Augmenting Choreography: Insights and Inspiration from Science (draft version)

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By Scott deLahunta, Phil Barnard and Wayne McGregor

Choreography and Cognition was a joint research project initiated by arts researcher Scott deLahunta and choreographer Wayne McGregor that engaged practitioners from the field of cognitive science in seeking connections between creativity, choreography and the scientific study of movement and the mind.[1] This chapter therefore concentrates particularly on issues to do with collaboration between the arts and the sciences, with special reference to this project. In the first sections of this chapter, deLahunta briefly describes how the initial discussions evolved into a six-month research project involving several cognitive scientists and the support of a unique arts and science research fund.[2] Following this is a short discussion about why a choreographer might be interested in cognitive science and vice versa and how this can be the basis for a structured collaboration. Cognitive scientist Phil Barnard then explains some of the background and results of one of the experiments that took place during Choreography and Cognition and makes a proposal for further mutually beneficial research. In the final section, Wayne McGregor responds to questions about his experience of working with cognitive scientists on Choreography and Cognition, which inspired the creation of *AtaXia* (2004), with heart specialists during the making of *Amu* (2005) and tells something about plans for his next collaboration with scientists.

Figure 1: image from AtaXia.

Introduction to Choreography and Cognition

Choreography and Cognition began as a discussion about developing new understandings of the choreographic process that might lead to alternative creative approaches and enhance collaboration processes. The conversation was initiated by Wayne McGregor's keen interest in Artificial Intelligence, the branch of computer science and engineering involved in creating intelligent machines, and the possibility of creating an *autonomous choreographic agent*.[3] We knew that such an ostensibly impossible project would require not only a better grasp on the workings of the mind, the "intelligences" involved in dance making, but would also rely on productive cooperation with scientists.

As a way of tackling both of these areas at the same time, we organised a series of meetings with cognitive and neuroscientists in the United Kingdom and France. We visited them in their labs and gave each other short presentations, asked questions, described, explained; taking the initial steps towards mutual understanding. Although we may have read some papers to prepare ourselves in advance, we knew relatively little about their field of expertise, in particular how they worked on a daily basis. And the scientists, in general, knew almost nothing about the field of contemporary dance; both sides had to construct new frames of reference from scratch.

To give the scientists a point of entry into choreographic practice, we usually began with a verbal description of some improvisation tasks or problems McGregor gives his dancers to solve as a way of generating movement sequences at the beginning of a creative process. The decision not to show video at this stage reduced the amount of information to process together; the descriptions coupled with some physical demonstration were sufficient. We tailored these by selecting examples of tasks involving a degree of complex mental work with specific cognitive requirements, for example visualizing shapes in space. This was enough to stimulate a focussed conversation about how mind, brain and body interact as we had hoped; and this positive outcome provided the inspiration to continue.

We were fortunate to be able to apply to and secure funding from a pilot Arts and Science Research Fellowship scheme in the UK to continue working over a period of six months with selected scientists from the first meetings: Alan Wing and Kris Hollands, SyMoN (sensory motor neuroscience research group), University of Birmingham; Anthony Marcel and Phil Barnard, MRC Cognition and Brain Science Unit, Cambridge; Alan Blackwell of Crucible/ Computer Lab, University of Cambridge; and Rosaleen McCarthy, Department of Experimental Psychology, University of Cambridge where Wayne was hosted as a Research Fellow. In addition, James Leach, a social anthropologist doing fieldwork on arts and science collaborations, took part and made a significant contribution to our understanding of the nature of the exchanges we were participating in.[4]

The following three objectives guided the six-month project:

1. **shared objective**: to seek connections between choreographic processes and the study of movement and the brain/mind that are scientifically and artistically interesting.
2. **artistic objective**: to integrate the participation and contribution from the scientists into the fabric of the choreographic process while maintaining the integrity of the modes of looking and questioning pertaining to their respective research areas.
3. **scientific objective**: to start to formulate specific questions and research methodologies that arise from the individual interests in this project in the context of the creative choreographic process.

In November 2003, the project began with a two-day shared session for all participants in the rehearsal studio in London to watch McGregor and his dancers from Random Dance working with some new scores and tasks for generating movement material. The goal was to elicit

observations from the scientists that could become the basis for further investigation and experimentation. McGregor intended to use these interactions to conduct his own research into creative starting points and processes for his next piece, *AtaXia*. The project had several successful outcomes, not all of which will be covered in this chapter, but can be read about in several articles and the project report available on the Choreography and Cognition documentation website (http://www.choreocog.net). The following sections of this chapter focus on some basic questions about shared interests and the collaboration set-up of the project.

Why might a choreographer be interested in cognitive science?

One does not have to be a cognitive scientist to know that in the past fifty years there have been big advances in our understanding of the brain; bringing with it new descriptions of what it is to think and how things like sensory perception, movement control and memory, as working parts of the mind as a whole, might interact. Research ranges from building intelligent computer models and developing clinical diagnostics to brain imaging and consciousness studies. For any artist interested in learning new things about creativity, cognitive science presents a possible pool of insights for both self-knowledge as well as understanding artistic collaborators, viewers and audiences better.

In an on-line article written on the topic of teaching cognitive science and arts, Cynthia Freeland, University of Houston philosopher writes that cognitive science

> is revolutionizing our understanding of ourselves by providing new accounts of human rationality and consciousness, perceptions, emotions, and desires, with great consequences for our understanding of the creation, interpretation, and appreciation of artworks in all mediums (www.aesthetics-online.org/ideas/freeland.html)

Freeland's three-part paper explores the idea of a course bringing cognitive science into relation with visual arts, film and music theory. The emphasis in her article is on seeking connections between mind/brain research and art theory and less creative practice; but she does tackle some of the difficult problems of inter-disciplinary knowledge exchange.

