Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 126 (2014) 16 – 20

Procedia
Social and Behavioral Sciences

ICTTP 2014

Time to act: New perspectives on embodiment and timing

Argiro Vatakis[1,2,]*, Helena Sgouramani[2], Andrei Gorea[3], Vassilia Hatzitaki[4], Frank E. Pollick[5]

[1]*Cognitive Systems Research Institute (CSRI), Makedonomachou Prantouna 7, Athens, 11525, Greece*
[2]*Department of Philosophy and History of Science, University of Athens, Panepistimioupoli, Ano Ilissia, Athens, 15771, Greece*
[3]*Laboratoire Psychologie de la Perception, UMR 8158, Université Paris Descartes & CNRS, France*
[4]*Laboratory of Motor Control and Learning, Department of Physical Education and Sport Sciences, Aristotle University of Thessaloniki, Greece*
[5]*School of Psychology, University of Glasgow, UK*

Abstract

Time perception may often be difficult to define in terms of processes and specific brain areas but it is ever-present in all aspects of our daily life. The study of timing has been central in Cognitive Sciences but recently research has been more vigorous extending from static and/or unimodal stimulations to moving and/or multimodal presentations. This symposium will focus on recent behavioral and neuroimaging work conducted with abstract moving and actual dance stimuli (enacted and observed) in relation to timing. The use of biological real or implied movement in timing research has made its appearance the last few years providing a new platform for the investigation of embodiment and timing. Research to-date has shown a distorted or enhanced time percept in the presence of a moving (actual, implied or apparent motion) as compared to a static stimulus, a fast as compared to a slow moving dancer (or crowd, objects etc.), an expert in terms of spatiotemporal training (e.g., dancer) as compared to a naïve participant, to name just a few. The differential temporal percept observed has been attributed to different clock processes for moving vs. non-moving stimuli to the recruitment of additional processes due to embodiment (e.g., memory). However, more research is required in order to obtain a better understanding of the above-mentioned issues. Through this symposium we aim to bring more focus on this area of research and promote discussion on current findings and theories.

Selection and peer-review under responsibility of the Organizing Committee of the International Conference on Timing and Time Perception.

Keywords: Timing; Time Perception; Embodiement; Action; Dance; Movement; Synchronization

1. Main text

The symposium "Time to Act: New perspectives on Embodiment and Timing" will be composed of four main talks. The talks will cover issues on the interaction of motion (abstract and dance stimuli) and space in timing, the role of speed and duration perception, the contribution of tactile cues in dyad dance performance and

1877-0428 © 2014 The Authors. Published by Elsevier Ltd.
Selection and peer-review under responsibility of the Organizing Committee of the International Conference on Timing and Time Perception.
doi:10.1016/j.sbspro.2014.02.302

synchronization, the role of spatiotemporal experience (dancers vs. non-dancers) in timing, and how embodiment of dance modulates activation in certain brain areas.

1.1. Time in perspective by Andrei Gorea

It is well known that perceived duration no less than perceived space are subject to a variety of contextual modulations and appear to be bound together: a constant retinal extent object appears to increase with its perceived distance from the observer (the "moon illusion") and the perceived duration of a moving object increases with its covered angular trajectory (therefore with its speed). Hence the perceived duration of moving objects covering equal angular trajectories should also increase with distance. Our experiments confirm this prediction: objects covering trajectories of 5.5°, 11°, and 22° in 600, 900, and 1200 ms in a distant fronto-parallel plane of a 2D linear perspective scene appear to live *longer* lives (by up to 50%) than objects covering the same length trajectories in more proximal planes because their trajectories are *overestimated* and because they have a *smaller retinal extents*. At the same time they appear to live *shorter* lives because in real life their motion is *slower* and covers *shorter trajectories*. Combined, these effects tend to cancel out to yield a form of *time constancy* within a 3D environment. I shall also present data to show that perceived duration depends on objects' *relative* rather than absolute velocity so that the PeDu (perceived duration) of a moving object that appears to be stationary (given a background moving in the same direction) will be equivalent to the Perceived Duration of a physically static object.

