music was introduced, the effect of its qualities on the dance artists are such that a dialogue ensues between the music and the unfolding structure of the final choreographic work. The effect of *Ghost Opera* on the work is subtle. It enhances the dynamic effect of the dancer's movement but the work is not set in an exact relationship with the score. *Red Rain* begins in silence followed by the

sounds of water trickling through a dancer's fingers. It ends with the evocative sound of red kidney beans falling in a torrent of 'red rain' onto dancers' bodies and a pile of textured paper. The audience is left to make its own connections with the mood and qualities of the musical score much as an audience makes connections in relation to the unfolding events in a film.

3.2 Phases in Smith's choreographic process

The major phases of Smith's choreographic process are shown in Figure 9. The first phase involved individual dancer response or improvisation to text, image or props offered by the choreographer and, sometimes, other dancers. The dancers learned the improvised sequences, they were modified, phrases developed. Certain improvised movements were selected by the choreographer for further rehearsal, editing, refinement, and synthesis. Movement material was experimented with, sequenced and re-sequenced in various combinations. At times, phrases were performed concurrently by two or more dancers so that new combinations formed. Longer and longer phrases were gradually joined together and, of necessity, movement was modified or extended enabling smooth transition between phrases. The transitions themselves became part of the continuous flow of sculpted patterns in time. The chronology of the process brings to light the fact that development of the piece was non-linear. The material to feature in the opening of the work, for example, emerged three months into the project. In creating this dance work, movement material was continually modified, sped up, slowed, and re-organised.

The phases in Figure 9 conform to the major structures of the Geneplore model of creative cognition (Finke, Ward and Smith 1996). Although hypotheses from this model were not specified a priori, Geneplore provides a convenient and established conceptual framework to analyse and explain the creative process for *Red Rain*. We return to a cognitive analysis using the Geneplore model in Section 4.

3.3 Creative development and creative relationships

The development of the dance work can also be traced through an analysis of the journal of Nicole Steven drawing on the technique of musical structure analysis developed by Heinrich Schenker in the early 1900s (Schenker 1979; see also Forte and Gilbert 1982). Schenker's method of analysis aims to reduce the complexity of a musical work, over the course of a number of stages, to a

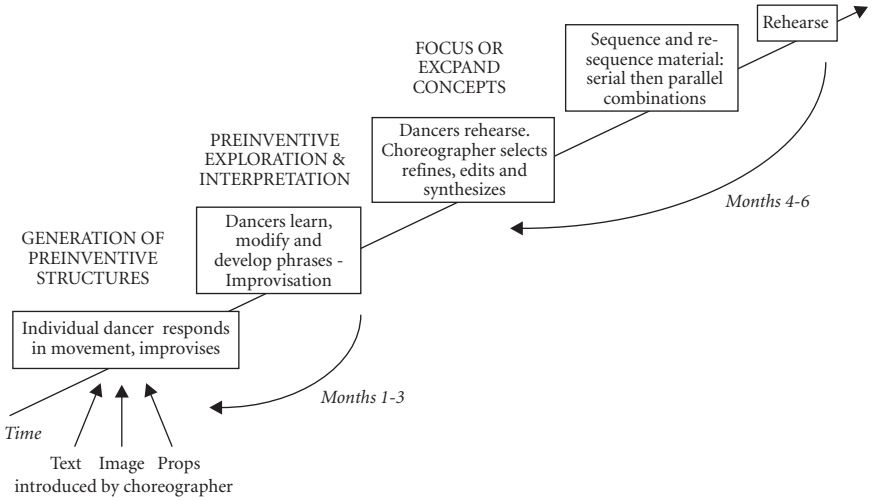

Figure 9. Phases of development of movement material noted from video footage of *Red Rain*. Recurrent arrows indicate that a phrase of movement would be conceived, developed, modified, rehearsed and the process begins again for creation of other new phrases of movement. A number of different phrases of movement were in development at any one time. Phases of the Geneplore model of creative cognition (Finke, Ward & Smith, 1996) applied to the present choreographic process are shown in uppercase.

nucleus of harmonic movement — thus showing how the entire structure of the work derives from simple harmonic progressions. The progress through various stages of reduction, from the *foreground* (which graphically explains the 'surface' of the music), through levels of the *middleground*, and finishing in the ultimate harmonic reduction (the *background*) is a way both to understand how the piece functions as an organic whole and to enable an entire piece to be represented on a single graph on a single page, enabling the whole piece to be grasped visually in a single moment.

