# Temporal Distortion Related Connectivity Mapping in Auditory Event Recognition

**Bora Çelebi** [1] **,Alp Tuna**[3]**, Ahmet Mete Karayaka**[2]**, Filiz Tezcan**[4]**, Funda Yıldırım** [1, 5]

[1] Cognitive Science Program, Yeditepe University, Istanbul, Turkey

[2] Department of Genetics and Bioengineering, Yeditepe University, Istanbul, Turkey

[3] Department of Computer Engineering, Boğaziçi University, İstanbul, Turkey

[4] Language and Computation in Neural Systems, Max Planck Institute for Psycholinguistics, Nijmegen, Netherlands

[5] Department of Computer Engineering, Yeditepe University, Istanbul, Turkey

When we are exposed to familiar environmental sounds, the origin of the action that caused that sound can often be predicted earlier than the event is terminated. We collect sensory cues as soon as we start hearing a sound and come to a decision when sufficient information is collected. Here, we used environmental sounds with temporal distortion that have cause and effect periods such as car break - car crash. This way, making sense of the sound in the first/cause part can be validated in the second/effect part. We compared the difference of connectivity patterns between the cause and the effect part of the sound events with various types of temporal distortion. The three types of temporal distortions were created in the following ways: (1) we divided the auditory stimuli in 10ms chunks and shuffled these chunks randomly, (2) we divided the auditory stimuli into 1 second sound slices, then divided each 1 second slice into 10 ms chunks and shuffled these 10 ms chunks randomly, while keeping the order of the 1 second sound slices intact and (3) we divided the auditory stimuli into two parts which are the cause and effect part, then divided each part into 10 ms chunks and shuffled these 10 ms chunks randomly, while keeping the order of the cause and effect parts intact (Figure 1). We collected EEG data from participants in an auditory recognition task. Participants were asked to identify the sound they heard using a 4AFC task after they listened to the environmental sound events with three temporal distortions. The event-based partitioning of the sounds as in (3) revealed a higher recognition performance than in random shuffling condition (1) and similar performance to the minimum temporal distortion condition (2) supporting our event-based information gathering and validation argument. We applied Granger Causality with Multivariate Auto-Regressive order of 18 using Bayesian Information Criterion. The connectivity measures taken from the effect part of the sound event in condition (3) resulted in higher connectivity coefficients from frontal to the parietal and temporal regions compared to the cause part of the sound events (Figure 2). We conclude that increased fronto-temporal and fronto-parietal connectivity in the effect part of the sound might indicate an error-correction and validation related mechanism in sound identification, similar to their function in the predictive coding framework (Dietz et., al., 2014; Philips et., al., 2015). Our study informs about the behavioral mechanisms and connectivity patterns involved in environmental sound recognition.

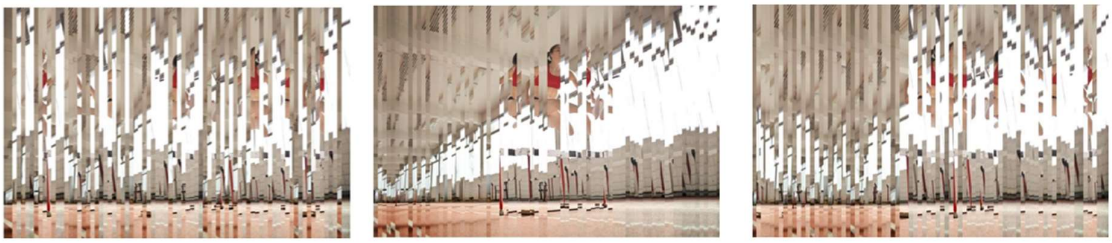

Figure 1: *A visual representation of the temporal distortion conditions applied on environmental sound events: From left to right: 10ms (1), Ordered (2) and Event Based (3). Numbers correspond to the descriptions of conditions in the text.*

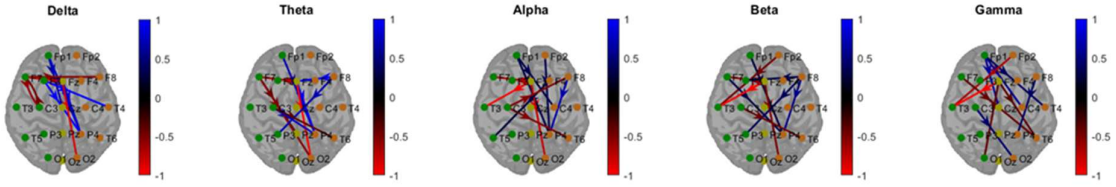


Figure 2: *Connectivity differences between the cause and the effect part of the sound events for five different frequency bands..*