1.2. "While we dance…": The effects of expertise, space, speed, and prediction on duration judgment by Helena Sgouramani and Argiro Vatakis

Dance is a universal form of art, which serves as a medium of expression and is composed of movement through space that unfolds in time. The spatiotemporal complexity and embodied nature of dance makes it a suitable tool to investigate various aspects of timing. A growing number of researchers in the Cognitive Sciences have recently been turning into the study of dance and behavior (e.g., Bläsing et al., 2012; Sevdalis and Keller, 2011). We are interested in the link of dance and timing and, therefore, in this talk we will present a series of experiments using dynamic dance for the investigation of timing in dancers and non-dancers. More specifically, we have been concentrating on the investigation of factors (i.e., expertise, speed, space, and predictability) that modulate duration estimation mainly using reproduction tasks.

We will first focus on the interaction of speed and expertise on duration estimation (Sgouramani and Vatakis, in press). Using ballet videos performed in fast and slow speeds (while controlling for the number of changes) it was demonstrated that both professional dancers and non-dancers underestimated fast speeds more than slow speeds during reproduction. The exact opposite was true in production. Dancers were significantly less variable in their time estimations as compared to non-dancers. Speed and experience, therefore, affect time estimation.

In Sgouramani and Vatakis (in press), the interaction of timing and speed was investigated using a dance step with and without spatial displacement. Results showed that spatial displacement leads to higher reproduction accuracy, thus a more systematic investigation is needed regarding the interaction of space and time. We are currently evaluating this interaction, in a new set of experiments, on how small or large spatial displacement in movement modulates timing. We expect that larger spatial displacement will lead to higher accuracy and consistency of responses, given that a lot of support is placed in the grounding of time in terms of space (e.g., Bueti and Walsh, 2009; Glasauer, Schneider, Grasso, and Ivanenko, 2007). Additionally, dancers are expected to be more accurate and less variable as compared to non-dancers, due to their extensive spatiotemporal training.

On a similar notion, we are also investigating the role of movement directionality on duration estimation. Using temporal reproduction and leftward vs. rightward movement, we aim to explore whether movement directionality affects duration judgments as has been demonstrated in other experimental paradigms (e.g., Casasanto and Boroditsky, 2003; Vicario, Caltagirone, and Oliver, 2007; Cai, Conell, and Holler, 2013).

In terms of directionality, there are several findings (mostly with artificial stimuli) indicating that a forward-moving (looming) stimulus leads to higher arousal levels as compared to backward-moving (receding) stimuli (e.g., van Wassenhove, Buonomano, Shimojo, and Shams, 2008; Wittmann, van Wassenhove, Craig, and Paulus, 2010). According to the scalar expectancy model, arousal modulates the rhythm in which the pacer emits pulses in the accumulator, with higher arousal levels leading to an increase of the produced pulses. Based on the above-mentioned ideas, we are currently investigating whether or not approaching and receding human movement (watching the dancers' front or back side while moving towards or away from the viewer) of different speeds affects duration estimates. We expect that movement towards the viewer will result in an overestimation of duration (due to triggering of threat/protection mechanisms and augmentation of arousal levels) as compared to movement away from the viewer. Using presentations with forward and backward movement while facing or not the viewer, will allow us to investigate whether overestimation in the forward moving stimuli is driven by increased arousal due to viewing a face or movement per se.

A final investigation pertains to the predictability of movement and how this relates to time estimation. Dancers and non-dancers viewed a set of dance videos with identical start points but with either a predictable or an unpredictable closure. We expect that unpredictable movement will capture attention more compared to the predictable movement, thus resulting to an underestimation of the tested intervals. Additionally, given that prediction leads to better estimations, we expect that predictable movement will lead to higher performance accuracy and decreased variability.

