

# Moving mind

the cognitive  
psychology of  
contemporary  
dance

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Contemporary dance is rich in complex cognitive processes such as creative thinking, imagery, memory for extended motor sequences, non-verbal communication, and spatial problem solving. Cognitive psychology is the study of mental processes such as thinking, reasoning, imagining, remembering, deciding, and problem solving. Cognitive psychologists infer the structure and function of these psychological processes from overt and measurable behaviour such as the accuracy or speed of response in performing a carefully-designed laboratory task, or analyse utterances using tools of discourse analysis and semiotics. The study of creative behaviour, such as that found in dance, presents a challenge to the experimental cognitive psychologist as the underlying cognitive processes of creativity and performance are notoriously difficult to capture in a controlled experimental setting. The study of contemporary dance thus challenges certain assumptions of psychological theory, and demands new, less linguistically and 'thought' bound notions of how humans create, communicate and remember.

Unlike dance, the production, performance and perception of music has been studied in detail by cognitive psychologists. Music has been recognized as a window into cognition. The status of dance, however, is less clear, and to date has received little acknowledgment or investigation of the kind now accorded to music: 'since music data are systematic, relatively clear and

accessible, it is theoretically and methodologically advantageous to study music as a way to study the mind'.<sup>1</sup>

We propose that contemporary dance too affords insight into human cognition if we consider the movement vocabulary, form and structures in a particular dance as the bodily expression through space and time of processes of the mind. Contemporary dance, by its very nature non-verbal, can be powerfully communicative. Indeed, we suggest that the multi-modal nature of dance — visual, auditory, kinaesthetic, spatial, temporal, motoric, affective, dynamic — makes it a most powerful art form in terms of layers of communication and meaning. The combination of the cognitive and the visceral make it at once intellectual and primal. Surprisingly, contemporary dance has rarely been studied from a cognitive psychology perspective. There are individual studies of memory for dance movement,<sup>2</sup> the role of imagery in creating and reproducing phrases of dance movement,<sup>3</sup> and comparisons of novice and expert performers,<sup>4</sup> but there has been no psychological investigation of the development of dance from inception to performance. The present account presents such an analysis.

During 1999 and 2000 a research team involving the Victorian College of the Arts, dance industry partners (Australian Dance Council, the Australian National Choreographic Centre), and researchers from Macarthur Auditory Research Centre (MARCS), University of Western Sydney, captured on digital video and in dancers' journal entries the creation of new dance works by two elite choreographers. A large amount of information was collected that documents a nine-month choreographic project. Working for an average of twelve to fifteen hours per week, choreographer Anna Smith and eight professional dancers created a new dance work of thirty-nine minutes duration. The video and written data present a rare glimpse of artists at work as they conceive, develop, edit and refine movement material for a new work, *Red Rain*. The interactive nature of choreographer and dancers working together to develop this work ensured the recording of discussions and the sharing of ideas both in words and in movement. Our aim here is to apply theories from cognitive psychology to the study of the creation and production of this contemporary dance. We begin by describing the

time-course of the particular creative journey and then explain aspects of the choreographic process drawing on current notions of creativity and memory. The final section of the paper applies recent ideas from physiological and developmental psychology to begin to explain the mechanisms at work in communication through dance.

### **The evolution of Red Rain**

The sessions began with the choreographer asking the dancers to think about, and respond to, ideas and images associated with the colour red. The ensuing discussion of associations and images on red and the blood-filled interior of the human body took the dancers into the beginnings of movement. Early experimentations investigated what choreographer Smith labelled 'through-lines'. The goal was to find a 'pathway out of the body' from the pelvis. Written notes from rehearsals describing the through-lines or pathways were used to prompt the dancers' own memory and enable explanation to other dancers. For example, one of the dancers, Nicole Steven, recorded in her journal:

My first through-line went as follows: At the hip, pours across into ribcage; Thread through into the spine; Crawl upward along the spine to the shoulder blade, falls back toward the floor; Up to tip of the shoulder; Down the bicep, elbow, wrist, hand.<sup>5</sup>

By the end of the first week the choreographer introduced an idea for the work based on a paper sculpture of the inside of a vein or artery. The dancers discussed and explored movement suggested by veins, pulsing, breathing, pressure, blood flow.