In neuroscience, a discipline often seen to be part of the cognitive science field, a controversial new line of research has emerged in the last decade known as neuroaesthetics, which attempts to explain some aspects of the perception of art on the basis of scientific study of the brain. Early proponents of this line of research include Semir Zeki (1999) and V. S. Ramachandran (1999).[5] Much of this research is focused on visual arts with more emphasis on historical than on contemporary references, and there is some related research in music.[6] In the field of contemporary dance, independent researcher Ivar Hagendoorn has written articles about choreography drawing on the same fascination with the explanatory strength of cognitive neuroscience; some of his writings explore the possibility that such scientific study can inspire dance.[7] In 2004, Hagendoorn organised a symposium, Dance and the Brain, hosted by the former company of William Forsythe, Ballet Frankfurt. Forsythe's own curiosity about neuroscience stems from an interest in refining his intuition about what people watch in his dances through understanding some of the cognitive mechanisms of attention.[8]

Why might a cognitive scientist be interested in choreography?

As a cognitive scientist, Phil Barnard's aim is to develop useful ways of thinking about the workings of the mind. His research programme is focussed on meaning – not only the kind of meaning that is expressed in language and symbols, but also deeper meanings about the self – living, moving, thinking and feeling in a complicated social world. In his own work at the Cognition and Brain Studies Unit in Cambridge, Barnard first develops models of the healthy

mind, and then considers how things might go wrong in clinical conditions such as major depression, mania, anxiety, anorexia, or schizophrenia. One characteristic of the cognitive psychology community is that different groups of researchers focus on particular mental faculties – such as language, perception, memory, attention, motor skills or emotion. As a modeller interested in clinical conditions, Barnard seeks to understand how these individual mental faculties all work together in a unified mental system.

In these clinical cases mentioned above, it is natural to emphasise dysfunctional thinking about the self, the world and other people and its emotional consequences. However, psychologists know that bodies clearly play an important role and that embodiment and multimodal sensation are an integral part of self-meaning. The difficulty is that in the scientific study of how people think and feel, any efforts to understand how bodies relate to meaning typically involve massive over-simplification. Against this background, choreography provides interesting research opportunities for a scientist like Barnard as indicated by his statements in the following paragraph:

> First, dance is inherently multimodal. In dance performance, thematic elements are packaged as movement, music and staging, all contributing to the viewer's emotional and intellectual experience. Secondly, this package challenges the psychologist's ability to think at the same time about many research topics embedded in a single rich context. Third, the experience of performing or viewing dance appears to provide conditions where, at least to some degree, it is possible to separate out the contribution of abstract senses of self and others from specific thoughts about those senses. Dance is something that can be performed or experienced without a continual flow of explicit verbal thoughts. Yet in domains of making dance, notating it, or discussing it those abstract senses of meanings are translated into verbal thoughts or graphic notations. Thus, dance and choreography provide a unique platform for studying, using both quantitative and qualitative methods how thought and abstract senses of the embodied self-work. (Phil Barnard Presentation, June 2006[9])

Barnard's understanding of what dance had to offer to scientists developed quickly during the course of the project. The other scientists similarly expressed their realisation that dance and choreography involves this exceptional multimodal blend of physical and mental processes. When we set up the Choreography and Cognition project we had hoped that this would be the case, that choreography would be an exciting research challenge for cognitive scientists already accustomed to working in an interdisciplinary mode. However, at the start of the project it was not known at all how this predisposition towards broad interdisciplinary research would work in collaboration with artists.

What might happen in the structure of a collaboration?

Having established points of mutual interest between dance artists and cognitive scientists, we can say a few more words about the setup of the Choreography and Cognition project. We understand that arts and science collaborations will always encounter some generic points of difference. Both domains are involved in processes of investigation and creation, but these processes are markedly different in each field. For example, in order for science to make progress it needs to make a *simple* model of the problems it wishes to investigate; and it is a requirement in science that someone else can come along and set up the same investigation and get the same result. For the artist, an investigation or research period may also involve breaking down a larger problem, but here the process tends to be dominated by internal self-referencing. As long as an artwork is the outcome, this process can be unique; and no one else has to be able to assume the position of the artist, McGregor for example, in order to verify the working procedures. For the Choreography and Cognition shared research project, we assumed and accepted these generic differences. Moreover, we extended this embrace of difference to the concept that any professional specialisation such as cognitive

psychology, would bring to bear a way of observing and describing phenomenon in terms consistent with this specialisation.

Figure 2: studio image from November session.

As Barnard noted earlier, in the domain of making dance, verbal and graphic description is clearly a part of the creation process even though the resulting performance can be experienced (on the part of both performer and audience) without the need for these explicit representations. For the cognitive scientist, these verbal and graphic elements provide clues to the processes of mind involved in dance making. This is another way of explaining why we began our collaborative encounter by focusing on an early stage of the creative process; researching and making movement material that might or might not be used in the final piece. The cognitive scientists were invited to a two-day session at Sadler's Wells Theatre, where Random Dance is company-in-residence, to observe McGregor and his dancers generate new movement material in the mornings and to discuss their observations in the afternoons. During the discussion sessions, which included McGregor and two of the dancers, the scientists were invited to present responses to what they had seen based on their individual areas of research or specialisation.