1.3. Interpersonal synchrony in dancers and non-dancers: Contrasting timing and haptic cues by Vassilia Hatzitaki, George Sofianidis, Mark T. Elliott, and Alan M. Wing

Interpersonal entrainment emerges spontaneously when dyads performing rhythmic movements together receive sensory feedback about the other's movements (Richardson et al., 2007). In a series of studies, we examined the nature of interpersonal synchrony mediated by light fingertip contact when individuals sway rhythmically at their own pace, same or different externally imposed (metronome) tempos. The effect of traditional dance expertise on interpersonal synchrony was also investigated. Three types of couples were tested: expert couples, consisting of individuals with at least 8 years systematic practice in traditional Greek dance, novice couples, consisting of individuals with no prior experience in dance, and mixed couples, consisting of one expert dancer and one novice partner. Cross-spectral analysis of the sway signals revealed that *during self-paced sway,* fingertip contact evoked a decrease of the dominant sway frequency difference between partners, an increase in the coherence between the sway signals and a concentration of relative phase angles towards the in phase region. When sway was paced by *the same metronome tempo (0.25Hz*), only expert dancers were able to further improve interpersonal synchrony with haptic contact. These findings suggest that the strength of the emerged interpersonal synchrony depends on the individuals' expertise to integrate tactile and timing cues about sway (Sofianidis et al., 2012). In a subsequent study, we asked whether dancers are able to suppress the haptically mediated interpersonal synchrony when swaying at *different metronome tempos (one partner at 0.25Hz, the other at 0.35Hz)*. Light fingertip touch evoked interpersonal synchronization of the signals only in mixed group whereas touch interference was weaker in the novices and absent in experts. Interestingly, the greatest touch interference was seen in the novice partner of the mixed group suggesting that the expert was leading the novice partner. By contrast in experts, the externally imposed timing cue was a control parameter sufficient to alleviate the tendency towards spontaneous entrainment. It is suggested that systematic practice in dance can differently shape the central nervous system possibly by modulating its self-organizing properties (Sofianidis, Elliott, Wing, & Hatzitaki, submitted). Further support of this view is provided by brain imaging studies confirming specific adaptations in the structure, function, and connectivity of sensori-motor cortical and sub-cortical brain regions as a result of dance practice (Hanggi, Koeneke, Bezzola, & Jancke, 2010).

1.4. Using intersubject correlation to compare brain activity across a collection of audiovisual dance videos by Frank E. Pollick

The technique of intersubject correlation (ISC) provides a data driven technique to determine from fMRI data which brain areas have correlated patterns of activity across a group of observers when experiencing a common stimulus. These correlations appear to arise because brain activity is time-locked to the processing of incoming sensory signals and subsequent cognitive activity. ISC has been used to examine brain activity when experiencing feature films, music and dance. In our research we use ISC as a means to compare brain activity related to watching videos of different dance performances.

We have obtained data from 73 participants, with no particular experience in watching or performing dance, across four separate experiments on watching dance. These experiments contained videos of various audiovisual combinations for a total of 8 different dance conditions. The properties manipulated across these conditions included the style of dance (ballet, contemporary) number of dancers (solo or duet), presence of video editing (cuts or single camera view) and presence or absence of audio. All participants were scanned at the Glasgow University Centre for Cognitive Neuroimaging and data analyzed with Brainvoyager and the Matlab ISC toolbox of Kauppi and colleagues.

For each of the 8 different conditions an ISC map was calculated for the particular group of observers. This map revealed the regions that were significantly correlated for the group of observers. We wished to interrogate these 8 conditions across the four individual experiments. To achieve this we organized the 8 conditions into three sets and performed a conjunction analysis to look within each set to find the brain areas that showed correlation among all conditions in that set. Our three sets were: 1) all 8 conditions, 2) the 5 conditions with sound, 3) the 2 conditions with video cuts. Results for Set 1 revealed correlation for only occipital and occipitotemporal regions. For Set 2, when sound was present, parietal cortex as well as auditory regions of temporal cortex also showed correlation. For Set 3, when video editing was present, widespread correlations were found in frontal cortex along with the regions previously found for Sets 1 and 2.