In the second week, the body through-lines were further explored and sequenced. Nicole described in her journal how difficult it was for the movement to be remembered. Her reasoning was that

it was something we had to really think about, as it was not borne purely out of a sense or kinaesthetic kind of bodily knowledge ... it was kind of imposed by our intellect, i.e. we chose points of our anatomy to work to and from. It was hard to do it without consciously thinking it through every step of the way ... With much repetition the movement became more kinaesthetic and our bodies began to take over.<sup>6</sup>

During the second week the choreographer asked the dancers to bring something red to rehearsal resulting in discussion of the objects and their inherent versus secondary 'redness'. 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 would be poured in streams from bowls and from folds in material held against the dancers' bodies or be pushed against a prostrate dancer leaving the trace of her form on the floor as she rolled away. The red kidney beans became a central metaphor for the idea or image of blood throughout the work. In another experiment the dancers took turns in having red wax dripped onto their skin. The movement improvised in response to this tactile and sensuous experience later made its way into the final work.

In Week 3 large squares of finely textured 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.<sup>7</sup>

During this week the choreographer introduced the idea of a lack of oxygen in the blood or body. How could this be described in movement terms and what would it feel like?

Another paper sculpture was introduced in Week 4. 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' verbal responses to the sculpture. For Nicole, the sculpture was reminiscent of the human spine with each piece of paper a vertebrae; 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. The artist who designed the paper sculpture had indeed intended the object to be a variation on a book. The journal entry of Nicole notes that the dancers 'liked the idea of

such a book being able to hold some of the information about ourselves, as our blood carries information about each of us through our entire body'.<sup>8</sup> Dancers then responded with movement 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. Dancers and choreographer then 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 their relation to blood in the body — the red and the blue suggesting oxygenated and de-oxygenated blood, respectively.

A change in the quality of generated movement material occurred in Week 5. To find a new awareness of each section of their bodies, the choreographer asked the dancers to construct movement that truncated the existing through-lines. 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 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, for communication purposes and possibly as memory cues.

As individual improvisations had been recorded on tape, the dancers could view the video and the choreographer select portions of each dancer's movement material. Grove noted that movement that originated in one dancer was taken into the group dance.<sup>9</sup> There was constant repetition, refinement of articulation, subtle changes to time. Slowly, phrases began to chunk together in serial fashion. At a later stage, parallel chunking of movement material would take place. By the end

of the first month a long sequence of movement began to emerge based on improvisation material selected from the group's study of video footage of earlier sessions. The series of paper spines forming a wall or curtain was used and further improvisations recorded. The dancers revisited sensations, ideas and feelings experienced in response to warm candle wax dripping onto their skin and the choreographer played a recording of music that she identified with the images associated with the wax. They then improvised some short movement sequences inspired by the images. Two phrases were considered successful and all dancers learned them.

Week 7 involved revision and consolidation of the movement material created in the previous two weeks. The choreographer began to sequence phrases and structure them roughly in time. Dancer Nicole noted that this 'gave us a chance to see this movement in a possible structure. We left it there and moved onto re-capping some of the earlier through-lines for memory's sake'.<sup>10</sup>

The dancers supplemented their own ideas and imagery with some library research on the symbolism of red, particularly in other cultures. They searched for titles containing the words 'red' and/or 'blood'; texts on human anatomy and medicine; Asian paper; and the Ganesha Festival in India where a fine red powder is thrown into the air, which creates clouds of red dust. 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 also covered 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. 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; the book *Juice of Life* was to be the focus for inspiration.<sup>11</sup> The dancers read through sections of the text with explanation and discussion where needed. The first attempt at improvisation using the text involved responses to

a passage chosen by each dancer. Nicole noted that this proved difficult. She reasoned that

it was this way because we had all poured a lot of energy into creating new material and were beginning to be influenced strongly by one another's ideas and how we might interpret them into movement terms.<sup>12</sup>

As a fresh alternative, the dancers split up and spent a day in personal rehearsal. Each dancer improvised on an individually chosen passage from *Juice of Life*. Nicole reflected:

I found myself focusing on the idea that an area of the body in my choice, the brain, could be overwhelmed with an abundance of blood. I was fascinated by the concept that it was not the quality of the blood per se that caused harm, but the superfluous amount of it being directed to one area. My movement rested heavily around this notion. I wondered, how long could the body withstand the pressure of excessive blood pressure? How would it react to an overflow? I explored these questions in my movement. I felt far happier with this movement than the direction I was taking in the shared rehearsal.<sup>13</sup>

The dancers re-grouped in Week II 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'.<sup>14</sup> Sections of the phrases and H's entire phrase were learned. The remainder of the week was spent sequencing these movements 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.<sup>15</sup>

Three months into the process, dancers responded to text and, again, phrases of movement were selected and further explored by the group. Ideas for the beginning of the piece

began to emerge at this time, incorporating earlier improvisations produced in response to dripping blood and wax, movement of peeling wax off skin, paper sculptures, texts, and truncated through-line sequences.

In conversation, the dancers and choreographer discussed the intricacy of pathways of blood in the body and one of the dancers mentioned the double helix from 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. The video shows choreographer and dancers drawing the pattern and coding the path of each dancer in colour. The dancers walked through the pattern, perfecting their path and velocity to avoid collisions. Coloured tape was used to mark out different strands on the studio floor. Finally, movement was added and the use of imagery encouraged. In Week 14 the next challenge was to find a way that H's circular phrase might link two or more dancers in an arcing pattern.

#### **Weeks 15–24**

During the latter months the images and ideas from Week I recurred, continuing to inspire and frame movement: visual, spatial, temporal, visceral, tactile and kinaesthetic images such as blood rushing, pulsing in and out. 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 was an emergent one.

At five months, there were five discernible sections to the piece. A great deal of time 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. Parallel combining was an influence of the parallelism of the helix pattern as well as the choreographer encouraging duo work with dancers practising their sequences 'against'

others. The parallelism was a distinctive feature of the final work with a reviewer of the premiere performance noting that 'sometimes as many as four or five different things are happening at once'.<sup>16</sup>

During the fifth and six months, props of paper, beans, and wax continued to be used in the studio and would feature 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 Choreographic Centre in response to the choreographer's closing image in the work. The completed 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 this 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.

### Hallmarks of creativity in the evolution of *Red Rain*

Creativity is almost universally defined in terms of novelty wherein a creative act, idea, solution, artistic form or product, is novel and original, and incorporates substantial new ideas not easily derived from earlier work.<sup>17</sup> Recent accounts of creativity emphasise processes of problem finding and problem solving, imagery and impulse as inspiration, and metaphorical thinking. We will now consider these points in the creation of *Red Rain*.

Evidence of **metaphorical thinking**<sup>18</sup> is apparent in the source of ideas for *Red Rain* including life, death, bodily pathways of veins, arteries, the spine. The extensive use of props by the choreographer reinforces the power of metaphor in this particular work: beans for sound and as blood dripping or pooling; wax as skin; curled paper squares as a nest or womb; books as a spine or personal history. The props both inspired development of movement material and were used to enhance particular sequences. 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. Understanding and communication in dance through metaphor and universal images is a rich topic deserving of empirical investigation.

The development of movement into an artwork involves working with the limitations of the human body, and finding aesthetically satisfying, imaginative use of the dimensions space and time. We posit that one of the tasks of choreography of contemporary dance involves determining a solution to the problem of linking body and limb positions when concatenating individually developed sequences. The video of Smith and her team's studio work contains numerous examples of this search for transitions, as well as instances of problem finding and solving. Imagining and performing a five-person dynamic helix is a vivid example of an original and generative artistic problem. 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 in the helix sequence 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. 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. Thus, for the choreographer the necessary transitions between individual moments must become an integral part of the artwork — movements do not sit as discrete beads on the string of time but unfold fluidly as sculpted shapes of time. The artistic composition of a dance work may usually be non-linear — the final work bearing little resemblance to the series of individual movement sequences that emerge during initial explorations.