It appeared to the second author of this paper that the task of beginning to discover relationships and important developmental moments in the creative journey as related in Nicole Steven's journal was a task similar to analysing a musical score, and the task of unearthing the more important elements, and investigating their inter-relationships, may be well served through a Schenkerian-style analysis. An important difference, however, is that a Schenkerian analysis is usually undertaken on a completed composition, where the time-course of the piece is finalised. Here we are investigating a creative process, searching for recurring ideas, so the notion of 'harmonic progression', central to a more usual Schenkerian analysis, is replaced with the scheme of a

small number of 'seed-ideas', from which other ideas and inspiration grow.

Figure 10 shows a 'middleground' analysis of the journal. The 'foreground', which is not reproduced here, consists of ideas and events extracted from Nicole's report of each week. Four layers were intuitively selected for the foreground to represent the material that was being reported — *concept* (a relatively abstract idea that the choreographer and dancers would play with), *embodiment* (an idea more directly related to the human body), *movement* (a type of bodily movement, a movement of an object, or a feeling of a movement), and *object* (an object brought into rehearsal with which the dancers interact). These four layers appear in the middleground graph shown in Figure 10. In this graph, time is represented along the horizontal axis, with the week-number of the journal entry being shown along the top. Where learning and structuring the work is explicitly mentioned in the journal without further reference this is noted along the top of the graph. The middleground is a reduction of the foreground achieved through grouping of ideas.

Figure 11 shows the background graph, which is derived from the middleground. Here, the elements of the middleground are reduced so that all ideas and events are still represented, but often in simplified form. A proposed derivation of ideas is shown through arrows — an idea at the end of an arrow is derived from the idea at the arrow's beginning. Time is no longer represented. This background suggests that the whole creative process rests on three 'seed ideas' — the colour *red*, the movement of *pelvic through lines*, and the object *paper sculpture*.

4. Cognitive analysis

Video footage (Figures 1–8), the choreographer's annotations, journal entries, identification of stages in the development of movement material (Figure 9) and analysis of the journal entries (Figures 10 and 11) provide a broad description of the choreographic and creative techniques used in the making of this dance. However, the cognitive processes that underpin these acts warrant closer analysis. A useful organising framework for an analysis of choreographic cognition is Finke, Ward and Smith's (1996) Geneplore model of creative cognition. Geneplore, as the name implies, considers both generative and exploratory cognitive processes. The model assumes that in the initial generative phase pre-inventive structures are invoked that have properties that promote creative discovery. The properties are exploited in the subsequent exploratory

Figure 10. A Schenker-style middleground graph of the 14 weeks recorded in Steven's journal.

