FROM CERTAINTY TO CHAOS: DISSOCIATING RISK AND AMBIGUITY IN THE HUMAN BRAIN

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Background: Decision-making under uncertainty takes an inherent part of human daily life and refers to scenarios where the decision-maker lacks information about relevant features regarding the outcomes of alternative options. Scientific disciplines, consistently describe at least two distinct concepts – risk, defined as an explicit variability of the likelihood of outcomes, and ambiguity, defined as imperfect or limited knowledge about the relative likelihood of outcomes. As existing literature focuses on independent manipulations targeting risk and ambiguity, it is unclear whether risk and ambiguity processing rely on shared or non-shared neuronal mechanisms.

Aims: The present research aims to experimentally dissociate the brain correlates of risk and ambiguity processing in decision-making.

Methods: Two studies were conducted. An EEG/ERP study with eighty community-dwelling volunteers and an fMRI study with thirty-four community-dwelling volunteers. Participants filled out self-report measures on attitudes towards uncertainty and risk and performed a behavioural economic decision-making task designed to dissociate risk and ambiguity while controlling for expected value and expected utility.

Results: Linear Hierarchical Modelling (LIMO) of ERP data shows differential effects of risk and ambiguity while controlling for relevant covariates. Specifically, while ambiguity processing starts early (around 200 ms) and lasts until 800 ms post-stimulus presentation, risk processing starts at 400 ms post-stimulus presentation, suggesting differential brain mechanisms being recruited. The fMRI analysis supports this observation, with increased ambiguity being mainly associated with increased activation of the dorsal attentional network while risk modulates brain activity in the insula and anterior cingulate cortex.

Conclusions: Results support the notion that uncertainty processing integrates information hierarchically, with ambiguity eliciting early and increased activation in attention-related brain regions.

Keywords: Uncertainty processing, Neuroimaging, Risk, Ambiguity

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