In descriptions of their individual choreographic practices, choreographers such as Limón, Humphrey and Cunningham note that choreography rarely starts with a text — with language structures.<sup>19</sup> Rather, creativity is movement-based and choreographers report generativity where material evolves from experimentation and exploration in the medium itself.<sup>20</sup> The source of an idea in a new work may be drawn from any modality: visual image; heard

or felt rhythm, beat, or texture; visual, auditory, muscular or psychological tension; emotion; sound; word; concept.<sup>21</sup>

Inspiration for movement during the creation of *Red Rain* was multi-modal, not simply visual or verbal as has been assumed in most cognitive theories to date. Dancers and choreographer drew on auditory, tactile, temporal and spatial qualities of objects and concepts such as the sound of beans spilling and the feel of wax dripping on skin. An aspect of the artistry of choreographer and dancers is in their recognition of an idea, pulse, impulse, beat, rhythm, pattern, or texture and their ability to express it in bodily form — we term this the **spatialisation of mind**, using **choreographic cognition**. Imagery is not purely visual or propositional and this non-verbal quality contributes to the power and universality of many contemporary dance forms. For the empirical investigation of contemporary dance, this non-verbal quality also necessitates development of new methods and techniques to record and manipulate 'bodily cognition'.

#### **Memory for complex movement vocabularies and structures in contemporary dance**

We have suggested that the inspiration for movement material may be much more than is suggested by propositional-based accounts of imagery and creativity.<sup>22</sup> It need not be either word or visual image but may be a rhythm, beat or lift 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. By extension, it also begs 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 memory for dance.

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 that 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. Grove said of these dancers: 'By having to think so hard about the movement, they embedded it more deeply **in the body**. It was as if the piece was being created from the **inside out**'.<sup>23</sup> This quote implies that the 'hard thinking' actually **gave way** to more visceral forms of cognition because thinking alone could not solve the problem.

From the video and journal material it appears that, at least initially, there is coding of single movements using verbal labels or cues, such as 'D's wrist; K's shoulders'. An individual dancer's improvisation needed to be learned rather than merely copied by other dancers because it appears to involve a transfer of knowledge and information. The material must be transposed, as it were, 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. Over time, longer and more complex movements are sequenced, rehearsed and chunked in memory.<sup>24</sup> 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. Comparing the dance of children and adults, McKechnie noted an apparent lack of 'movement intelligence' among adults who came late to the dance experience.<sup>25</sup> Recently, Damasio has argued that once language is learned it is impossible to not use it as everything is named and this tends to take over.<sup>26</sup> The children's superior ability in being able to 'look and do' as described by McKechnie supports the notion that kinaesthetic perception and knowledge precedes the verbal coding stage. Perhaps those destined to be great dance artists either bypass the verbal coding stage or retain their early movement intelligence — new movement material is then rapidly represented in kinaesthetic and muscular memory.<sup>27</sup> In either case, not only the motive for creating movement material, but also the representation of movement in memory, is non-verbal, ineffable.

### Meaning and communication in contemporary dance

In moving from a description of the process undertaken we now propose ways in which this knowledge can be interpreted within a cognitive psychology framework. The language used therefore becomes more explicitly psychological and relates to mechanisms that underpin human communication.

The basis of dance is bodily movement through time, and this movement 'speaks' to a person who is watching attentively. Buck, in his work on the development of emotion decoding skills, distinguishes between **emotion perception** (a direct perception process) and **emotion cognition** (understanding the emotional experience through reflection).<sup>28</sup> Both will occur as we watch a piece of dance. However, in contemporary dance, unlike classical ballet, there is far less reliance in the work on dance convention and representational overlay. Thus, we propose that the primary method of communication in contemporary dance is through **emotion perception**. We further propose that emotion perception occurs via three interlocking processes — sympathetic kinaesthesia, activity of **mirror neurons** and sympathetic response to **vitality contours**:

Informally, elite choreographers and dancers note that they experience somatic and kinaesthetic sympathy when they observe dance performance. Anecdotal reports suggest that expert observers actually **feel** the movement or feel as if they are performing the movement; we term this sympathetic kinaesthesia. Recent neurophysiological findings suggest a part of a mechanism that may underpin the phenomenon of sympathetic kinaesthesia and emotion perception. Neurons have been identified in both monkeys and humans that fire according to particular actions of the hands and mouth, rather than with the component movements that form them. A class of these same neurons fire when the action is **observed** being performed by an other.<sup>29</sup> Rizzolatti and Arbib suggest that these **mirror neurons** represent in an observer the actions of an other.<sup>30</sup> If this is so, then it is possible that as we observe a dance performance particular neurons are firing that represent particular dance actions in us.

