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Predicting Perception?

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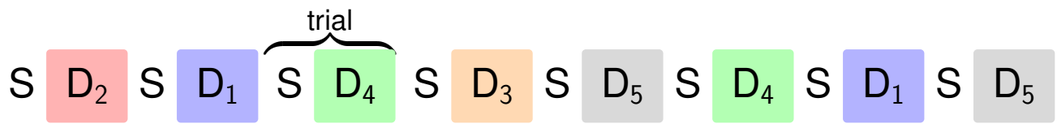
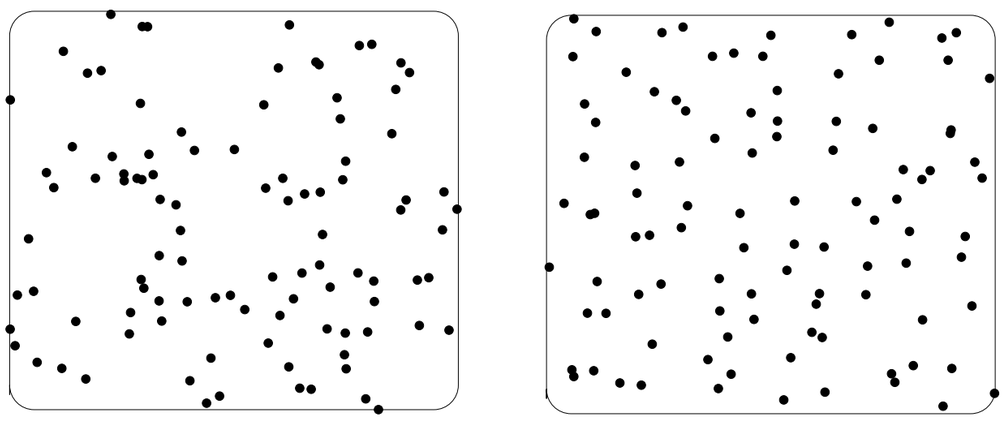
Point of Departure

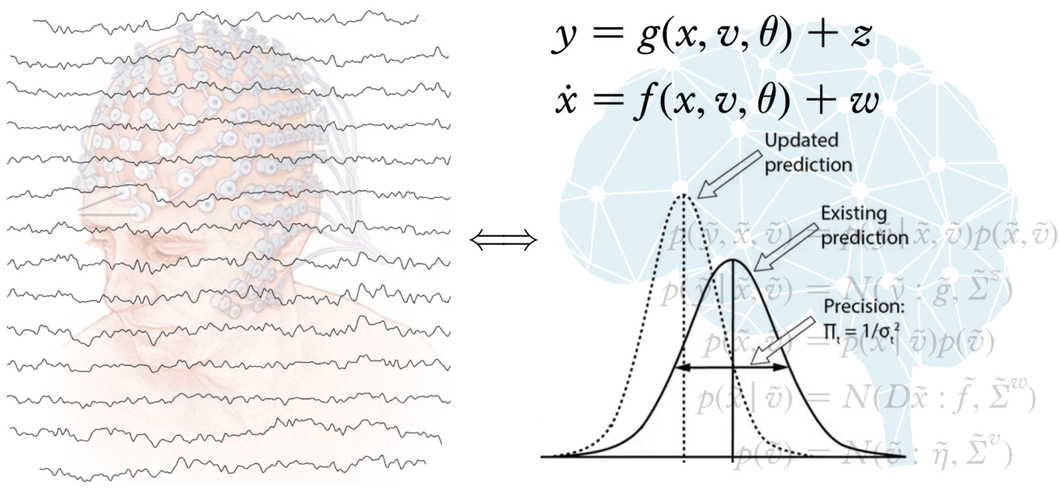
To address this question of predicting perception the Optimum-1 Paradigm is considered. It consists of a sequence of trials. One trial is constituted of one standard and one deviant tone. Regarding the deviant tone, five deviants exist varying in frequency, intensity, sound location, timing and duration. A sequence of trials is called a block, where the distribution of each deviant D_i is random. As for instance



This paradigm was employed in an experimental study by Alejandro Blenkmann and colleagues. High frequency EEG activity (75–145 Hz) was recorded from 90 intracranial insular electrodes across 16 patients who were candidates for respective epilepsy surgery while they passively listened to a stream of standard and deviant tones.

Which is Random?





Is Randomness Predictable?

The paradigm exposes the brain to a stream of random sequences where only the trial itself provides a structure.

Can the brain be aware of randomness, or does it always compute a pattern? In other words, does it always try to make sense or use of a given prior sequence?

As shown above, a phenomenon termed clustering illusion lets us intuitively see patterns were there are non.

Clusters or repetitions of points are identified as nonrandom, whereas a pattern with overalternations (here white space between dots) is considered maximally random.

Hence it seems plausible that the brain tries to exploit patterns naturally existent in randomly distributed sequences and that it is only able to perceive randomness when it fails to encode it.

Can such an attempt of making sense be predicted by a computational model employing Predictive Coding? Can an actual prediction signal be identified while anticipating an event in a random environment?

Methods

Within the framework of a synthesis, that is to say a simulation-based approach, these two questions are addressed.

Given a prior sequence, a statistical representation is computed. Based on that statistic, a prediction for the next deviant tone is made. This procedure is repeated on each time step.

This is performed with elaborated computational models based on the theory of Predictive Coding, Bayesian Methods or Hidden Markov Models. These concepts are useful to capture the underlying processes of perception in order to determine or predict abstract perceptual variables such as for instance surprise, prediction error or prediction change.

Subsequently, a correlation analysis between these predicted variables and the recorded experimental data (EGG activity) will be performed. These steps try to identify a connection between the computed variables and oscillatory brain waves with the aim to contribute to the illumination of the principles of perception.