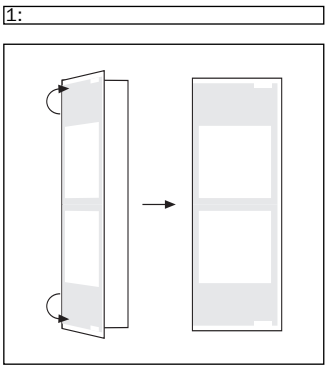

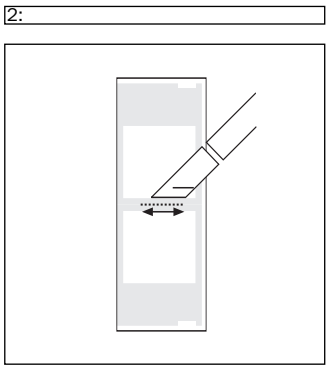

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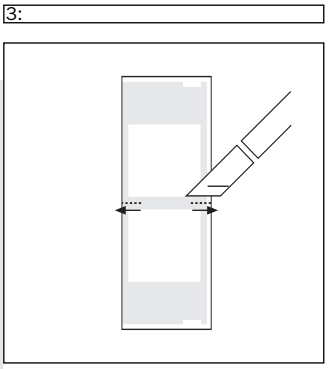

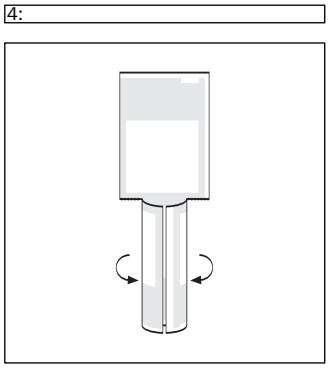

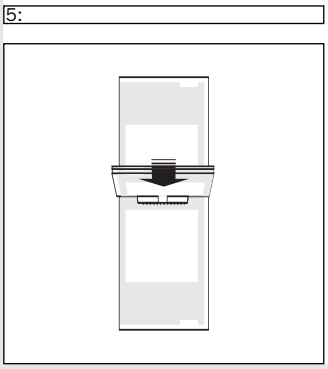

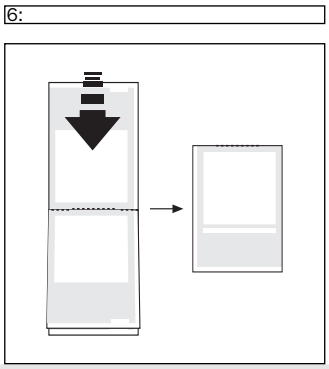

1: First, fold each sheet in half along the vertical axis.

2: Using a craft knife or scalpel, cut a horizontal slot along the centre dotted line of the first sheet. (pages 1/2/13/14)

3: Then cut along the dotted lines on all the other sheets. Make sure to cut to the very edges of the paper.

4: Stack the folded sheets in ascending order with the even numbers at the top. Curl the bottom half of the second page (pages 3/4/23/24).

5: Thread the curled page through the centre slot of the first page. Repeat this process with the third (pages 5/6/21/22), fourth (pages 7/8/19/20), fifth (pages 9/10/17/18) and sixth sheet (pages 11/12/15/16) with the even pages in ascending order.

6: When all the pages have been threaded through, check the pagination. Finally, fold the booklets in half along the horizontal axis.

DIFFUSION *Species of Spaces*

SEPARATE SPACES

SOME COGNITIVE DIMENSIONS OF MOVEMENT

SCOTT DELAHUNTA

COGNITVE MAPPING

Cognitive science is usually described as an interdisciplinary study of the mind or intelligence drawing together a set of key fields such as computer science, philosophy, neuroscience, linguistics and psychology. One of the projects of cognitive science has been to research and develop new understandings and descriptions of the organisation and processing of information in the biological correlate of the mind, the brain.