In these afternoon sessions, the scientists described what they had observed in these creation sessions using their own frames of reference and articulated the themes they individually thought of interest. Not surprisingly this triggered a lively debate amongst the scientists, since they shared these references more immediately amongst each other than with the artists present. However, the shared respect and curiosity that drew us together during the initial meetings over a year earlier now provided a critical foundation for the project's success. This meant that bridges of understanding were continuously being forged between artists and scientists through the mutual generation of what McGregor has described as "conceptual frameworks, discussions, debate, explanation and dialogue that surround the practical events themselves".[10]

As identified earlier, the aim was to elicit observations from the scientists that could become the basis for further investigation and experimentation; and on the second day, they were invited to present a hypothesis, or tentative theory, that they could investigate through subsequent experimental or empirical methods. The ultimate goal was to arrive at some starting points for further research that could be explored from different scientific starting points and that had implications for McGregor's creative research for *AtaXia*. Time had been set aside over the next two months when each scientist could return to the rehearsal studio at Sadler's Wells to work with McGregor and the dancers to pursue these lines of enquiry.

Eventually, each scientist came up with a separate set of questions and a proposal for an experiment to investigate these further. One of these experiments, devised by Barnard and his colleague Tony Marcel from MRC Cognition and Brain Science Unit in Cambridge, was the Viewing and Parsing Exercise described in the following dialogue with Barnard. [11]

The Viewing and Parsing Exercise: a dialogue between Phil Barnard (PB) and Scott deLahunta (SD)

SD: Can you briefly describe your experience of first encountering Wayne and the dancers creating dance material in the rehearsal studio?

PB: The invitation to observe Wayne generating movement material for a future dance piece came with the offer that we could each do some empirical research in collaboration with his dance company. I entered this enterprise with a vaguely formed and naive ambition to study how properties of movement influenced the emotional experience of the viewer. Unsurprisingly, the first thing to fall by the wayside is the predetermined plan. As I watched Wayne work developing his movement material with the dancers, I was quickly perplexed. I knew what was happening in the studio: Wayne briefed, observed and re-instructed the dancers and periodically interacted with his own notebook. But I realised I didn't have a clue what was going on in his mind. The questions in my own head suddenly changed. What on earth was he "seeing" in what the dancers were doing and how was he seeing it? When he saw something, what was he using to support his thought process and creativity? To what extent was there a shared understanding between the choreographer and dancers? How on earth did the exploration of small phrases of movement like these relate to the wider context of creating and staging a piece intended to explore the theme of dysfunction (which was Wayne's starting point for the research for his next work)? Choreographers would no doubt have their own clearly framed ideas about this. As a cognitive scientist, I was entirely in the dark.

SD: Can you briefly describe the experiment you devised to investigate these questions further?

Working with Wayne, you and other colleagues, we set out to develop a simple exploratory method for addressing some of these questions. Wayne and the dancers developed eight short dance sequences of between one half and two minutes in duration, which we videotaped and digitized. Using software that made it possible to watch, stop, start and move forwards or backwards through the sequence we asked the ten dancers and Wayne to analyse each of the eight sequences and identify temporal units of movement in them – a bit like parsing a sentence into words and phrases.

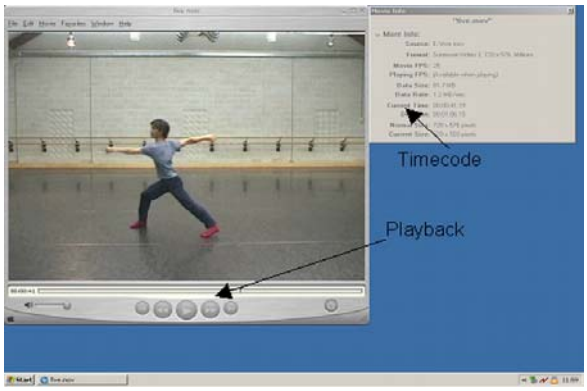

Figure 3 and 4: The Quicktime software used for the viewing and parsing exercise/image of Matthias Sperling watching the sequence

The setup for the study was like this: first each dancer watched each sequence through a few times, and we then asked them to indicate where the particular units they saw began and ended; stopping and starting the video when necessary. We recorded their judgements of where units of movement started and ended as our primary quantitative data; these were read off the panel in the right side of the interface shown here (see Figure 3). Importantly, we left it entirely up to each individual to determine what a unit was – we were very careful not to bias them about what might or might not be a phrase or what properties they should focus on. At the end of the data collection we asked the dancers to discuss their experiences of viewing the movement material in this way.

SD: Did you have any expectations about what the results might be from this viewing and parsing experiment?

PB: One simple principle of cognitive psychology is that we can only "think" about a limited range of things at a time. Movements of the kind the dancers were watching have many attributes, including bodily configurations, energy, use of space, or underlying intention and no one can attend to all at the same time. It would be astonishing if all ten dancers plus Wayne were to focus on exactly the same things: so in the parsing experiment we expected considerable variation. And indeed there was a great deal of variation; but at the same time there was a great deal of overlap.

