# Individual differences in obligatory processing of unexpected, intentionally-ignored events

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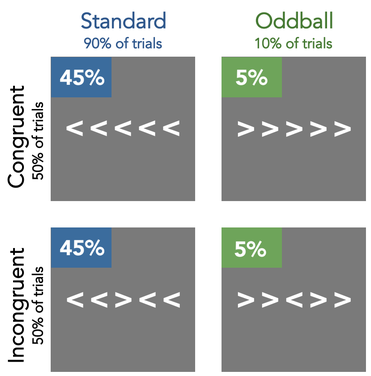
## How do predictable flankers influence attentional selection? Does this effect vary across individuals?

The brain is sensitive to events that violate its explicit and implicit predictions about forthcoming sensory stimuli. One result of this sensitivity is the automatic allocation of attention to unexpected events. Further, individuals differ in their ability to control attentional focus, and in their sensitivity to sensory input.

We modified the flanker task (Eriksen & Eriksen, 1974) so that the distractors had either a common or an uncommon (Oddball) form, and measured reaction times and accuracy while people performed the task. We also recorded scalp EEG to investigate the neural correlates of Oddball flankers. Finally, we used temperament scores to assess whether self-reported reactivity predicted neural and behavioral susceptibility to Oddball flankers, as measured by stimulus-related alpha-band activity and the evoked visual mismatch negativity.

## Frequency-Manipulated Flanker Task




**Stimuli:** Sets of 5 chevrons, 1 central and 4 flankers, presented for 50 ms.

**Task:** Report direction of central chevron within 2 seconds of presentation.

**Feedback:** Keeping accuracy between 75% and 90%. Subjects were instructed to increase either speed or accuracy.

Central chevron was equiprobably left/right, congruent/incongruent. **Flanker direction** was counterbalanced within subjects.

N = 20; 1920 trials per subject.

**Temperament:** Measured via Adult Temperament Questionnaire (ATQ, Evans & Rothbart, 2007). Scores on two temperament factors, attentional control and orienting sensitivity, were selected a priori as relevant predictors.

## EEG Recording and Analysis Details

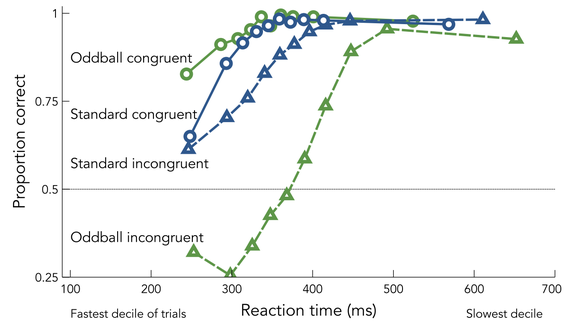
High-density scalp EEG was recorded while subjects performed the flanker task. We used a wavelet transform to compute alpha power during a pre-stimulus interval, -500 ms to -100 ms, and a peri-stimulus interval, -100 ms to +100 ms.

Then, we computed ERPs timelocked to stimulus onset for **Oddball** and **Standard** flankers. Clustering and permutation-testing (Maris & Oostenveld, 2007) allowed us to identify time windows and electrodes that dissociated conditions.

N200 peak amplitude was the strongest predictor of vMMN magnitude; we partialed out peak amplitude on **Standard** trials before examining individual-differences effects.

Czigler (2007). Visual mismatch negativity. *Psychophysiology, 21*, 224-230.
Eriksen & Eriksen (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics, 16*, 143-149.
Evans & Rothbart (2007). Developing a model for adult temperament. *Journal of Research In Personality, 41*, 868-888.
Maris & Oostenveld (2007). Nonparametric statistical testing of EEG- and MEG-data. *Journal of Neuroscience Methods, 164*, 177-190.

## Oddballs Enhance the Flanker Congruency Effect

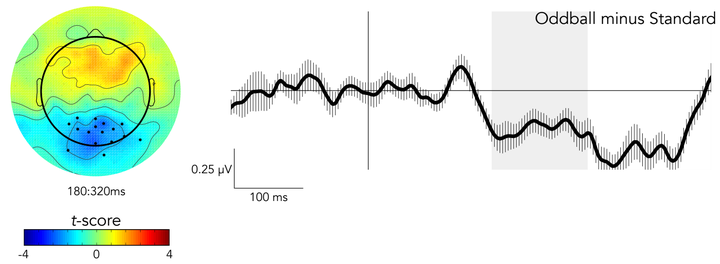



People were faster and more accurate on **Congruent** than on **Incongruent** trials. This effect was substantially larger for **Oddball** flankers than for **Standard** flankers.