In the early 19th century, phrenologists developed the first theories relating areas of the brain to some of the basics of cognition. **(1)** Developed without a scientific method, these early theories were exposed as fundamentally incorrect, but the phrenologists still have a place in the history of mapping the brain/ mind. This continues today with non-invasive brain imaging techniques that began with the invention of the PET (positron emission topography) in the mid 1970s. **(2)** While these techniques are still in the early stages of development and give rise to more questions than answers, the resultant images with colours and graphics depicting corresponding local activity areas continue the tradition of the phrenologists in developing theories of brain/ mind space.

THE EXPERIMENTS

By the end of the final afternoon, we arrived at three main lines of enquiry that had implications for McGregor's creative process and could at the same time be explored from different scientific starting points, i.e. cognitive, neurological, psychophysical and biomechanical: **[1] PERTURBATIONS – THE INTRODUCTION OF DISRUPTIONS AND SELECTIVE INTERFERENCE TO DANCED MOVEMENT AS A CREATIVE STRATEGY; [2] PARSING – THE PERCEPTION OF SEGMENTATION OF DANCE SEQUENCES; AND [3] REPRESENTATION – THE EXAMINATION OF CHOREOGRAPHIC DESIGN PROCESSES INVOLVING EXTERNAL REPRESENTATIONS (NOTATIONS) AND ASSOCIATED BEHAVIOURS.**

Before the scheduled research studio time in December and January, these three themes were revised and expanded upon. Alan Blackwell, following the third line of enquiry, Representation, collected notebooks and scores from McGregor and four of the dancers and used interview techniques and analytic methods drawn from his research into the cognitive dimensions of notation systems to discover where they might experience the limitations of these as design tools. The aim of this project is to see how McGregor might improve on the use of notations in the context of his creative process.

Marcel and Barnard took the Parsing line and began with the premise that larger sequences of movement are constructed from smaller units; which makes it possible in the creative process to pull sequences apart so that components can be recombined. What would these units of movement be and how would they be selected or perceived? Would perceived units differ for different kinds of viewers, e.g. dancer, choreographer or audience? Would perceived units differ for sequences of movement generated under different instructions, for example lower level instructions (passing through points in space) versus higher level instructions (verbal/ emotional)? In order to obtain reliable experimental measurements to relate to these questions, they asked McGregor to give the dancers two different types of exercises to generate very short movement phrases. These phrases were videotaped and from these recordings a total of eight were selected for viewing and 'unitising' by McGregor and the ten dancers. They recorded their individual responses (lengths and numbers of units) on data collection forms, which have since undergone a preliminary analysis. Based on what the dancers each perceive to be single units, some of the initial results give interesting indications about how perceptions can be compared in relation to different types of instructions for generating movement material as well as giving a comparative picture across the entire company. While it was noted that the experiment forced an analytical viewing stance and did so in relation to limited scope movement sequences, interesting questions about what is and isn't noticeable emerged from looking at the

CHOREOGRAPHY AND COGNITION [INTRODUCTION]:

A few years ago London-based choreographer Wayne McGregor (artistic director of Random Dance) and I began a discussion about finding new ways of understanding the choreographic process that might lead to alternative creative approaches to making dances. Starting from a mutual interest in artificial intelligence and neural nets, this conversation eventually led us to develop a project for exploring potential insights that might emerge from the interdisciplinary research context of cognitive science.

For a first phase, we organised a series of meetings in November 2002 with individuals working in the field of cognitive science in the United Kingdom and France, and positive reactions to these inspired us to continue with another set of exchanges. We were able to secure funds from a new arts and science research scheme that enabled us to continue working with five of the individuals from our November 2002 meetings: Alan Wing, SyMoN (sensory motor neuroscience research group), University of Birmingham; Rosaleen McCarthy, Department of Experimental Psychology, University of Cambridge, UK; Anthony Marcel and Phil Barnard, MRC

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10. Whereas the first morning McGregor had given a task that related to points in space around the body, on the second morning the task involved instructions more explicitly emotional and narrative in connotation and reference.