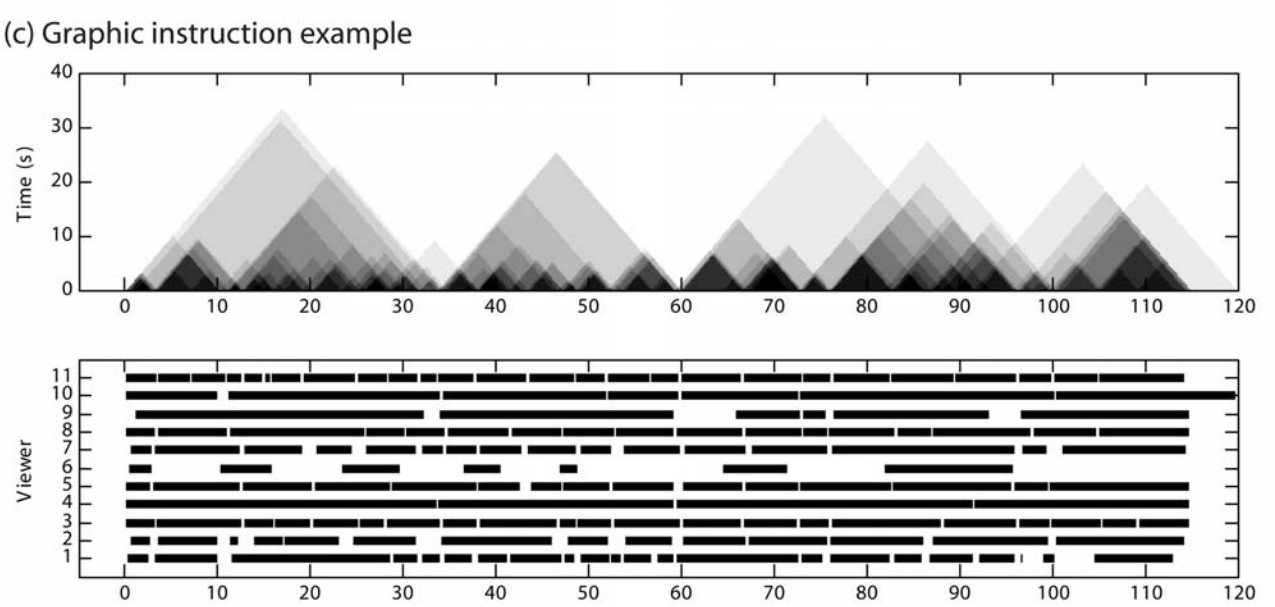

Figure 5: Graphic Instruction example.

Here are two ways we developed for presenting the quantitative data on how one of the movement sequences was divided up into units by Wayne and the dancers. Let us first focus on the lower panel. The eleven horizontal lines show, as expected, that the eleven viewers all segmented the sequence differently and this was a consistent feature across all eight sequences. Notice that the middle line only shows just seven black segments. This is the representation of Wayne's results. Whereas the other dancers all parsed the whole sequence, he, the choreographer, focussed only on selecting the elements he found interesting. The upper panel is a new visualisation invented by our statistician, Ian Nimmo-Smith. He cleverly thought up the idea of placing time on both the vertical and horizontal axes. The mountain range, or pyramid like structure that results uses greyscale to show the extent to which the dancers agreed. Regions where it is completely black index total agreement that adjacent frames were part of a coherent unit. The lightest shade of grey indexes where only one observer saw a coherent unit. What you effectively see here in a

single visualisation is a statistical summary of the variation in phrase structure that we observed. Simultaneously, you can see multiple structures assigned to exactly the same movement sequence.

SD: It is fascinating how this single visualisation captures all eleven viewers simultaneously; like a snapshot of the entire company at once. One thing that is interesting is how the exercise registers what each individual dancer sees in the movement sequence without resorting to verbal description (e.g. asking them to say what they see) and makes it possible to compare and contrast these different registrations. The set up of the viewing experiment itself forces a unique mode of analysis using video, a common tool for dancers. I am tempted to see this representation of movement analysis as a sort of dance notation.

PB: What we have here is not a dance notation. These visualisations simply make explicit abstract properties of the perception of dance as seen by eleven different viewers. It makes it possible to directly see relationships that cannot be captured in simple numbers. In some regions, for example, we see immediately from the branching structure that there are regions where there is agreement on where something starts but greater indeterminacy about its perceived end and vice versa. In this case, the visualisation makes explicit attributes that might otherwise have remained implicit or difficult to articulate verbally in a discussion about the phrase. The pyramids expose contrasts within and between pieces and render them intellectually tangible. From this platform we can think back to the questions we posed initially.[12]

SD: And I think this might have interesting consequences for a student of choreography. The student maker might be encouraged through seeing this visualisation of the parsing exercise not to get lost in the detail (a common problem for inexperienced makers) and to maintain an overview of the range of possible meanings of any one particular moment in a dance phrase. Our representations imply that while viewers are unlikely to agree on particular moments; they do agree quite a lot in more general ways and that these densities of agreement can be featured hierarchically; making it possible to discuss more than one level of "seeing" or noticing and how different levels might happen simultaneously.

PB: As a cognitive scientist I have my own questions about attention and meaning that could be pursued from this point. Of more significance to choreographic processes we might ask: What properties applied in those regions that Wayne considered interesting and how did they differ from those that he did not select? Are dancers seeing units in terms of the same or different properties to the choreographer or even a naive audience? But while it is tempting to speculate about the mechanisms of attention to movement and about what properties the dancers attended to, one area we would like to focus on in the future is how the methods and concepts from cognitive science could potentially be applied to augment dance analysis as well as choreographic construction.

SD: It would be fascinating if setting up an experiment to try and generate valuable scientific results could also be used to augment the choreographic creation process. Can you explain a bit more what you mean by this?

