**Dissociating Temporal Order & Simultaneity: A Perceptual Learning Study**

**Nestor Matthews1, Rebecca Achtman1, Rachel Fenton1 Brynn FitzGerald1, & Leslie Welch2**

1 Department of Psychology, Denison University

2Cognitive & Linguistic Sciences, Brown University

**Introduction:** Dynamic environments often contain stimuli that vary simultaneous and stimuli that vary sequentially. As a result, evolution would likely favor organisms that correctly judge simultaneity and temporal order. In principle, simultaneity judgments (SJs) and temporal order judgments (TOJs) could parsimoniously share a neural computation, i.e., the difference between the arrival times of two stimuli. To the extent that SJs and TOJs share this (or any) neural computation, one would expect practice-based improvements on SJs to generalize to TOJs. We tested this prediction by measuring TOJ accuracy before and after extensive SJ training.

**Method:** Ten Denison University undergraduates viewed bilateral-stream RSVP displays containing two targets, one in each lateral hemifield, shown either simultaneously or at various asynchronies. Participants judged the targets’ temporal order on the first and last days of our six-day procedure. Across the intervening four daily training sessions, participants judged whether the targets appeared simultaneously or not. Retinal stimulation remained identical across the SJ and TOJ tasks. Collectively, the participants completed 36,000 trials (600 trials per day \* 6 days \* 10 participants).

**Results:** The percentage of correct simultaneity judgments (SJs) increased significantly between the first and second of the four SJ training sessions (p<0.0005), and remained asymptotically high thereafter. Despite this significant perceptual learning on SJs, TOJs before and after SJ training were statistically indistinguishable from each other (p=0.568, n.s.). Additionally, SJ accuracy significantly exceeded TOJ accuracy both before (p<0.006) and after (p<0.01) SJ training.

**Conclusion:** Because significant perceptual learning on SJs did not generalize to TOJs, and SJ accuracy significantly exceeded TOJ accuracy, our findings argue against the parsimonious possibility that SJs and TOJs share a neural computation. Evolution appears to have missed a "two-for-one sale". Instead, our study suggests that the neural events mediating TOJs are separate from, and less accurate than, those mediating SJs.

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