**Of chickens, eggs, and yolk: The electrophysiology of breaking a rule**

Roland Pfister¹, Katharina Schwarz², Robert Wirth¹, Marco Steinhauser³, & Wilfried Kunde¹

¹ University of Würzburg, ² University Medical Center Hamburg-Eppendorf, ³ Catholic University of Eichstätt-Ingolstadt

**BACKGROUND**

Not all rules can be obeyed at all times, and failures to obey a rule can be either unintended or intended (Reason, 1990). Interestingly, whereas the electrophysiology of unintended errors has been studied extensively in the last decades, virtually nothing is known about the electrophysiological signature of intended rule violations. The present study targeted two ERP components to address this question: The error-related negativity (ERN / NE) and the P300.

Because the ERN is assumed to reflect monitoring of unexpected events (e.g., Holroyd & Coles, 2002) we did not expect any ERN-like waveforms for intended rule violations. In contrast, we expected violation-specific effects on the P300 component, which has been linked to the (direct) mapping from stimuli to canonical responses (Verleger et al., 2005). Because rule violations are the opposite of such canonical responses, we expected attenuated and/or delayed P300 responses for rule violations as compared to rule-based behaviour.

**RESULTS**

The stimulus-locked analysis of the ERPs elicited by the target stimulus is shown to the left, and a clearly attenuated and delayed P300 response emerged for rule violations as compared to normal, rule-based responses (time to peak amplitude at Pz: 448 ms vs. 404 ms; p = .008, d = 0.77).

**Upper left:** Mean voltage distributions, 300-450 ms post-stimulus. The blue mock head represents rule violations, the grey mock head represents normal, rule-based responses. The plot in between both heads shows the difference between the conditions.

**Lower left:** Exemplar ERP data for the candidate electrode Pz (upper plot) and the difference wave (lower plot). The blue line of the ERP represents rule violations, the dashed, grey line represents normal, rule-based responses. The coloured area around the difference wave indicates ± 1 standard error of paired differences (Pfister & Janczyk, 2013), computed separately for each time point.

**REFERENCES**


Contact: roland.pfister@uni-wuerzburg.de

**SUMMARY & CONCLUSIONS**

The present results are clear-cut: First, intended rule violations do not give rise to ERN-like components in the ERP as unintended errors do. Second, the P300 response to the stimulus prompting a violation was attenuated and delayed compared to normal, rule-based responses.

These findings indicate that rule violations are a complex type of behaviour, distinct from normal, rule-based responding. Human agents thus seem to be unable to simply reverse a to-be-violated rule; rather they continue to be influenced by the original rule. Rule breaking therefore reminds of ironic effects of facilitating behaviour that an agent intends to suppress (Wegner, 2009). The relation of rule violations to such ironic effects on the one hand and the exact processes that underlie the observed results on the other hand clearly await further investigation.