PB: Even from this initial exercise, it became clear that through following our instructions for the parsing exercise the dancers had arrived at interesting insights about the movement they were looking at. Although they had obviously viewed dance material many times on video before, here they were asked to attend to many different features at any one of several “levels” of decomposition. At the same time they had to make decisions about what a unit of movement was for them individually. Additionally, using the software tool for viewing and marking times in the movement sequence rendered their observations explicit through non-verbal means. Here is one observation made during the post-data collection discussions:

> "… as the exercise went on, also *I felt my perspective of how I was looking at the exercise started to change a bit*. I think I started off feeling like a unit to me in the beginning was more of a chain of movement. Then *eventually it became not only just a chain of movement but perhaps looking at the intention of where the movement was coming from*. I guess that came out through the quality of what was happening. So it wasn't just about starting and stopping and starting and stopping. There is another level that comes into it. After a while, after you really watch it again and again and again." (Kham Halsackda)

There were many other similar observations by the dancers such as enhanced perception of movement features where they initially had only an "implicit" feeling or empathising in a new way with the point of view of the choreographer.[13] We cannot be certain what it is was about the parsing exercise that led to such changes in understandings. Perhaps it was the combination of specificity and ambiguity in the instructions combined with the ability to review detail many times over using the software tool that was significant. But these comments made by the dancers about their experience and our speculation about the various choreographic meanings that may be latent in the resulting visualisations suggest to us that students of choreography and their mentors could benefit from sharing intellectual territory with cognitive science.

Developing augmentation techniques: a proposal by Phil Barnard

While interdisciplinary collaborations can focus on reciprocal exchange of concepts and ideas about the significance of movement and dance, there is an inherent danger that the different disciplines will tend to talk *at each other rather than with each other*. In the course of our collaboration, it occurred to us that a useful approach to counter this would be to target future research on developing a range of techniques for augmenting choreographic processes. In this way we might develop the scientific study of choreographic cognition while offering back into the dance community something of immediate value – a possibility suggested by the apparent mutual benefits of the viewing and parsing exercise just described.

The parsing exercise, while productive for us, dealt only with a tiny fraction of the full making process. If we are to develop this as an area of research, we need also to explore how to visualise and summarise longer sequences in a much richer way. In order to work effectively, both choreographers and dancers need to put themselves in a frame of mind that supports analysis, creativity, criticism or just the replication of a performance. Here we already have many clues about potentially productive avenues for future research. Reviewing and analysing dance on video is common practice in the dance community and technological support of various kinds is currently being explored. For example, as I have learned through this project, choreographer William Forsythe among others is exploring the potential of new interactive multimedia tools for visualising and analysing dance.[14]

We all know that photographs provide powerful reminders of past experiences and that trailers for TV shows will sample brief components of the previous episode to remind us where we are in the overall story. There is evidence that video snaps (very short time slices) of the recent past can help patients with severe memory problems to prompt recollections that otherwise would have been inaccessible. Annotated replays of short segments of action are now an integral part of commentaries on sport. Such observations raise the prospect of using dynamic images to reinstate past choreographic experiences and frames of mind in the context of making or discussing dance.[15]

Imagine viewing one of the movement sequences we mentioned earlier or even imagine a short part of a recent live performance you have seen? Then imagine how much you might

be able to recall. To what extent can you reconstruct movements only in your mind's eye or through empathic bodily feelings? One approach we have been exploring to aid movement recollection is through making a temporal montage of video snaps from longer sequences with each snap lasting around one second.

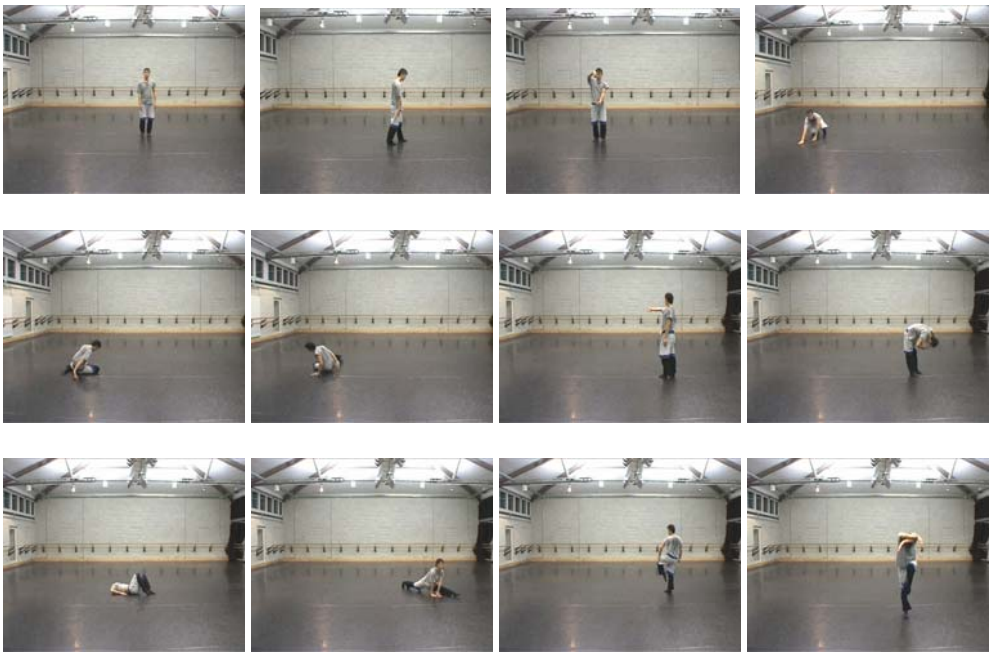

Figure 6: 12 stills from the video of Kham Halsackda a dancer with Random Dance during the Choreography and Cognition project.