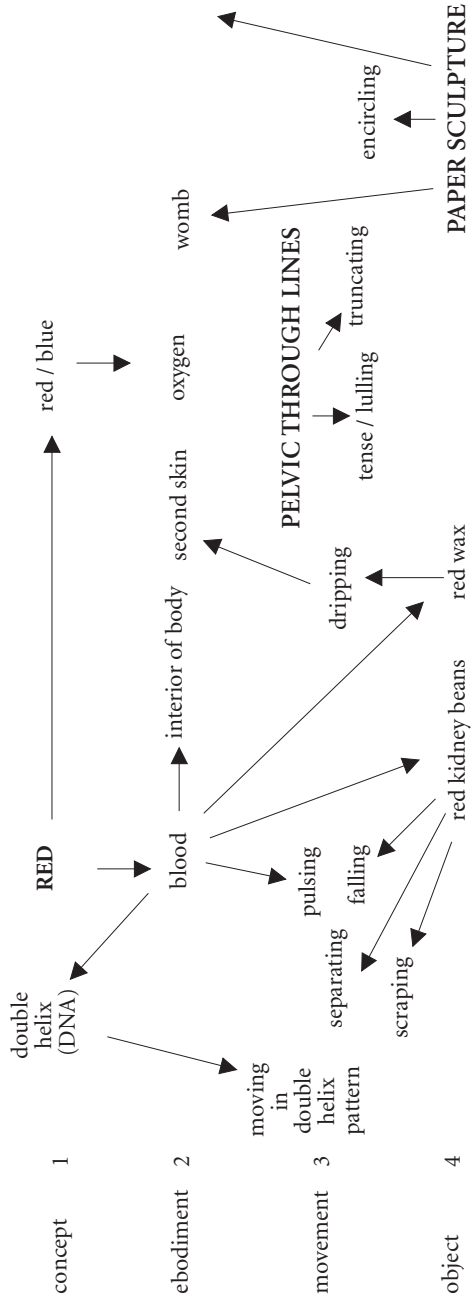

Figure 11. A Schenker-style background graph derived from the middleground shown in Figure 10. Arrows show a proposed derivation of ideas.

phase wherein attempts are made to interpret the pre-inventive structures in meaningful ways. During creative cognition, pre-inventive structures are generated, regenerated and modified in creative exploration (Finke, Ward and Smith 1996: 17). The creative process is cyclic with the number of generate-explore cycles determined by the desired extent of conceptual refinement or expansion (p. 18). The descriptive phases observed in the creation of *Red Rain* are outlined in Figure 9 and overlaid with the components of the Geneplore model. Specific examples from *Red Rain* that reflect generativity and exploration such as memory retrieval, imagery, metaphorical thinking and problem solving, will now be discussed.

4.1 Generative processes in choreographic cognition

Generative cognitive processes that are specified in the Geneplore model include retrieval, association, synthesis, analogical transfer and categorical reduction. An early generative process evident in the creation of *Red Rain* involves retrieval and discussion of red images by dancers and choreographer. Images were visual and verbal in modality (e.g., tomatoes, blood, red earth, red sunset), but also tactile (red wax, fire), olfactory (wine, roses), gustatory (plums, kidney beans, berries) and haptic (carpet). Single images elicited the retrieval of other associated images. For example, the notion of blood led to the associated concepts, life, bodily pathways of veins, arteries, the spine, death, and ritual. The concepts air, pressure and breathing were associated and led ultimately to the reporting of sensations by dancers as they described real or imagined sensations associated with a loss of oxygen (Week 3). The mechanism that underpins associative memory epitomised here can be explained by a spreading activation model of long-term conceptual memory (e.g., Anderson 2000; Collins and Loftus 1975).

Generativity through synthesis in the creation of *Red Rain* is evident in the blending of associations. Breathing, air, and oxygenated and de-oxygenated blood were blended mentally with the blue-red paper sculpture (Week 4). Examples of analogical transfer (Gentner 1989) can be seen in the hanging paper sculpture being regarded equally as a spine or personal history (Week 4; Figure 6). The complex five-strand helix is an example of movement material analogous to the double helix structure of DNA. Categorical reduction, where objects or elements are reduced to more primitive categorical descriptions, captures a quality of contemporary dance where an idea or concept is expressed in a primitive or reduced form through changes to movement and dynamic

qualities. The simplification of movement material or tempo change is also a form of reduction, such as the selection of H's circling movement from the more tense and dramatic improvisations inspired by *Juice of Life* (Week 11).

Pre-inventive properties characteristic of creative cognition, according to Finke, Ward and Smith (1996), include novelty, ambiguity, meaningfulness, emergence, incongruity, and divergence. Examples of pre-inventive properties from *Red Rain* include novel motives and cues for developing movement around the pelvis; the ambiguity of blood-related images as being both life-giving and life-draining; and the emergence of new or larger structures and sections in the work from concatenation or juxtaposition of smaller units. Convergence and divergence are both present in the final work where at times there is synergy between movement and music, and at other times a divergence of aural and spatial dynamics.

