World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Time's Arrow and Entropy: Violations to the Second Law of Thermodynamics Disrupt Time Perception

Authors : Jason Clarke, Michaela Porubanova, Angela Mazzoli, Gulsah Kut

Abstract : What accounts for our perception that time inexorably passes in one direction, from the past to the future, the so-called arrow of time, given that the laws of physics permit motion in one temporal direction to also happen in the reverse temporal direction? Modern physics says that the reason for time's unidirectional physical arrow is the relationship between time and entropy, the degree of disorder in the universe, which is evolving from low entropy (high order; thermal disequilibrium) toward high entropy (high disorder; thermal equilibrium), the second law of thermodynamics. Accordingly, our perception of the direction of time, from past to future, is believed to emanate as a result of the natural evolution of entropy from low to high, with low entropy defining our notion of 'before' and high entropy defining our notion of 'after'. Here we explored this proposed relationship between entropy and the perception of time's arrow. We predicted that if the brain has some mechanism for detecting entropy, whose output feeds into processes involved in constructing our perception of the direction of time, presentation of violations to the expectation that low entropy defines 'before' and high entropy defines 'after' would alert this mechanism, leading to measurable behavioral effects, namely a disruption in duration perception. To test this hypothesis, participants were shown briefly-presented (1000 ms or 500 ms) computer-generated visual dynamic events: novel 3D shapes that were seen either to evolve from whole figures into parts (low to high entropy condition) or were seen in the reverse direction: parts that coalesced into whole figures (high to low entropy condition). On each trial, participants were instructed to reproduce the duration of their visual experience of the stimulus by pressing and releasing the space bar. To ensure that attention was being deployed to the stimuli, a secondary task was to report the direction of the visual event (forward or reverse motion). Participants completed 60 trials. As predicted, we found that duration reproduction was significantly longer for the high to low entropy condition compared to the low to high entropy condition ($p=.03$). This preliminary data suggests the presence of a neural mechanism that detects entropy, which is used by other processes to construct our perception of the direction of time or time's arrow.

Keywords : time perception, entropy, temporal illusions, duration perception
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020