The role of mid-frontal theta oscillations in value-biased objective decisions.

Value has been demonstrated to impact rapid perceptual choices by being initially integrated into the decision process, sometimes to the detriment of performance (Afacan-Seref et al., 2018; Corbett et al., 2023). This study proposes that conflict-processing brain mechanisms are engaged in detecting and resolving conflicts between sensory and value-based information, and enhancing cognitive control (Botvinick et al., 2004; Cavanagh & Frank, 2014) via the dorsal-anterior cingulate cortex (dACC) and its related mid-frontal theta-band oscillations (4-7Hz).

In the experiment, participants (N=31) were presented with pairs of images of edible items with varying estimated price (ΔP) and preference differences (value; ΔV), and asked to quickly select the cheapest item. Congruent pairs had a large ΔV, where the cheapest item was also the preferred option, while incongruent pairs had competing value and sensory information.

As predicted, congruency influenced both response time and accuracy (χ^2=43.8, p=3.1x10^{-10}), with congruent trials being faster (mean±sd: $m_{congruent}$=.646±.44ms, $m_{incongruent}$=.667±.39ms, z=-12.57, p=3.1x10^{-36}) and more accurate than incongruent trials ($m_{congruent}$=.74±.10, $m_{incongruent}$=.72±.09, z=3.99, p=2x10^{-4}). There was no interaction between congruency and ΔP (accuracy: χ^2=1.42, p=.49; RT: χ^2=.42, p=.81), suggesting that the observed congruency bias was due to automatic activation of the value-based system, rather than a voluntary strategy. EEG analyses revealed higher mid-frontal theta power for incongruent compared to congruent trials (p_{adj}=.038), which correlated with the magnitude of the congruency effect on RT (r=-.42, p=.02). Furthermore, mid-frontal theta power predicted accuracy in incongruent (z=2.77, p=.006), but not in congruent trials (z=.46, p=.64), indicating that successfully monitoring conflict in incongruent trials requires higher mid-frontal theta activity.

To the best of our knowledge, this is the first study to show the automatic impact of value on objective decisions in the absence of anticipatory preparation. What is more, it establishes a link between value-based biases on behaviour and mid-frontal theta oscillations, and suggests an underlying mechanism of cognitive control that redirects the decision process towards the goal-relevant evidence.