4.2 Exploratory processes in choreographic cognition

Exploratory phases as outlined in the Geneplore model involve attribute-finding, conceptual interpretation, functional inference, contextual shifting, hypothesis testing and the search for limitations. Attribute-finding may refer to the exploration of emergent features that result from the creation of conceptual combinations and metaphors (Finke, Ward and Smith 1996:24). There is an abundance of such explorations in the creation of *Red Rain*. An interesting transition occurs with an image becoming more contextualised as the work develops, and its metaphorical relations take shape. The red/blue paper, for example, becomes at once a womb or a nest (Figure 5); the flow of red kidney beans appears visually as blood flow, and aurally as rainfall; and new movement patterns emerge from combinations and intersections of individually developed phrases.

The speculation and experimentation of dancers with the book/spine paper sculpture is a good example of functional inference and the exploration of potential uses of a pre-inventive structure. Props both inspired development of movement material and were used to enhance particular sequences in *Red Rain*. For example, the wall of paper spines was used to suggest passages and doorways, umbilical attachments, wisps of memory or history flowing this way or that. Images that were initially visual and verbal were transformed into events to be experienced using auditory, haptic or spatial senses — beans for sound and blood dripping, wax as skin, and the DNA helix unfurling in space and time.

The exploratory phase of creative cognition is also characterised by processes of problem solving. Hypothesis testing, as a means to test and evaluate different solutions to movement, spatial and temporal problems in *Red Rain,* includes the construction of the five-person dynamic helix. Five hours or two full rehearsal periods of studio time were dedicated to creation and implementation of the human helix. The duration of this rapidly executed sequence in the final work is a mere 20 seconds. It is also significant that the complexities of this movement material, the parallelism, and structure informed much of the final work. For example, the impression of turbulent flow created by several dancing bodies was imaginatively contrasted with sequences of subtle delicacy enacted between two or three dancers, or with the inward focus of a single stilled figure with its evocation of silent introspection. Hypothesis testing and problem solving were also apparent when the delicate spine paper sculpture presented a challenge for creation of movement that complemented the gentle sway of the hanging spines (Week 4). Experiments with dripping red wax were conducted in the studio in Week 2 (see Figure 4) and, in Week 14, a solution was needed that allowed a circular phrase to link two or more dancers in an arc shape.

The creative process for *Red Rain* may be summarised as a cycle of generative and exploratory actions. The cyclical process is likely to contribute to the non-linearity of the composition processes — the final work bears little resemblance to the series of individual movement sequences that emerge during the initial generative tasks and explorations. The choreographer must determine solutions to the problem of linking body and limb positions into a narrative of expressive movement while concatenating individually developed sequences. The linking and transition movements between individual moments must become an integral part of the artwork. Ideally, the final work will appear seamless — movements do not sit as discrete beads on the string of time but unfold fluidly as sculpted shapes of time. Thus creativity in composing dance lies as much in sequencing, melding and linking the parts of the work, as in the creation of the parts themselves.

4.3 Memory for contemporary dance

We have suggested that the inspiration for movement material may be neither word nor visual image but may be a rhythm, beat or lilt apprehended from any modality and expressed in body and movement. The ineffability of such motives or impulses presents a challenge for psychological theory that, in general, assumes visual or verbal cognitive representation — thereby begging

the question of the form of the representation of movement material in human memory. How is visual, auditory, propositional, spatial, temporal, proprioceptive and kinaesthetic information integrated and represented? Video and diary material of *Red Rain* provides some insight into this question.