Furthermore, Rizzolatti and Arbib report that the mirror neurons have motor properties that are indistinguishable from similar neurons that do not respond to action observation, and which are solely concerned with actions that we do ourselves. Thus, not only does there appear to be a system that **represents** in us the actions of others, but there is a brain-based tendency to **imitate** the gestures of others. Even though there exists a strong spinal cord inhibition that blocks us simply mimicking the actions we see,<sup>31</sup> under experimental conditions an increase in motor evoked potentials has been measured in the muscles of subjects that would be used in the production of an action that they are observing.<sup>32</sup> Thus, as a person observes an action there is a tendency to 'join in', possibly this tendency becoming stronger the more practised the observer is in the movement they are observing — their body and mind have greater sympathy for this movement. This supports the reports by dancers of kinaesthetic sympathy mentioned above. This tendency to join in would also be a useful device to facilitate synchronised group activity, such as dance,<sup>33</sup> and would help to explain why we find it stimulating to observe graceful or 'pleasing' or 'artistic' movements in others — our bodies respond to them, and we, quite literally, feel the artistry.<sup>34</sup>

In dance the language of communication is not words or images, but movement, and we have suggested that mirror neurons are part of a system that contributes to our motivation to participate in and observe dance. However, we have not explained why emotions would be engaged by the activity. To mimic an other, however slightly, implies we are attentive to his or her behaviour. Dance does contain mimicry, but, more importantly, contemporary dance is composed of narratives of movement that convey contours of affect. To take part in a movement narrative, or to appreciate it as an observer, we must respond to the movement we see. If no response is there, no interaction or exchange of emotional meaning can occur. We thus need to be able to abstract a component from a person's movement that contains affective meaning, and, if we are taking active part in the narrative, to respond in a fashion that reflects or acknowledges that affective meaning. This moves a mere mimicking relationship to one of externalising an aspect of

one's inner life while in relationship with an other. An exchange of affect has taken place.

A possible vehicle for this exchange of affect is Stern's theory of **vitality contours** and **affect attunement**, which he uses to explain his observation of cross-modal imitation in mother-infant interactions — a situation where movement, the way the mother touches the infant, the way the infant moves and orientates, is a vital mechanism for affective engagement and interaction. Affect attunement is the multi-modal mechanism by which vocal and body gestures (which express vitality contours) carry meaning in parent/infant communication — it is 'the performance of behaviours that express the quality of feeling of a shared affect state, but without imitating the exact behavioural expression of the inner state'<sup>35</sup> — in other words, without simply mimicking. In affect attunement the affect of a vocal and/or bodily gesture is attuned to by another and then re-expressed in a different form from the original. According to Stern, this largely unconscious 'recasting' of events is necessary to 'shift the focus of attention to the ... quality of feeling that is being shared' — that is, focus is shifted to the vitality contour, expressed through the amodal qualities intensity and timing that are embedded in the gesture. Intensity and timing are two qualities vital to dance. Thus, we propose that as we watch a contemporary dance work, through emotion perception<sup>36</sup> we grasp the narrative that is told through the succession and interaction of the vitality contours contained within the movements. Affect attunement may help to explain why in our observation of body gestures in dance we feel 'moved' — we experience the affect, both bodily and emotionally, that is carried by the vitality contours of the dancers' bodily gestures. We experience the 'patterned flow of feeling' of the vitality contours.<sup>37</sup>

So far we have proposed that mirror neurons are part of a mechanism by which we feel sympathetic kinaesthesia during observation of body movement in others, and that our mechanism of emotion perception while watching this movement is facilitated by an ability to 'read' the affect conveyed via the vitality contours embedded within these movements. What remains to be investigated is our appreciation of the passage of time, of rhythm — a vital component of dance. There is strong evidence to

support the view that humans are inherently rhythmic beings. Wittman and Pöppel reviewing the psychophysical research by Pöppel, postulate 'a general temporal principle of inter-personal communication':

The expressive and the perceptual side [of humans] are both embedded in a temporal framework in which the contents are transmitted. Communication, therefore, can be characterised as an interplay of temporal information segments exchanged between two persons (or a group of people). These information segments are constrained by the temporal integration mechanisms of the brain.<sup>38</sup>

