The role neurotransmitters play in contextual preference reversals

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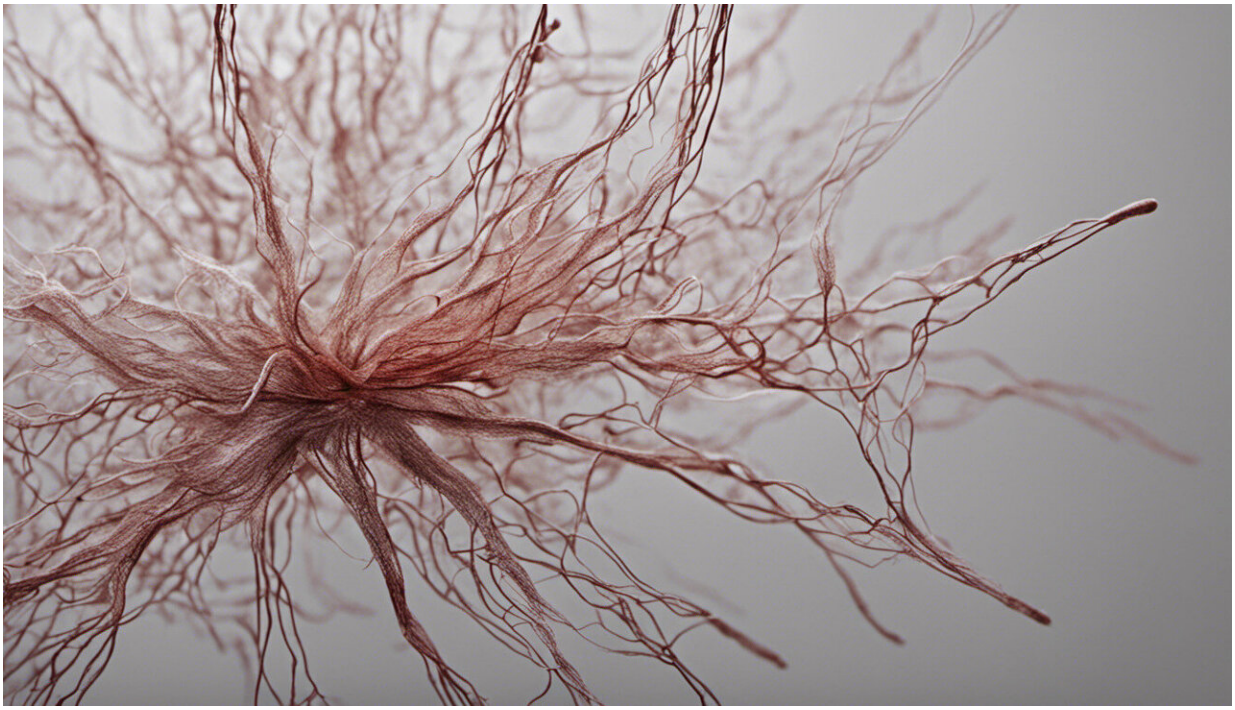

Credit: AI-generated image (disclaimer)

With advanced neuroimaging tools and clever experimentation CODIR went beyond the neoclassical behavioural economics contention that humans act irrationally; the team actually quantified precisely what information processing limitations lead to rationality violations.

Every day we make a large number of decisions. Some decisions are fast and automatic, such as whether to turn left or right on our route to work. However, other decisions, especially important ones, require longer deliberation and more effort. People frequently reverse their original choice in the presence of an added inferior option – a class of phenomena called 'contextual preference reversals' (CPRs).

The EU-supported CODIR project set out to empirically investigate the brain mechanisms responsible for CPRs and to examine differences across individuals. The project pinpointed violations of rational choice theory within neural information processing at the level of cortical dynamics and neurotransmitter functioning.

Using pharmacological manipulations in healthy individuals, CODIR found that the neurotransmitter controlling inhibitory interactions in the brain (GABA-A), underlie these rationality violations. Here, inhibitory interactions mediated by GABA-A were shown to essentially control the extent to which attention focuses disproportionally on the positive features of decision alternatives. A richer understanding of the neural computations that GABA-A orchestrates were achieved with the help of magnetoencephalography recordings (MEG).

Decision making experiments

Explaining the rationale for CODIR, lead researcher Marie-Curie Fellow Dr. Konstantinos Tsetsos says, "Past research has not addressed what characteristics of information processing lead to anomalies. In our research, we attempted to fill this gap. By building on our previous work, we created an experimental task that maintained the core features of complex decisions but was simple enough for brain activity measurement and characterisation of neural information processing."

Participants observed two streams of numbers (presented in quick

succession) after which they had to select the stream that had the highest sum. The task replicates real-life multi-attribute decisions where the brain very likely processes 'value samples' sequentially to assess information, while avoiding overload.

"This psychophysical task allowed the project to trace brain activity across the entire processing hierarchy: from the visual representation of numbers (input) up to the brain signals that reflect motor preparation before action execution (output)," adds project supervisor Prof Tobias Donner.

The team manipulated brain activity via means of pharmacological intervention by administering low dosage lorazepam (a benzodiazepine used to treat among others anxiety and sleep disorders) in order to increase the efficiency of the GABA-A neurotransmitter. This manipulation had evident results both in brain activity and behavioural performance.

CODIR developed a model which included the inhibitory interactions between value samples and the time frame for attentional selection. The MEG data, as well as the pharmacological intervention, provided crucial constraints for the simulations.

Overall, this model was found to predict decisions better than its previous iteration, which had itself already largely outperformed comparable decision-making models.

Applications for clinicians and consumers alike

CODIR identified the links between high-level decision phenomena, CPR's and brain mechanisms. Identifying why people err when making decisions could contribute to the development of decision support systems, for instance consumer protection tools.

Additionally, the establishment of a causal link between neurotransmitters and decision-making behaviour also has clinical implications. "Knowing which neurotransmitters give rise to certain behaviours can help build diagnostic tools for some neuropsychiatric diseases using CODIR's experimental task, something which we are already pursuing in collaboration with psychiatrists," Dr. Tsetsos summarises.

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