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My approach is to use non-invasive method for measuring brain such as EEG, to clarify our cognition and behavior and apply these results to brain-machine interface (BCI) and neuromarketing.

Theme1 : Visual stimuli and cognitive processes

When humans see objects or hear noise created them, they not only perceive what they are but also implicitly endeavor to estimate their familiarity and naturalness to us. A positive ERP (event-related potential) component occurring 300–500 ms after the onset of a stimulus—known as P3—has been suggested to reflect various cognitive processes.

We investigated the P3 component using an oddball paradigm. However, the typical oddball paradigm is inappropriate for examining stimulus familiarity and naturalness, because the difference in task difficulty and frequency between standard and target stimuli contaminates that of the stimulus property itself.

We focused on the relationship between stimulus pairs and their amplitudes during oddball tasks. The participants in the experiments performed two oddball tasks replacing the target stimulus with the standard stimulus. The researchers used pairs of natural and unnatural visual stimuli: a female face and an inverted face; a human pose and an impossible pose; a natural upright face and a bluish face; a natural orange and a gray orange.

As a result, the naturalness of the target stimuli differentiated the P3 amplitude: the unnatural target enhanced the P3 amplitude rather than the natural one, and elicited P3 asymmetry.
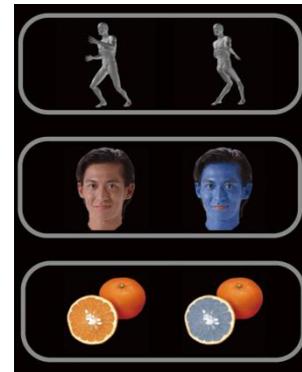

Pairs of stimuli used in this study

The asymmetry of the P3 amplitude during an oddball task might be useful as an evaluation index for stimulus features.
Keyword : EEG, P3, unnaturalness

Theme2 : Estimation of ambiguous states from a single-trial EEG recording

The purpose of this study was to classify ambiguous states through a single-trial analysis. Subjects were presented with binarization images (BI) and color images (CI) in a specific order (BI - CI - BI), and were instructed to judge by button press whether they recognized what the binarization image is or not. During the experiment, EEG was recorded from 19 electrodes. EEG signals were analyzed through a wavelet transform, and were calculated amplitude information and phase information. Using these features of the brain states, cognitive states were classified by a support vector machine (SVM). The best classification accuracy was obtained when the beta band power was used as an input feature. Additionally, the spatial and temporal distributions of the conversion matrix of SVM were analyzed. As a result, the association of the memory was reflected in the alpha band activity in the frontal region, thereafter, the contrast process comes into being in the beta band activity in the frontal region; finally, the cognitive process accrues in the gamma band activity in the right occipital temporal region.
Keyword : : EEG, BCI, ambiguity

What is this object?