11. For information about the work of Wayne McGregor see the Random Dance website: http://www.randomdance.org. Other forms of project documentation and analysis will be disseminated via a website http://www.choreocog.net, and a further application for funding to continue the project via a network has been submitted to the EPSRC (Engineering and Physical Sciences Research Council) in the UK.

12. Phrasing of this sentence taken from the EPSRC proposal mentioned above in reference #11 drafted by Alan Wing and Kristen Hollands.

13. Stevens, K., S. McKechnie, S. Malloch, & A. Petocz. Choreographic Cognition: Composing Time and Space. Proceedings of the 6th International Conference on Music Perception & Cognition. 2000. http://www.ausdance.org.au/unspoken/research/cognition.html

(with thanks to Susan Rethorst for editing assistance)
Photo Credits: James Leach and Scott deLahunta

Some cognitive scientists don't refer directly to images of the brain, but chart out the dynamic systems of thought through references to abstract spaces and processes that are no less real. The concept of 'mental spaces' is attributed to Gilles Fauconnier, Professor in the Department of Cognitive Science, University of California San Diego, who writes in an unpublished article summarising the work he began in the mid 1970s, "Mental spaces are very partial assemblies constructed as we think and talk, for purposes of local understanding and action." These spaces are dynamic territories that unfold during conversation, their creation guided by language in a process where "thought and discourse... are connected to each other by various kinds of mappings". (3)

Another scientist, Margaret Boden, Professor of Cognitive Science, Sussex University uses the term 'conceptual spaces', in her book *The Creative Mind*, first published in 1990. Referring to maps of the mind as "generative systems that guide thought and action", Boden describes these spaces as ones that can change themselves, and cites several examples of new conceptual space being created by both artists and scientists using different exploration processes. (4)

This brief introduction of various approaches to the idea of cognitive mapping provides a frame for the remainder of this article in which I will describe aspects of the *Choreography and Cognition* project; a project that combined the exploration of mental spaces in the context of creating movement in physical ones.

Species of Spaces

SEPARATE SPACES
SOME COGNITIVE DIMENSIONS OF MOVEMENT
Scott deLahunta

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Design: Studio Tonne

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This publication is one of a series of essays commissioned by Proboscis for the series Species of Spaces – inspired by and in homage to George Perec's eponymous book. The series contemplates how we occupy space in the contemporary world of the twenty-first century – the virtual and physical, emotional and social – what Perec called the "infra-ordinary". Species of Spaces questions the trajectory of contemporary urban existence, intervening in current debates on how the virtual and the physical relate to each other, and how technological advances affect cultural and social structures.

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Cognition and Brain Science Unit, Cambridge; and Alan Blackwell of Crucible/ Computer Lab, University of Cambridge. In addition, we invited James Leach, a social anthropologist doing fieldwork on arts and science collaborations, to participate. **(5)**

This Phase Two of the *Choreography and Cognition* project was scheduled into a six-month period from September 2003 to the end of February 2004. **(6)** We began with a two day shared session for all participants over a weekend in November 2003 in the rehearsal studio in London. Our daily schedule consisted of observing McGregor and his dancers work with some new exercises to generate movement material in the morning and holding discussion sessions in the afternoon. During these discussions, the scientists were invited to present responses to what they had seen based on their individual areas of research. We had set aside two weeks in December and one week at the end of January 2004 when they could return to the studio to continue whatever line of questioning might have emerged for them. Our goal for the end of the two days was to define some starting points for the research to take place during these return visits.

PROBLEM SOLVING:

During the mornings of this shared session, McGregor generated movement material by giving tasks or problems to the dancers to accomplish or solve through the creation of short sequences of movement material. These exercises were invented by him and usually communicated to the dancers through some form of description and instruction involving both language and images (graphic or pictorial) either from outside sources or as drawings made during the generation session. After these instructions, the dancers were given a period of time to come up with their sequence of movement. Generally developed individually, these short sequences, no more than a minute or two long, may be kept, discarded or parsed into smaller units for future recombination. This resulting pool of movement material begins to constitute, in McGregor's terminology, the 'vocabulary' for a new choreography.

