Review and Summary of:

Dance and the Brain

An international symposium hosted by the Ballett Frankfurt with financial support by the Dana Foundation

17 January 2004 Frankfurt am Main, Germany

Speakers

Ivar Hagendoorn – *Introduction and closing remarks*
Marc Jeannerod – *Actions from within*
Julie Grèzes – *Seeing what we can do: The influence of motor knowledge and expertise on action observation*
Andrea Heberlein – *Neural systems for social perception from movement*
Tania Singer – *Neural correlates of empathy: feeling someone else's pain*
Petr Janata – *Why does music make us want to dance?*

Summary

The symposium was opened by **Ivar Hagendoorn**. In his introductory remarks he provided a rationale for the symposium. All our actions, perceptions and feelings are mediated and controlled by the brain. The thoughts and feelings evoked by a dance performance are no exception. The feelings experienced when watching dance, whether on stage, television or in a dance studio, depend on the properties of brain processes involved in the analysis of sensory stimuli on the one hand and the interaction of expectations, associations and preferences as laid down in the brain, on the other. He illustrated the former with reference to the finding that watching still images of people in motion, as in, for example, dance photos, activates regions in the brain associated with producing and controlling movement. As Ivar Hagendoorn pointed out a choreographer is also an observer when creating a choreography and findings about how the brain perceives dance therefore also apply to the creative process. Studying dance and the brain may therefore not only tell us more about the brain, it may also tell us more about dance and how choreographers create a choreography. Finally the insights gained from investigating how the brain perceives and controls movement may also be useful in physical therapy.

The first speaker, **Marc Jeannerod**, argued that when we imagine that we move, we, that is the brain, simulates, the action. He illustrated this with a summary of his research of the past 10 – 20 years (e.g. Jeannerod 1994, 1997, 2001). In an intriguing experiment Jeannerod and his colleagues had shown that it takes about the same time for people to walk a certain distance as it takes them to imagine walking that distance. What's more, it even takes longer if they imagine carrying a heavy object. This provides tentative evidence for the hypothesis that when we imagine a movement we engage in motor imagery and employ the same brain regions as when we actually perform the movement. Next Marc Jeannerod argued that when we *observe* someone moving the brain simulates the action performed by the other person. One experiment Jeannerod referred to in this respect showed that the respiratory rate of an immobile observer was increased while he/she watched an actor performing an effortful action such as running on a treadmill. An exciting thought, as Ivar Hagendoorn remarked following Marc Jeannerod's talk, for it suggests that we may get tired from watching a dance

performance! Marc Jeannerod concluded by providing an overview of neurophysiological evidence for the hypothesis that the same brain regions are activated when we perform and execute a movement, as the finding of so called mirror neurons suggests.

Julie Grèzes expanded on the talk by Marc Jeannerod by providing an overview of neuroimaging evidence for the hypothesis that when we observe others, we mentally simulate the actions that we see. As Julie Grèzes argued this mechanism is influenced both by implicit knowledge of the movements that can be produced as well as by the motor competence of the observer. Each person's motor repertoire is constrained not only by common musculoskeletal anatomy, but also by the acquired skills that the person has learned. Two brain regions that have been found to be activated when people watch human movement, the premotor and the parietal cortex, are only activated when participants in the experiment perceived possible as compared to impossible movements, as determined by biomechanical and joint constraints. This suggests that these regions are selectively activated to process actions that conform to the capabilities of the observer. In a fascinating experiment using dancers with different expertise in two dance styles, classical ballet and capoeira, Julie Grèzes and her colleagues showed, that when the observed action pertains to the motor repertoire of a trained expert, there is more activity in the parietal and premotor cortex than when the observer sees a movement that he or she cannot do. Julie Grèzes concluded that during a dance performance there will be activations within each observer's parietal and premotor cortex as each observer will internally simulate the perceived movements. But the extent and level of activity within those regions will depend on each person's motor competence, that is, it will be constrained by the acquired skills that the person has learned. With this experiment Julie Grèzes convincingly showed how dance and neuroscience can join forces.