At various stages, the dancers working with Smith commented on the extraordinary amount of information they needed to retain while working with new and demanding movement material. On a particular occasion, a dancer watched herself perform a slow and intricate move on video but had little recollection of performing it or how she made her body move in a particular way. The dancer's journal comments on the difference between producing movement by looking at the image on screen, and being given a verbal prompt. Analysis of video and journal material suggests that, at least initially, there is coding of single movements using verbal labels or cues, such as "D's wrist; K's shoulders; sore sides; hangs". The labelling is used for communication purposes and perhaps as memory cues for dancers and choreographer. Smyth (1984: 106–107) states that verbal labelling is one obvious method for translating one type of input into a central code. However, because both preverbal children and some apes can match felt and seen movements, she notes that it is unlikely that verbal labelling is the only way in which visual and kinaesthetic information is matched and integrated.

In the development of *Red Rain*, an individual dancer's improvisation needed to be learned rather than merely copied by other dancers because it appeared to involve a transfer of knowledge and information — the material must be transposed into the kinaesthetic system of the other dancer. This is particularly important when the material is as yet uncoded in the body by previous experience. Use of a digital camera in the studio with the possibility of immediate playback appeared to facilitate revision and refinement of improvised material — movement that originated in one dancer was taken into the group dance (Grove 1999). Observing the dancers respond to verbal prompts in Week 5, Grove noted that "identifiable phrases of invention could be performed, not just by their originators but by everyone: 'D's wrist; K's sitting bones; N's Number 3' became democratically available". Over time, longer and more complex movements were sequenced, rehearsed and presumably chunked in memory (Smyth, Pearson and Pendleton 1988; Smyth and Pendleton, 1990, 1994; Solso and Dallob 1995). With repetition, the entire sequence becomes part of kinaesthetic memory.

An interesting possibility is that for most individuals learning complex movement there is some verbal coding and conventional memorisation. Perhaps those destined to be dance artists, or those trained in dance, bypass the

verbal coding stage to some extent, and movement is rapidly represented in kinaesthetic and muscular memory (Roberts et al. 1997). In this case, not only the motive for *creating movement* material, but also the *representation* of movement in memory, is non-verbal. An alternative view to the reduction of memory for movement to a sequence of labels is to recognize bodily action as cognition. Thelen (1995) exemplifies this view arguing that the way in which infants acquire seemingly simple body skills supports a view of cognition in which thinking is grounded in, and inseparable from, bodily action. Thought is *embodied* — it contains the very essence of bodily experience. The power of contemporary dance to express and communicate is a logical extension of this embodied and dynamical systems view of human cognition.

5. New directions for experimental research in cognition and dance

5.1 Audience response to contemporary dance

5.1.1 *Sympathetic kinaesthesia*

So far, choreographer and performer have been the focus of our analysis and little has been said of observer response to a dance performance. Dancers report that when they watch dance, they have a sense of dancing themselves (e.g., Marie Rambert, in Foster 1976: 44; Hanna 1979). One possibility is that observation of movement elicits a sympathetic response in relevant muscles and/or motor neuron pathways (e.g., Decety et al. 2002; Fadiga et al. 1995). In a similar vein, Dascal and Dascal (1985) theorise that understanding art involves "knowing how" — a concept that enables the harmonious combination of emotive and cognitive components.

It is timely to investigate sympathetic or mirror responses in the context of contemporary dance and expressive movement. We propose that a fundamental form of communication between performers and observers may be at a physical level, mediated by sympathetic kinaesthesia. Dascal and Dascal (1985), like developmental psychologist Thelen (1995), note that the body and movement are the basis for all forms of perception of the world and for all modes of self-expression. Importantly, current research into mirror neurons begins to provide a mechanism for this communicative process (Gallese and Goldman 1998; Rizzolatti and Arbib 1998). A future research project conducted by our team will measure both muscular response and brain activity (using magneto-encephalography — MEG) to examine the effect of expertise and movement

quality on sympathetic and mirror responses while observing expressive movement. We ask the question: is there sympathetic muscular response evident in observers of human movement, and does the intensity of sympathetic response increase concomitantly with increasing specialist expertise (e.g., dance; athletics)?