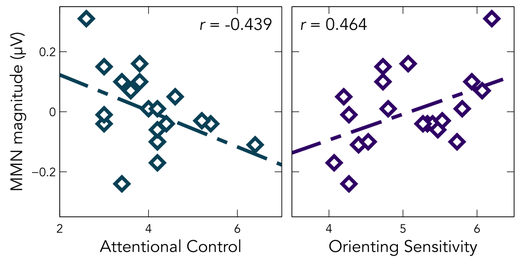
This **Oddball Congruency Effect** demonstrates attentional selectivity's reliance on distractor predictability.

## vMMN to Oddball Flankers

The visual mismatch negativity (vMMN) occurs in response to occasional deviant elements in a regular sequence (Czigler, 2007). **Oddball** flankers elicited a more-negative ERP than **Standard** flankers.

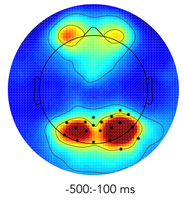


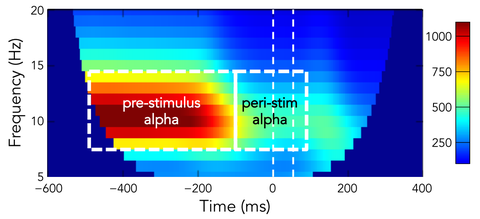

Multiple regression showed that two components of temperament account for differences in vMMN magnitude. Attentional control predicts larger vMMN; sensitivity predicts smaller. $R^2 = 0.35$.

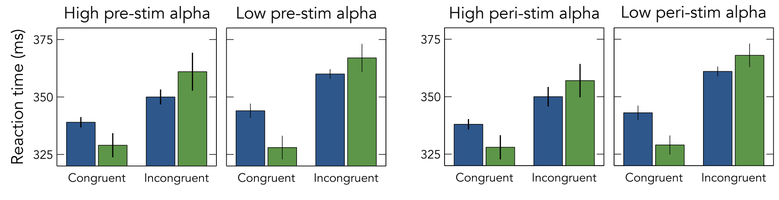



Supported in part by CELEST, an NSF Science of Learning Center (SMA-0835976). Thanks to Stephanie Bond and Brian Dorfman for assistance with experiment coding, data collection, and analysis, and to Lisa Payne for wisdom regarding EEG analyses.

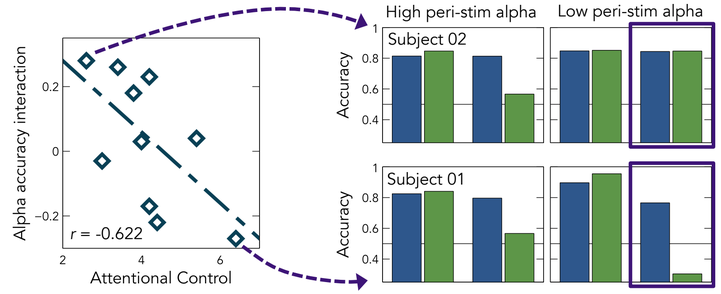
## Alpha Oscillations and the Oddball Congruency Effect




High pre-stimulus alpha reduces the Oddball Congruency Effect. High peri-stimulus alpha improves reaction time on trials with **Standard** flankers, but not with **Oddball**. Alpha may reflect an attentional strategy supporting focus on the target by suppressing the flankers.




Alpha power interacts with the Oddball Congruency Effect, and this interaction is correlated with subjects' attentional control score. For subjects with high attentional control, peri-stimulus alpha power reduces the Oddball Congruency Effect. This further supports the hypothesis that alpha serves as an attentional selectivity mechanism, actively suppressing the distractors.

### Oddball distractors demand attention.

The Oddball Congruency Effect demonstrates that, when distractors are predictable, people can suppress otherwise-automatic processing. This suppression is disrupted by unexpected flankers.

### Oddball flankers elicit a vMMN.

These results link a canonical attention task to an ERP marker of prediction errors, opening up a vast array of possible future studies into the mechanisms of attentional selection.

### Temperament predicts susceptibility to Oddball distractors.

Self-reported temperament captures a substantial portion of individual variability in the neural responses to this task. Both ERP magnitude and the effect of peri-stimulus alpha activity are reliably predicted by temperament scores.