What is common to all 8 conditions is a structured visual input provided by the dance and thus it is not surprising that only visual areas were found common to the ISC maps of all 8 conditions. Similarly, the additional presence of auditory regions for Set 2 can be expected with the addition of structured sound. However, that frontal regions became present only with video editing is not obvious and points to the important influence of editing alone. These results are promising and motivate the development of more sophisticated analysis techniques and systematic choice of experimental conditions to study the brain processes involved in the interpretation of extended action sequences. In particular we are interested in how to use these techniques to study multisensory processes.

Acknowledgements

The authors and speakers were supported by the European COST Action ISCH TD0904 "TIMELY" (www.timely-cost.eu).

References

Bläsing, B., Calvo-Merino, B., Cross, E. S., Jola, C., Honisch, J., & Stevens, C. J. (2012). Neurocognitive control in dance perception and performance. *Acta Psychologica, 139*, 300-308.

Bueti, D., & Walsh, V. (2009). The parietal cortex and the representation of time, space, number and other magnitudes. *Philosophical Transactions of the Royal Society B, 364*, 1831-1840.

Cai, Z. G., Connell, L., & Holler, J. (2013). Time does not flow without language: Spatial distance affects temporal duration regardless of movement or direction. *Psychonomic Bulletin Review, 5*, 973-980.

Casasanto, D., & Boroditsky, L. (2003). Do we think about time in terms of space? In R. Alterman & D. Kirsch (Eds), *Proceedings of the 25th Annual Conference of the Cognitive Science Society*, (pp. 216-221). Mahwah, NJ: Lawrence Erlbaum.

Glasauer, S., Schneider, E., Grasso, R., & Ivanenko, Y. P. (2007). Space-time relativity inself motion reproduction. *Journal of Neurophysiology*, *97*, 451-461.

Hanggi, J., Koeneke, S., Bezzola, L., & Jancke, L. (2010). Structural neuroplasticity in the sensorimotor network of professional female ballet dancers. *Human Brain Mapping, 31*, 1196-1206.

Nather, F. C., & Bueno, J. L. O. (2012a). Exploration time of static images implying different body movements causes time distortions. *Perceptual & Motor Skills, 115(1),* 105-110.

Nather, F. C., & Bueno, J. L. O. (2012b). Timing perception in paintings and sculptures of Edgar Degas. *Kronoscope, 12(1),* 16-30.

Richardson, M. J., Marsh, K. L., Isenhower, R. W., Goodman, J. R., Schmidt, R. C. (2007). Rocking together: Dynamics of intentional and unintentional interpersonal coordination. *Human Movement Science, 26*, 867-891.

Sevdalis, V., & Keller, P. E. (2009). Self-recognition in the perception of actions performed in synchrony with music. *Annals of the New York Academy of Sciences, 1169*, 499-502.

Sgouramani, H., & Vatakis, A. (in press). "Flash" Dance: How speed modulates perceived duration in dancers and non-dancers. *Acta Psychologica*.

Sofianidis, G., Elliott, M. T., Wing, A., & Hatzitaki, V. (submitted). Can dancers suppress the haptically mediated interpersonal entrainment during rhythmic sway?

Sofianidis, G., Hatzitaki, V., Grouios, G., Johannsen, L., &Wing, A. (2012). Somatosensory driven interpersonal synchrony during rhythmic sway. *Human Movement Science, 31*, 553-566.

van Wassenhove, V., Buonomano, D. V., Shimojo, S., & Shams, L. (2008). Distortions of subjective time perception within and across senses. *PLoS One, 3*, e1437.

Vicario, C. M., Caltagirone, C., & Oliveri, M. (2007). Optokinetic stimulation affects temporal estimation in healthy humans. *Brain and Cognition, 64*, 68-73.

Wittmann, M., van Wassenhove, V., Craig, A. D., & Paulus, M. P. (2010). The neural substrates of subjective time dilation. *Frontiers in Human Neuroscience, 4*, 1-9.