

This is an excerpt from a report on the Temporal Experience Workshop at the University of Toronto in May of 2013, written by Kevin Connolly, Mike Arsenault, Akiko Frischhut, David Gray, and Enrico Grube, available at http://networksensoryresearch.utoronto.ca/Events_%26_Discussion.html

4. Do we have one central clock for time, or different clocks for each sense modality?

At the workshop, participants gave prima facie reasons both for the view that humans have one central clock for time, and for the view that each person has multiple clocks. One reason given for thinking that there is a central clock is that we can match-up temporal information in different modalities fairly easily, which suggests a common metric, and a common counter. On the other hand, one reason given for the claim that there are different clocks is that time is often distorted differentially. Consider the multi-modal oddball effect, for instance. In the standard (unimodal) oddball effect, a novel stimulus is inserted into the middle of several tokens of the same type stimulus. This makes the novel stimulus appear longer. In the multi-modal oddball effect, introducing an auditory stimulus at the same time as a visual oddball can modulate the duration of the visual stimulus, but introducing a visual stimulus at the same time as an auditory oddball does not modulate the duration of the auditory oddball (Chen and Yeh, 2009). On its face, one of these cases seems to involve a distortion in one modality but not the other, implying a different clock for each modality.

In the workshop, some speakers thought that the two options (one central clock, or several different clocks) were not mutually exclusive. In particular, they thought that there could be differential temporal distortions that fed into one centralized clock. In Ian Phillips' talk, for instance, he argued that the relative duration of mental activity is used as a standard for making judgments about the absolute duration of other events. This sounds like a central clock model. Since there's only one unit of measurement, which is mental activity, it seems like the view wouldn't allow that time dilation could happen in one modality but not in another. However,

Phillips argued his view did not preclude modality-specific temporal distortions. This is because such distortions could be determined quite independently of the mental activity, by mechanisms that are below the level of anything that conscious experience could tell you about them. In the multi-modal oddball effect, for instance, it could be that the effect has to do with perceptual attention, and that mental activity has nothing to do with it. This would be a problem for Phillips' view only if the sole mechanism determining durations was how much mental activity there was, a view that he rejected.

In his session, Alan Johnston also tried to make differential temporal distortions consistent with a central clock model. He presented evidence for temporal distortions in different spatial regions, rather than in different sense modalities. In one study (Johnston, Arnold, and Nishida, 2006), subjects were asked to look at a fixed central point, while a sine grating drifting at 20 Hz was placed either to the left or the right. In the next phase of the experiment, gratings drifting at 10 Hz appeared on both sides of the fixed focal points. The result was that subjects perceived the grating located on the same side of the first sine grating as lasting a shorter time. This might seem to indicate that there are many different clocks, perhaps even one for every spatial region. However, Johnston rejected this conclusion. On his view, it is not that there are clocks at every position in space, but that there are adaptable mechanisms at every position in space that can alter your perception of an event with regard to how long it occurred for. Furthermore, he offered a reason for thinking that there is a central clock: you can match-up temporal information in different modalities fairly easily, which suggests a common metric, and perhaps even a common counter.

In his talk, Mohan Matthen gave an argument that there is a single representation of time common to all modalities. Among other things, he pointed to the common experience of

watching television and having the audio lag behind the visual. While the perceptual system does not synchronize long lags, it does synchronize short ones. Matthen took this synchronization as evidence that the brain works to figure out the temporal structure of the events we perceive. Perceptual experience represents events as happening “now,” i.e. at the time of the experience. But the brain receives information about these events in different order. The brain then works to figure out the temporal structure of the events we perceive (across sense modalities), as time gets imposed on perceptual experience by sub-personal cognitive processes.

In the final panel discussion, Susanna Siegel introduced a related, but remaining question. Her question concerned the specious present, an extended temporal duration of which we are aware of at any given instant. In particular, she asked whether the specious present lasts different times in different modalities. Do the units that constitute the specious present amodal, or are they modality specific? This is a question that was left unanswered from the workshop.

References:

- Chen, K. M., & Yeh, S. L. (2009). Asymmetric cross-modal effects in time perception. *Acta psychologica*, 130(3), 225-234.
- Johnston, A., Arnold, D.-H., and Nishida, S. (2006). Spatially localized distortions of event time. *Curr. Biol.* 16, 472–479.