5.1.2 *Developing a psychometric audience response instrument*

Red Rain is a work rich in imagery, metaphor, sensuality, varying spatial patterns and dynamics. It is also relevant to analyse the interpretive, aesthetic and affective responses of an audience as they watch a performance of the work. An Audience Response Tool (ART) has been developed and is currently being evaluated first in the context of *Red Rain,* and then generalised to other contemporary dance works (Glass 2003). The ART consists of three open-ended questions that invite audience members to record and describe cognitive, emotional and aesthetic responses to the work, followed by a series of specific questions and rating scales. The ART has been conducted in both written and focus group (oral) form. The eight dance artists have also completed the ART after each of five performances of *Red Rain* enabling us to identify co-variation of responses between dancers and audience. Long-term memory for, and response to, the work is being gauged in a follow-up questionnaire that is administered two weeks after a performance. These data will provide a detailed account of cognitive, affective and aesthetic responses to *Red Rain* recorded under controlled conditions, in an ecologically valid environment. Performances have been held in three different city and regional locations in Australia involving live audiences from 80 to 100 in size. The effect of audience member variables such as amount and type of dance experience, gender, socio-economic status, and interest and involvement in other performing arts, on emotional, cognitive and aesthetic responses, is being assessed.

The motivation for the development of the ART is to better understand the way audience members respond to contemporary works, the effect of different kinds of pre-performance information sessions, and personal and contextual factors. Ultimately, the ART will assist in the interpretation and inter-relation of continuous measures of affective change and physiological response as a work unfolds in time.

Generalisation and verification of our observations in another context involving different choreographers and dancers is underway. Having provided a global description of composing contemporary dance, the next step is to subject the cognitive processes to experimentation. For example, two hypotheses

relating to the nature of memory for complex movement could be examined. The first hypothesis is based on the assumption that memory for movement among elite performers is immediately kinaesthetic, and the other hypothesis assumes a gradual transition from a propositional to a kinaesthetic and bodily code. The interference paradigm from working memory research would be applicable to this issue (e.g., Smyth and Pendleton 1990; 1994). Surprisingly little research has examined the correlation between intent on the part of choreographer or dancer, and perception of movement and meaning inferred by an observer (exceptions are Gabrielsson 2000; Lagerlöf and Djerf 2000). The ART will provide a method to investigate when and how often the intent of choreographer and dancers and the understanding on the part of the observer coincide. The mediating effect of an observer's experience with dance will also be examined in this context, as well as when we seek empirical evidence of sympathetic muscular and neural activity. In choreographic cognition, we have observed the transition of images from word and vision to auditory, haptic, tactile, and spatial modalities. The increasing resolution and availability of brain imaging technology will enable analysis of the neural activity that underpins these inter-modal generative and exploratory cognitive processes.

Although we have reported the case of an individual choreographer developing a particular dance piece, there are general principles at work. One feature of the artistry of choreographer and dancers is the recognition of an idea, pulse, impulse, rhythm, beat, pattern or texture and their ability to express it in bodily form. Time to create, revise, synthesize, and refine movement material also appears to be a crucial element. The Geneplore model of creative cognition has assisted with the identification of generative and exploratory features of the creative process. Further theoretical and empirical work is needed to verify the perceptual, cognitive, and developmental mechanisms that mediate creation of and response to contemporary dance. The innovation in developing empirical methods to examine contemporary dance is that it presents cognitive scientists with a new domain for the study of motor and kinaesthetic memory, multi-modal imagery, metaphorical thinking, problem finding and solving, emotion and gesture expression and recognition, sympathetic kinaesthesia, neural mirroring, and non-verbal communication. We hope that through our investigations cognitive psychology and dance theory and practice will be enriched.

Notes

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1. The research project was motivated by the observation that the creation and development of significant works takes time. Composition and preparation in Australia is assigned, most often, three to four weeks, with little recognition of the need for time to explore, test, and revise creations. A costly but short-lived production most often results. One aim of the industry-funded research partnership was to provide lengthier periods of creative time, comparable with that enjoyed by Germany's Pina Bausch, France's Maguy Marin and America's William Forsythe.

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