Inviting the scientists to observe these morning sessions and then present responses based on their individual areas of research in the afternoon was to make room for differences in perception, terminology and understanding to emerge not only between the 'scientists' and

REFERENCES/ NOTES [ALL URLS ACCESSED 06/05/04]:

1. Gazzaniga, Michael S., Richard Ivry, George Mangun. Cognitive Neuroscience: the Biology of the Mind, 2nd Ed. New York: W.W. Norton & Co. 2002. pp. 2-3.

2. Raichle, Marcus E. Brain Imaging. In: Conversations in the Cognitive Neurosciences. Ed. M. S. Gazzaniga. Cambridge, MA: MIT Press. 1997. p. 16.

3. Fauconnier, Gilles. Mental Spaces (on line article summarizing and reproducing parts of earlier work: 1985, 1997, 2002). pp. 1-2. URL: http://cogsci.ucsd.edu/—faucon/151/mental%20spaces.pdf

4. Boden, Margaret. The Creative Mind: Myths and Mechanisms 2nd Ed. London: Routledge. 2004. p. 59.

5. The pilot Arts and Science Research Fellowships scheme was jointly funded by the Arts Council England and the Arts and Humanities Research Board.

6. In preparation for Phase Two, we developed three objectives intended to establish the conditions out of which specific lines of enquiry or starting points could emerge: (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.

7. Some of the scientists have websites with quite a bit of material about their research areas: Phil Barnard http://www.mrc-cbu.cam.ac.uk/personal/phil.barnard/;
Alan Wing http://www.bham.ac.uk/symon/people/alan.htm;
Alan Blackwell http://www.cl.cam.ac.uk/users/afb21/.

8. The ten core dancers of Random Dance Claire Cunningham, Laila Diallo, Fred Gehrig, Khamlane Halsackda, Odette Hughes, Léo Lerus, Ngoc Anh Nguyen, Matthias Sperling, Hilary Stainsby and Amanda Weaver were all involved to varying degrees in the project.

9. Berthoz, Alain. The Brain's Sense of Movement. Cambridge, MA: Harvard University Press. 2000. p. 21. & Clark, Andy. Mindware: an Introduction to the Philosophy of Cognitive Science. Oxford: Oxford University Press. 2001. p. 162.

Anthony Marcel takes an integrative approach to the study of aspects of consciousness. **(7)**

The problem solving in the morning gave way to a different form of problem solving in the afternoon, the difference partly marked by the shift from a space in which movement was valued as a means of exchange to one in which the conversation was of primary importance. Used to describe, instruct, explain, narrate and interrogate language was essential in both contexts. However, whereas the problems posed in the morning sessions gave rise to what could be referred to as choreographic solutions expressed in physical space; the primary problem to be solved in the afternoon was to figure out what was going on in the mind of the choreographer and the dancers. This initiated the exploration of their mental spaces; a process that would be fine- tuned and further developed throughout the project.

sions of the sort Wing's and Holland's work suggests. Or to imagine the shared cognitive space of the dancers as implied by the Parsing project with its comparative framing of a collective perception. And what might happen if the dancers and choreographer had a better understanding of each other's cognitive 'toolkit'; or if our uses of notations could be enhanced through an enhanced awareness of connections between internal and external representations? Physical and mental spaces are still separate spaces and there is no danger of one collapsing into the other. However, our understanding of the complex interrelations between them is evolving well beyond forms of dualism, and this seems the ideal project to involve joint research by choreographers and cognitive scientists..