The next speaker, **Andrea Heberlein**, discussed how we come to know intentions, emotions and personality traits from movements (Heberlein et al. 2004). Like Marc Jeannerod and Julie Grèzes before her Andrea Heberlein advocated what is known as simulation theory, according to which the question how it feels to look or move like that is implicitly answered by the brain by answering how *I* feel when *I* look or move like that. As Andrea Heberlein showed different brain regions are critical for different forms of emotion judgement from the same stimuli, short motion capture clips of people moving in particular ways exhibiting only dots at the head and some major joints. Damage to the right somatosensory cortex impairs emotion recognition from movement (whether a movement is happy or sad). Damage to the left frontal operculum is associated with recognizing personality traits (whether a person is deemed unfriendly or shy). In the 1940s the psychologists Heider and Simmel showed that people spontaneously ascribe intentions and emotions to simple geometric figures when asked to describe a short cartoon featuring two triangles, a rectangle and a circle. As Andrea Heberlein discovered patients with right somatosensory damage use significantly less emotion words to describe this movie. A patient with bilateral amygdala damage also used less emotion words but in addition didn't anthropomorphize the figures. This leads to some interesting questions about the relationship between emotion recognition and other social behaviors as well as intriguing speculations about how we 'read' and experience abstract dance and whether some brain regions are critical for understanding the emotional content in dance.

Tania Singer tied in with the previous speakers' arguments in favour of simulation theory. She argued that understanding dance is not confined to understanding the actions or movements of the dancers, but also encompasses the ability to understand the *emotions* and *feelings* they display. This capacity to understand the feelings of others is commonly referred to as empathy. As Tania Singer pointed out understanding the feelings of others is not restricted to emotions such as sadness or joy but extends to sensations of pain, tickling or sensual touch. She demonstrated how empathic responses can be measured 'on-line' in a neuroimaging experiment, which studied empathy for pain (Singer et al., 2004). Since in dance everyday feelings and situations are enlarged, this new research paradigm may be

fruitfully combined with video records of dance to further investigate the neural correlates of empathy. An interesting question that emerged from the discussions was why we actually go to the theatre and cinema to see other people portray pain. As Ivar Hagendoorn pointed out if the scene or movie becomes too realistic and comes too close, as for instance *Irréversible* by Gaspar Noë, many people turn away and walk out of the theatre, whereas the cartoon violence in Quentin Tarantino's *Kill Bill* is more easily digestible.

The last speaker, **Petr Janata**, addressed the question why we often feel like dancing when we hear certain music and why dance and music go together so well (Janata and Grafton, 2003). He illustrated this with a video from his 21 month old daughter as she danced along to a popular song. Petr Janata argued that music and dance engage the same sensorimotor loop since listening to and producing music as well as dancing involve the processing of sequences of movements and/or auditory information.

In his closing remarks **Ivar Hagendoorn** expressed the hope that neuroscientists, dancers and choreographers will take inspiration from the present symposium, and will forge collaborations to discover more about the nature and practise of dance. He also reminded the audience of the variety of forms of expressions in dance and that the answers provided by neuroscience are tentative and still need interpretation. With reference to the same mechanisms we can explain why some people find Butoh dance boring (not much happens and the brain's tendency to look for difference makes it bored and easily distracted), while others find it intriguing (the same tendency has the brain search for tiny differences and small events become surprising) a point illustrated in the last scene of *Communications from the Lab*, a choreography by Ivar Hagendoorn which was performed in the evening.

The symposium was very well attended with more than 75% of tickets sold. During the interval and after the symposium lively discussions ensued between speakers, audience and the dancers and choreographers in the audience.

Response in the media

Two television programs (one general and one science program) and one radio program covered the symposium. Several local and national newspapers and dance journals reported on the symposium.

Further reading

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