Similarly, but with more far-reaching consequences, Trevarthen proposes that an integrated body-imaging core system (which he calls the Intrinsic Motive Formation — IMF) forms in the brain of a human embryo, and persists throughout life. The existence of a system like the IMF has also been suggested in the neuropsychological literature as a brain-based body schema.<sup>39</sup> Trevarthen proposes that the IMF, as co-ordinator and regulator of human movement, contains a system of generators of neural and body-moving time called the Intrinsic Motive Pulse (IMP).<sup>40</sup> Trevarthen bases existence of the IMP on research into parent/infant communication. Parent/infant communication, as in the arts of dance and music, does not rely on linguistic meaning — instead, communication takes place through the prosody and regularities of the infant-directed speech, the infant's participation in this,<sup>41</sup> and the facial and gestural movements of both parent and infant.<sup>42</sup> Together, these form a multi-modal co-ordinated 'package' of vocalisations and body movements.

The ability for an infant to participate in vocal regularities implies that at a very early age we are able to sense regular time units. That timing abilities and reading of body movement are bound-up with one another is tested by Boone and Cunningham (in review) in their investigation of the relationship between general temporal sensitivity in adults and the ability to decode bodily expressed emotion. Boone and Cunningham conclude that 'emotion perception [of body movements] may be driven by a sensitivity to specific spatio-temporal cues embedded in emotive displays and differences in emotion decoding ability may be a function of a



greater (or lesser) sensitivity to the specific cues that convey discrete categories of emotion.<sup>143</sup>

What are the implications of the theory presented here for understanding our appreciation of contemporary dance? We believe that appreciation of human dance comes out of an ability to mimic and to experience sympathetic kinaesthesia, to 'read' vitality contours, and to sense regularities in passing time (rhythm), all within the very immediate process of emotion perception. Further, we suggest that what we know as dance (and music) are particular cultivated instances of an intrinsic aspect of being human — the ability and desire to communicate and sympathise through time with other humans and with their humanly expressed affect and meaning. This ability relies on self/other perception. But, as suggested by research on mirror neurons (and body schema), this very self/other perception blurs the distinction between self and other. When we watch a sequence of dance, we are, to some extent, dancing the dance as well. Thus, part of the reward of watching a dance is not only to receive communication of affect and meaning from the dancers, but also to experience that affect and meaning as expressed by our own bodies and minds.

### Conclusions

We have proposed that the creation, performance and appreciation of contemporary dance are rich behavioural phenomena from the perspective of cognitive psychology. They are manifestations of complex multi-modal perceptual and cognitive processes and, as such, are useful test-beds for the evaluation of contemporary psychological theory. Notably, the impulses, ideas and images that inspire the creation of dance, the way in which complex spatiotemporal sequences are learned, retained and performed by dance artists, and the communication of affect and thought through dance reveal a range of non-verbal cognitive processes — the moving mind.

The present analysis of composition and development of a single dance work brings to light areas for future investigation and validation. For example, how general are the creative processes and practices reported here? Are insights to be gained from tracking and analysing the movement of a dancer as s/he improvises and refines bodily expression? Surprisingly little research has examined the correlation between intent of the choreographer and perception of movement and meaning inferred by an observer. In future studies, we will ask: when and how often do intent of composer and understanding of observer, coincide? Are metaphors shared and understood by choreographer, dancer and observer? To what extent does an observer's experience with dance affect meaning and understanding? We will also record physiological responses of observers in real-time, and analyse temporal changes in heart rate, breath rate, and muscle tension for evidence of affect attunement and sympathetic kinaesthesia.

Dance phenomena challenge existing cognitive theories that assume only propositional or verbal forms of imagery and knowledge in human creativity and memory. We suggest that the investigation of dance creation, performance and appreciation with a focus only on propositional representation and verbal cues will miss a vital human mechanism that is intrinsic to dance and to other forms of human communication. Finally, we highlight the importance of problem solving as integral to creative thinking in the sequencing and re-sequencing of phrases of movement in contemporary dance. The skill appears to come not only in creation of discrete units or parts of beauty, but in the way those parts connect, intersect, and stand in relation to one another. The local and global structures, patterns and polyrhythms that emerge from the dynamics of movement of an individual part or dancer, and the dynamics of movement of interacting parts and a group of dancers, ensures that the 'whole' in contemporary dance is far greater than simply the sum of its parts.

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