the 'artists', but equally importantly between the five of them as individual researchers. While referring to themselves generally as psychologists each differs from the other along the lines of their specific focuses within the domain of psychology. These differences are in some cases quite radical: Alan Blackwell with qualifications in professional engineering and experimental psychology studies the cognitive dimensions of design and notation systems; Alan Wing's research is focused on sensory motor function in reactive and predictive control of movement; Phil Barnard has been developing a theory called Interacting Cognitive Subsystems towards understanding "how the different components of the mental mechanism are configured… and the overall dynamics of their interactions in real time"; Roz McCarthy has a background in the use of neuropsychological and neuropsychiatric methods for the investigation of cognitive representations in memory, space and perception; and

THE DANCER'S MIND:

The afternoons were organised for each scientist to chair the discussion for twenty minutes to describe in their own terms what they had observed in the movement generation sessions and to freely query and seek clarification from each other, McGregor and the dancers. **(8)** Alan Blackwell, drawing upon his research in design and notation systems, began with how he viewed McGregor's use of sketches and charts during the morning movement generation sessions. Blackwell made a distinction between the "inside" of the choreographer's head and the space of the page used as a device to assist the creative process. The implication that the space of page could be used to help free up space in the head introduced the notion of internal and external representations. The word representation is used widely in the context of cognitive science partly to describe the interplay between mental and external spaces. There is, however, much debate about the nature of these internal representations, e.g. that the implication of a visual image in the brain conceals "subtle forms of dualism" (the belief that mind is separate from the physical world). **(9)** This is a debate we did not take up directly in our own discussions, although it was clearly implicit throughout the project.

Questions and responses from the group arising from Blackwell's initial proposal helped to clarify McGregor's perspective and his intentions in relation to the creative process and collaboration with the dancers; as well how this view resonated with the research of others. Phil Barnard commented that he had difficulty knowing how to approach understanding the generative procedures he had seen in the morning because for him it was clear that far more of the design process was going on in the mental spaces of the choreographer and dancers than could be represented in notations on the page. Eventually, Barnard and Anthony Marcel would work together to devise research approaches to systematically obtain more information from the dancers and McGregor about the cognitive dimensions of their creative process (see the Parsing experiment described below).

The conversation continued with each scientist taking a turn to present his or her responses to the morning sessions. While the topic of what was going on in the mind of McGregor and the dancers was a prevailing one, it was not the only focus of the wide-ranging discussion. Marcel and Barnard both posed questions related to the larger social cultural context within which McGregor's choreographic works might be viewed and interpreted. Marcel brought up the concept of "immersion and non-observational awareness of one's actions" in reference to the dancers' experience of performing. Alan Wing, whose research into sensory motor function and control makes use of highly specialised motion tracking systems, commented that he makes a distinction between the move-

CONCLUSION[S]:

Most of the information or data gathered by the five scientists is still in the process of being analysed. To observe and design experiments is only a part of the scientific process; the analysis and interpretation of the results takes up a much larger proportion of time in relation to its collection. This is perhaps the most significant difference in the research practices and procedures of choreographer and cognitive scientist. McGregor is premiering a new choreography in London in June 2004 that has been influenced creatively by these shared exchanges; it will be months before final results are available from Alan Wing's project for example. However, Phase Two of the *Choreography and Cognition* project has come to a close and the consensus is that all three objectives have been met (see reference #6). The project has demonstrated that connections can be discovered and sustained between choreographic processes and the study of movement and the brain/ mind that are both scientifically and artistically interesting. **(11)** Valuable and productive connections emerged from the intersection between the different perspectives, vocabularies and understandings we have shared during this project, and these connections

can greatly inform creative thinking in a range of practices if the opportunities for such exchanges continue.

Dance and dance making involves a unique blend of physical and mental processes; multiple interacting dimensions of mind, brain and body spanning sensation, perception, cognition, emotion and movement control. **(12)** The powerful story of cognitive science as a field is that no single discipline or domain can come up with the complete picture of how all of these processes interact. It is only through radical and shared interdisciplinary research that we can gain knowledge of these interactions and continue to advance our understanding of our own understanding. This also points towards the fundamental conundrum of the cognitive sciences: how to merge understandings of mental and physical spaces in which our descriptions of these spaces are a product of the spaces themselves. The *Choreography and Cognition* project while solving many problems along the way has not attempted to come up with a solution to this one, but we have considered the minds of the dancer in relation to choreographic practice in ways that have been conditional and flowing through a range of physical, mental and conceptual spaces.