Here, in Figure 6, we reproduce a sequence of stills from one of the videos we used in our parsing exercise. Try and imagine how viewing these in sequence, like a series of almost arbitrary jump cuts, might bring certain parts of the movement sequence back to your mind. Unlike a succession of static stills (such as you see here in the Figure here), a short time slice of the video captures something of the dancer's dynamic, and his use of space. In our initial explorations, we simply mechanically sampled a small segment from every ten seconds of the kind short sequences used in our parsing study, the average duration of a perceived unit in that study. We made no attempt to align the cuts with the perceived units that are represented in the graphic visualisation shown earlier (though we could have done this). A sequence of dynamic snapshots is effectively summarising the whole movement sequence. And its mechanical nature could be important partly because it can be easily automated at low expense in terms of time. Something that can be done quickly and rapidly reviewed may in certain cases be more supportive to the creative process of making dances than techniques requiring an army of editors.

This process was never intended to be art. The rapid and disjoint juxtaposition of fragments brings together different yet related elements. It could be significant precisely because it does not allow time for thought about each one as it happens but rather rapidly re-injects or re-instates potentially large amounts of movement material back from the past into the present moment. It is potentially a tool with properties that might be of interest to the choreographer to stimulate recollection and creativity. If we can stimulate by reinstatement certain prior thinking states in the mind of the choreographer, we may be able to provide a very different range of technical resources for augmenting choreographic processes, and ones that are especially tuned to current understanding of how cognition works.

Notebooks full of words, sentences and graphical notations have one set of properties – they require time to inspect and mentally analyse and they omit the physical context from which

they were derived. Perhaps they promote one particular slow mode of propositional thinking. It can even be argued that this mode could inhibit rather than promote creativity. Creativity seems to be linked to an alternative mode of thought in which generic and experiential senses in the mind are more prominent than specific propositions – intuition if you like. With colleagues at the Cognition and Brain Sciences Unit in Cambridge we are already researching how these modes of mind might work in psychopathologies such as the rapid and fragmentary thinking involved in mania or the slow propositional ruminations that accompany depression; and using that understanding to guide the development of new therapeutic interventions. It is potentially very exciting to uncover intellectual common ground between the domain of normal laboratory work and the world of dance. It would be even more exciting if, in the future, we could develop together new and practical ways of augmenting mental processes of value in both domains.

Science/Dance collaborations: a dialogue between Wayne McGregor (WM) and Scott deLahunta (SD)

SD: The process of making both AtaXia and Amu brought you into close working relationship with scientists.[16] Can you say something about this working relationship, this collaboration, in general, e.g. how it started, what sustained it? What were some of your discoveries?

WM: All collaborations, whether they function between artists and other artists or artists and scientists, are demanding. Their success is based not so much on the nature of each individual's specialism or level of expertise but on an ability to communicate well, to share ideas and to listen. This openness of approach and willingness to think outside of the box is vital to true collaborative endeavour where all parties are taken on a journey of mutual exploration. The science/dance collaborations that have been the most productive for me have been those that tread this path of investigation in a dynamic, fluid and ever evolving form. It's very difficult to establish exactly why a particular relationship works and why certain ones do not. The alchemy of collaboration, especially when you are blurring the boundaries of thinking throws up new challenges for everyone. It is how you deal with these challenges that sets the tone for fruitful exchange. I am beginning to understand from my investigation with cognitive psychologist Phil Barnard for example, that what I articulate to be important in my creative process is firstly always done in retrospect, that is, a memory of the process and often, if not always, *not* reflective of the actual creative decision making process. It's a form of theatre in its own right, a construct. We have all acquired formulas to articulate our processes, necessary for funding applications, post performance discussions etc that are not accurate records, traces of the events that take place. This is a fascinating revelation and pushes one to genuinely reflect on one's process utilising a completely different intellectual framework. These encounters have the potential to change thinking and bring us to an altered state; this is what provides the biggest catalyst for creation.

SD: Could you say something about how both scientific processes (experiment/data collection) and science outcomes (descriptions/ explanations) informed your creative process for both works. e.g. I have heard you describe the idea of the prisms/vision disorientation for AtaXia -- so stories like this. What information did you take back into the studio to make the dance/and how did you use it?

WM: The scientific 'experiments' Random undertook during the *AtaXia* process directly fed back into the dance making to generate a new physical language. It's easy to see how and why this was possible. There was a very clear relationship between the aspiration of the research project (Choreography and Cognition) and my interest in undermining the relationship between the body and the brain and quite literally making the behaviour of the body dysfunctional. Experiments were facilitated to disrupt the body's ability to co-ordinate its movements and these scientific choreographic interventions or perturbations actually made extremely able bodied, virtuosic dancers unable to stand up, let alone balance. Through a

series of dual tasks, vision disorientation techniques, motion capture/motor control experiments etc, there was a very practical puzzle for the body and the brain to solve. The *process* of solving the puzzles, the time it took to see the body and brain attempt to come to terms with the difficulty and the ensuing solutions provided the most useful information to capitalize on in the studio. It was the journey of thinking through the unfamiliar that was a greater resource than the actual end results. Because ultimately the brain finds a solution, it maps a framework that now facilitates easily the task – the brain learns fast.

