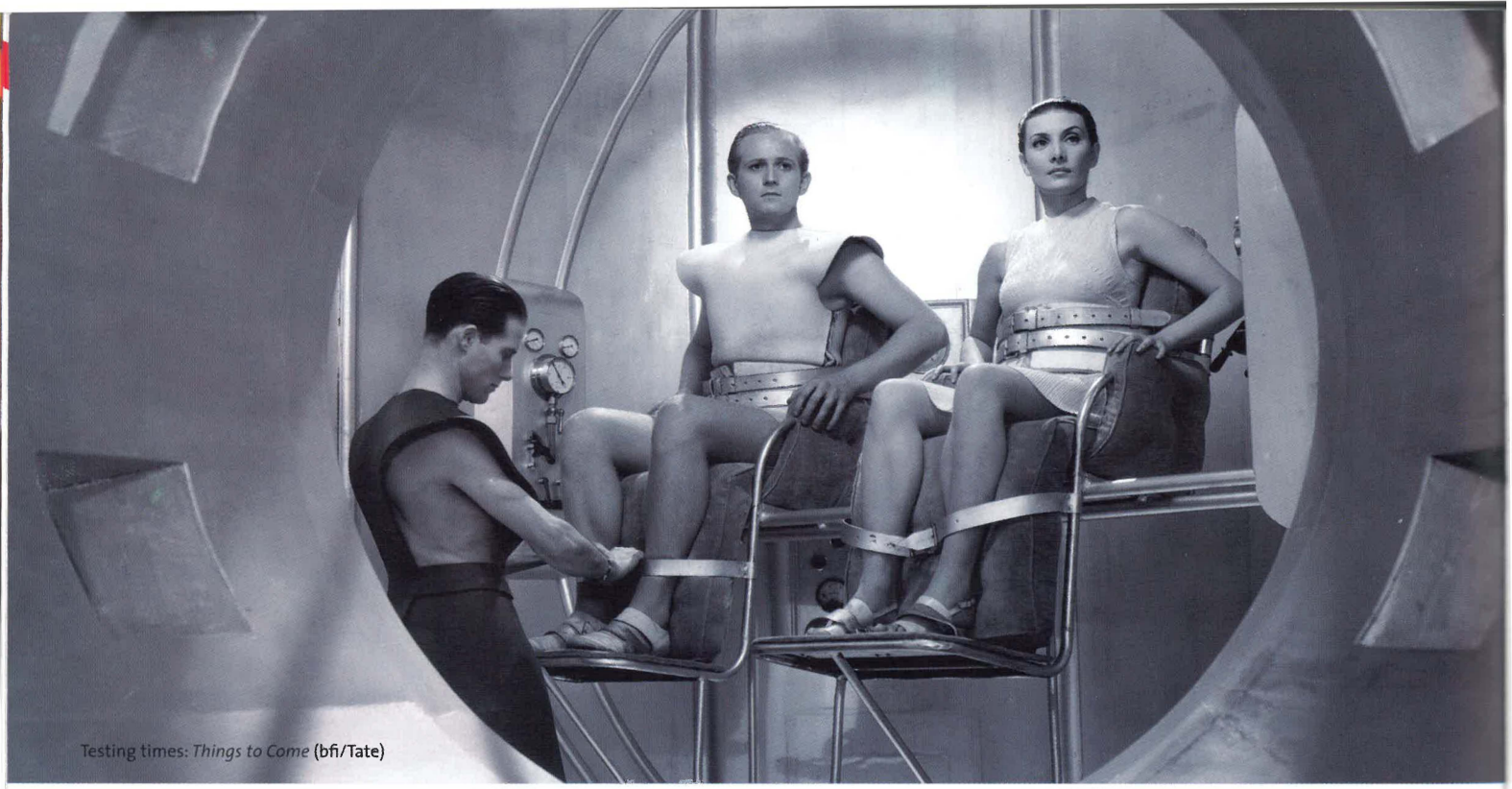

Testing times: *Things to Come* (bfi/Tate)

Dance is pushing the boundaries of science, from ecology to genetics. *dance gazette* discovers what they're asking down at the lab

The appliance of science

Question 1: Do bees dance?

The researcher Norman Carreck at Rothamsted Research, Harpenden, UK.

Why do honey bees dance?
People had noticed that honey bees dance on the comb inside their hives for centuries, but their purpose remained a mystery. It was the Austrian bee scientist Karl Von Frisch, working from the 1920s, who began to understand their meaning. He showed that the dances are used by bees to indicate the location of food sources. The 'dancers' are incoming foragers who have found a good food source, and 'attendant bees' who follow the dances are recruited to the same sources. He described two main dances. The first is the 'waggle dance', where a dancer follows a figure-of-eight route on the vertical comb surface. In the middle, the dancer waggles her tail. The duration of the waggle portion is related to the distance of the source from the hive, and the angle of orientation of the waggle run indicates the angular direction at the hive entrance between the sun and the source. The attendant bees follow the dancer round the dance, probably by vibrations (it is dark in the hive). The dance is therefore a symbolic method of communication encoding the distance and direction information to a source. A simpler version, the round dance, indicates a source close to the hive.

What prompted your own research?
Although most bee scientists accepted Von Frisch's explanation, it is clear that bees (like humans) use a number of different methods of navigation (colour, odour, visual cues), so that it is difficult to separate out the use of dance communication. Sceptics argue that bees cannot read the dances, and the controversy became very heated. Harmonic radar, however, for the first time enables one to directly follow the route taken by the bees. Experiments in Germany involved tracking bees which had attended dances indicating an unscented sugar feeder. Some were tracked directly from the hive, whilst others were carried to a remote location and then released. All bees performed a straight flight in the distance and direction indicated by the dances. In the case of the bees released at the hive, this took them to the vicinity of the feeder. However, since the feeder was unscented, they then began an extensive search, and those that found it only did so after some delay. So bees can indeed use the information encoded in the dance, but need other cues to actually find the feeder.