Preferring at this stage an open-ended and perhaps deferred knowing, our project hasn't tried to construct a theory of choreographic cognition as has been attempted by a similar project based in Australia **(13)**. The choreographic mind we have been considering would resist such explanations at this stage. It may be more appropriate to refer to choreography as physics having cognitive dimen-

Roz McCarthy was interested in those aspects of the first person cognitive experience she could reveal through a careful disruption of selected perceptual processes, and she proposed that this exploration of the cognitive 'toolkit' of the choreographer and dancer might lead to a better understanding of the communication between them during the choreographic process. She posed the following questions to frame her approach: how does the choreographer stimulate the dancers' creativity along the desired lines? How do they understand what he says? Is creativity assisted or hindered by any tensions in communication? Drawing on her expertise in neuropsychological methods for the investigation of cognitive representations, she set up some simple dual task experiments with the dancers using imagined movement as a means of approaching these questions. Dual task experiments assume that if one does two things at once there is a general loss of efficiency in cognitive terms and a specific loss if there is an overlap in the tools required. By asking the dancers to imagine a short known movement sequence and timing them without any interference, and then asking them to imagine the same phrase while performing various tasks, e.g. haptic/ spatial, verbal/ spatial, static visual, etc. she began to gather information that may be useful to McGregor in communicating movement generating exercises differently to his dancers; i.e. what sort of instruction/ stimuli he might choose to give and in what order, etc.

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ment that one perceives or is aware of (the percept) and movement in terms of forces, positions and timing (physics). His response to the morning sessions focused on the relation between unconscious and conscious movement control and implications for variability in relation to the creative process. Wing's descriptions of how he was thinking of the things he had seen in the morning session provoked Marcel to comment that the physics he was referring to are the "foundational aspects of mind" too often ignored by psychology.

Roz McCarthy returned to the concepts of internal representation and wondered what kinds of prior information were the dancers and McGregor bringing to the process of generating movement vocabulary. She asked how McGregor's problem solving exercises were informed by the imagined aesthetic output to which he responded that at this early stage in the creative process he tries just to stick to the task. Eventually, this line of questioning would lead to her designing some simple experiments to explore the mental space of the dancers and its underlying representations.

These conversations continued the afternoon of the second day after another session observing McGregor and his dancers work with a very different set of exercises to generate movement material. **(10)** As mentioned earlier, three weeks in the rehearsal studio had been reserved for the scientists to return, and our goal for the end of this shared session was to define some starting points for the research that would take place during these return visits. The final afternoon discussion began

with McGregor responding to what he had found of interest in the observations and work of the scientists. For example, how neuroscience research might help him invent movement generation exercises that would disturb normal patterns of perception and motion control.

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results, and this could be something that might contribute to the collective making process.

Alan Wing and his Research Assistant Kristen Hollands took as their starting point a broad set of questions such as: what 'frames of reference' are dance movements controlled in? Are the movements guided in space with respect to features of the room or with reference to the midline of the body? What are the crucial sensory systems for describing these frames of reference? How might selected disruptions or perturbations help to test this? In order to investigate these questions, four dancers learned and performed a movement sequence passing through three arbitrarily selected spatial reference points around the body. They were recorded performing these sequences using an optical motion capture system that records the timing and position of movement in a three dimensional space at a very high degree of resolution. Various disruptions or perturbations were introduced, e.g. performing with eyes closed and different parts of the body, at different speeds, in reverse and with mirrored and rotated reference points, etc. The collected data has undergone a preliminary analysis that points towards some possible benefits ranging from: an increase in the scientific understanding of how movement is planned and executed; to offering an improved or enhanced understanding of how to encourage artistic variability of movement and expand movement vocabularies.