This very practical experimentation is only one of the valuable aspects of a collaborative process with science. As important are the conceptual frameworks, discussions, debate, explanation and dialogue that surround the practical events themselves. This transfer of knowledge(s) permeates the process in many fundamental ways. Choreography is very much about making decisions, and decisions are shaped by immersing oneself in the actual content of the work. This total immersion in the subject of the work allows strategies for making to emerge. It inspires new choreographic form with possibilities drawn from science but applied in dance; and opens up totally new territories of language because the currencies of language we are exposing ourselves to are non arts based. This was keenly seen in the *Amu* process where Random Dance were exposed to biological, medical, mechanical, spiritual 'learning' sessions focussed around building a knowledge system for the heart. This included having our hearts scanned, watching open-heart surgery, understanding flow and dynamics of the heart, meditation techniques etc. Each new session built a more dynamic, richer imagination for the heart and resonated very individually with each artist. This approach of immersion fuelled improvisations and physical investigations that drew directly upon our collective experience of learning about the functions of the heart and our individual experiences of building an empathy with our own heart. That is, science making visible the unknown, art using that discovery and translating it into something equally meaningful, but in a very different language. Sensibilities converge...

SD: Where would you say the evidence of these projects (these working relationships) shows up in both the choreography (the art) and the science? For the choreography this should be partly answered by your response to question 2, but if you have other thoughts about its value for choreography/art you could add that here; and can you say something about what you think the scientists get out of the relationship?

WM: I think what is vital in genuine collaboration between art and science is the notion that neither is in the service of the other. Science cannot be used to merely serve the artist in the same way that artists cannot merely provide data for the scientist. These may be outcomes or aspects of the collaboration, but they are not or should not be the point of departure. Therefore, in all of the collaborative processes with the scientists I have undertaken I have not prioritised the making of a new work. New work has resulted from these dynamic exchanges but new work has not been the focus. The focus has been a series of questions, propositions, ideas to be thrown between us, tested, examined and explored. Some questions lead to actual experiments, some remain in the world of the abstract and are no less important. In the same way, some of the scientists we have worked with have published journal articles and given papers on work we have undertaken because during the evolution of our interchange particular points of interest converge with their science. Again these have emerged and have not been a condition of collaboration. The outcomes of the science/dance collaborations have been varied and remain alive. The questions for all of us live on.

SD: You are about to embark on another period of research with scientists that will inform the creation of the new work ENTITY. Would you describe this is an evolutionary step: in other words is this next phase a development out of the previous two dance/science projects (or maybe not)?

The intention to develop ENTITY, an autonomous choreographic agent, has been with me for some time. Both *AtaXia* and *Amu* have gone some way to provide a framework for this research in that *Ataxia* very much looked at the direct connection between the body and the brain and discovered what happened when this connection was interfered with. The whole project was very much driven from the perspective of the brain being the central organism that controls everything the body does and experiences. *Amu* looked more at the biological functions of the body through the filter of the heart and attempted to explore a connection between the heart and brain, ultimately exposing the generation of emotion. Both of these projects have used kinaesthetic intelligence as a starting point for exploration. The human body, connected to itself and its environment, a complex, complicated, virtuosic, thinking, memory-laden entity provides an unrivalled window into human experience. And dance - the most complete amalgam of all of the technologies of the body and brain - is a rich subject for never ending research.

With this physical thinking in mind the aspiration of building a new form of body, this ENTITY that has embedded inside it kinaesthetic intelligence has come to fruition. We do not want to build a body that replicates human physical behaviour. On the contrary we want to build a body that can do the unexpected; after all, it will not have the restrictions of a 'real' body. Its decision making processes and learning although based on human kinaesthetic intelligence should surpass human capabilities with an embodied imagination of its own. ENTITY should be able to interact with us in the studio but provide us with encounters with the alien, the unfamiliar, an uncertain artistic future that destabilises our formulas of making and disrupts our aesthetic sensibilities. ENTITY generates challenge.

Unfamiliar Thinking Territories: a brief glance back by Scott deLahunta

In the Introduction to this chapter, we wrote that the Choreography and Cognition project began as a discussion about developing new understandings of the choreographic process that might lead to alternative creative approaches and enhance collaboration processes. Wayne and I started this conversation in 2001 when we collaborated on the Software for Dancers project: a research into new concepts for digital creative tools for choreographers.[17] Now, we are preparing for a ten week research period at the University of California San Diego (UCSD) where Wayne has been invited to be Innovator-in-Residence with the intention to conduct initial research on the ENTITY project. As with the other collaboration projects, the idea of the 'autonomous choreographic agent' is intended to be both a stimulus for shared dance and science research and creative impetus for a new artwork.

As Wayne says in the last Section, the urge to create this agent (or collection of agents) that can generate unique solutions to choreographic problems alongside his own decision-making processes, has been with him for some time. It has taken several years, however, to gain enough collective experience and understanding to be able to approach the idea productively. Working together again in the late summer of 2006 on a site visit to UCSD, the three of us (Wayne, Phil and myself) were able to draw on our past experience to make concrete suggestions for the upcoming residency. The basic proposal is to continue probing the interconnection of mental, emotional and physical processes involved in dance creation; and Wayne has outlined a three-stage development that emphasizes building conceptual frameworks through dialogue and practical investigation through various experimental formats. With the coordinators at UCSD, we have identified a handful of key research areas and laboratories there, which can bring interesting perspectives to bear on the ENTITY project, e.g. memory, attention, distributed cognition, creativity, reasoning decision-making, protocol analysis in rich task environments, design rationale and cognitive design tools.