How did you observe the dance?
The dances can easily be observed in a small hive with glass sides. On a sunny day when there is much forage available, many bees may be observed dancing for different food sources at the same time.

Question 2: Is dancing in our genes?

The researchers Professor Richard P Ebstein and Rachel Bachner-Melman at Hebrew University, Jerusalem.

What inspired you to investigate dancers?
Bachner-Melman: I dreamed of dancing as early as I can remember. I reached the advanced level of the RAD in Australia at age 18, when I made a very difficult choice to stop in order to give priority to academic studies. My love of dance was certainly central in the decision to choose a group of dancers as an interesting comparison group in my doctoral research, which focuses on genetic and personality characteristics of women with anorexia nervosa. Dancers, like anorexic women, focus on their bodies and experience pressure to be thin.

Why did you suspect dance is an evolved trait?
Ebstein: I teach a course in evolutionary psychology so I am always on the lookout for antecedents of human qualities in our distant ancestors. I became interested in genes and music by way of a collaboration with a musicologist, Roni Granot, at the Hebrew University. We are looking for genes that may contribute to musical memory. Brain structures in humans have shown remarkable evolution over the past 6 million

Complex Unison from the Emergent Improvisation Project: Katie Martin (foreground), with Carson Efird, Zornitsa Stoyanova, Jaamil Olawale Kosoko Photo: Paul Kyle

years that separate us from the chimpanzees. So it's a short jump to conjecture that human dance also evolved along with the rest of our brains. However, dance as a natural phenomenon exists across the animal kingdom and I suspect that humans didn't have to invent dance de novo but already had built into their neural networks many of the 'biological' requirements of dance.

What are the characteristics of the genes that relate to dance?

Ebstein: We found an association with two genes, which we think are more related to the communication and spiritual side of dancing, rather than to musical or dance ability. One is the arginine vasopressin receptor 1a, which across the mammals is important in affiliative behaviours like mating or pup rearing practices and social communication. We hypothesised that its association with dance reflects the need of professional dancers to communicate their emotions with the audience. The second gene, the serotonin transporter, is related to a chemical messenger in the brain called serotonin. Serotonin is a chemical that has been linked in some studies to the spiritual activities of the brain, and we conjecture that dancers need to 'feel' and 'experience' the spiritual side of the music.

Are would-be dancers dependent on their genes?

Bachner-Melman: I believe that they are. Motivation and opportunity are essential ingredients for a successful career in dance and most other endeavours, but they are not sufficient. Without suitable physical endowment and a gift for communication through dance, which are largely genetic, no dancer can be successful.

Question 3: Does dance improvisation connect to neuroscience?

The researcher Susan Sgorbati is on the Dance Faculty at Bennington College, Vermont, USA.

What made you suspect that neuroscience might be a fertile area for investigation?

I have been teaching improvisation to dancers and musicians at Bennington for the last 20 years. I was always interested in the structuring principles that came out of this work. Five years ago an evolutionary biologist, Bruce Weber, moved into an office two doors away. He introduced me to a new paradigm in scientific inquiry that related to complexity, or dynamical complex systems. I also read *A Universe of Consciousness* by Gerald Edelman (Nobel Prize winner and founder of the Neurosciences Institute, California), and had a major revelation that there was a very strong resonance between what I had observed with my dancers and these concepts in scientific inquiry. This led me to believe there might be deep structuring principles across disciplines.

What connects improvisation and neuroscience?

- A key concept in complexity is 'self-organisation': when there is no outside agent instructing the system. In natural systems, like flocks of birds or schools of fish, or even neurons in the brain, the structuring principles arise from within the ensemble. This is exactly what had intrigued me all these years with dancers and musicians.
- Another key concept is 'emergence', the ability of a system to create a new form through this process of self-organisation: the sum is greater than the parts. Again, I was observing dancers creating patterns and recognising them without being pre-planned.
- In science, complex systems in nature appear 'at the edge of chaos': they hold together, but are open-ended enough to adapt to new information. Dancers and musicians in emergent improvisation are working in this area: creating forms that are recognisable and ordered, yet open enough to adapt.

How did the project work?

Initially, I assembled eight former students who are now professional dancers and three musicians. We began to work intensively on two forms that I kept observing over the years: the Complex Unison Form (in which open-ended processes constantly adapt to new information, integrating new structures that emerge and dissolve) and the Memory Form (where the ensemble creates and reconstructs an event, revealing memory as a complex process of creation). The Neurosciences Institute and the New England Complex Systems Institute were both interested in the performances happening at their sites. While I was pretty confident about the ideas I was working with, I totally questioned whether these forms would contain the elements for performance. Would an audience be interested? Was there an aesthetic beauty to the forms? I can now say with certainty that not only are the ideas valid, but there is an exciting, dynamic vision in performance. The forms are beautiful to watch: just as in complex systems in nature, the audience commented that there is enough pattern to recognise the forms, but how they came out in each performance was different.

What are the implications of this research for dance?

The implications are exciting. Potentially there are hundreds of structuring principles out there, just like in nature, waiting to be discovered and replicated with ensembles of dancers.

Katie Martin's emergent solo from the Emergent Improvisation Project Photo: Cynthia Locklin