In the past, support for arts and science collaboration has often fore grounded an increased public understanding of science as one of its key objectives; but as more collaborations have been undertaken and more open-ended funding opportunities appear it has become possible

to imagine and pursue joint research under other terms.[18] This means to explore the possibility of doing collaborative research that, as Phil Barnard has written, uncovers intellectual common ground and leads to valuable outcomes in both domains. Interdisciplinary collaborations between artists and cognitive sciences in particular in which differences are understand and exploited in shared description, research and creation processes stand a chance of making unforeseen discoveries and giving rise to new insights as has been the case with our collaboration. Ultimately, this requires all involved to go beyond and blur the clearly defined and relatively safe objectives outlined at the start of the Choreography and Cognition project. To follow, as Wayne has written, the creative need to journey into unfamiliar thinking territory. This compels us, at least momentarily, to step away from the shelter of institutionalized categories. As Anthony Marcel, a close colleague of Phil and one of the collaborators on the project who was prepared for this unfamiliar journey from the start, wrote in a letter to Wayne: "... what you and the dancers are doing IS science. It's just another way of doing it."[19]

This chapter is adapted from presentations at the *Underskin Symposium,* La Biennale di Venezia Dance sector, Venice on 9th June 206.

Notes:

[1] For full documentation of the project see http://www.choreocog.net (date accessed 28.11.06)
[2] The pilot Arts and science Research Fellowships scheme was jointly funded by the Arts Council England and the Arts and Humanities Research Board (now Council) of the UK.
[3] For more explanation of the autonomous choreographic entity see the section in this chapter: Science/Dance collaborations: a dialogue between Wayne McGregor and Scott deLahunta
[4] Leach, James. "Extending Contexts, Making Possibilities: An Introduction to Evaluating the Projects". in the: "Special Section: Arts and Science Research Fellowships -- Arts Council England and Arts and Humanities Research Board" in: Leonardo. Vol. 39, No. 5. 2006. pp. 447-451.
[5] Ramachandran, V.S. (Contributor). Art and the Brain: Controversies in Science and the Humanities. Journal of Consciousness Studies. Imprint Academic: October 1999; Zeki, Semir. Inner Vision: an Exploration of Art and the Brain, by Semir Zeki, Oxford University Press, 1999.
[6] For a bibliography related to neuroesthetics see http://brainethics.wordpress.com/2006/09/27/a-short-bibliographic-guide-to-the-emerging-field-of-bioaesthetics/ (date accessed 28.11.06).
[7] An international symposium organized by Ivar Hagendoorn and hosted by the Ballett Frankfurt with financial support by the Dana Foundation. January 2004. Speakers: Marc Jeannerod, Julie Grèzes, Andrea Heberlein, Tania Singer, Petr Janata. Introduction and closing remarks Ivar Hagendoorn. For more information and related papers see: http://www.ivarhagendoorn.com/ (date accessed 28.11.06).
[8] Author's personal communication with William Forsythe, April 2006
[9] Barnard and deLahunta presentation. *Underskin Symposium*, La Biennale di Venezia Dance sector, Venice on 9th June 2006.
[10] Refer to the section in this chapter: Science/Dance collaborations: a dialogue between Wayne McGregor and Scott deLahunta
[11] More detail can be found on the Choreography and Cognition website http://www.choreocog.net (date accessed 28.11.06).
[12] See for more detailed discussion: Scott deLahunta & Philip Barnard, "What's in a Phrase?", in: Tanz im Kopf / Dance and Cognition, ed., Johannes Birringer & Josephine Fenger, Jahrbuch der Gesellschaft für Tanzforschung 15, Münster: LIT Verlag, 2005, pp. 253-66; Scott deLahunta and Phil Barnard. "Densities of Agreement" (co-authored with Ian Nimmo-Smith, Jennifer Potts and Cristina Ramponi). to be published in: Dance Theatre Journal. 21:3. (autumn 2005).
[13] Halsackda comment / reference: Scott deLahunta & Philip Barnard, "What's in a Phrase?", in: Tanz im Kopf / Dance and Cognition, ed., Johannes Birringer & Josephine Fenger, Jahrbuch der Gesellschaft für Tanzforschung 15, Münster: LIT Verlag, 2005, pp. 253-266.
[14] Forsythe, William. Improvisation Technologies: A Tool for the Analytical Dance Eye (CD-ROM). Ostfildern, DE: Hatje Cantz Verlag, June 2000.
[15] Berry, E.L., Kapur, N., Williams, N., Hodges, S., Watson, P., Smyth, G., Srinivasan, J., Smith, R., Wilson, B. & Wood, R. The use of a wearable camera, SenseCam, to aid autobiographical memory in a patient with limbic encephalitis: A preliminary report. Neuropsychological Rehabilitation. IN PRESS.
[16] For information about AMU and the collaborative research with heart specialists see http://www.oftheheart.org (date accessed 28.11.06)
[17] See the Software for Dancers project http://www.sdela.dds.nl/sfd/ (date accessed 28.11.06).
[18] In Australia, another extensive research project involving cognitive scientists and dancers took place. More information can be found on line: http://www.ausdance.org.au/unspoken/ (date accessed 28.11.06); Grove, R., Stevens, C., & McKechnie. S. (Eds.). *Thinking in four dimensions: Creativity and cognition in contemporary dance*. Carlton: Melbourne University Press. 2005. See the e-book at http://www.mup.unimelb.edu.au/ebooks/0-522-85144-4/index.html. (date accessed 28.11.06)
[19] Tony Marcel letter to Wayne McGregor, November 2003.