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### Ever wondered why perceptual performance fluctuates over time? We found answers and new questions in our latest project, out now @PLOSBiology, by analyzing over 20 million perceptual decisions in humans and mice (https://doi.org/10.1371/journal.pbio.3002410). A🧵:

🔍 It has long been known that perception detaches from external inputs in recurring intervals that last from milliseconds to seconds and even minutes. We wondered whether these fluctuations in performance are just noise or help to make perception more efficient.

🚀 To answer this question, we needed a lot of data. We found these data in two great open science projects on perceptual decision-making in humans (the Confidence Database, https://doi.org/10.1038/s41562-019-0813-1, @DobyRahnev) and mice (the IBL Database, https://www.internationalbrainlab.com/data, @IntlBrainLab).

📊 We confirmed that humans & mice slowly fluctuated between intervals of enhanced and reduced sensitivity to external inputs. When less sensitive to external inputs, humans & mice didn't behave more randomly, but were more likely to repeat previous choices.

Twitter data 1

🔄 This may indicate the perceptual inference in bimodal, alternating between an external mode, when perception is more sensitive to external sensory information, and an internal mode, when perception is stabilized by preceding choices.

🤔 But how may slow fluctuations between external and internal mode improve perception? We propose that spending time away from external information may help the brain to balance sensitivity to change with robustness against sensory noise.

💡 Our world is strongly autocorrelated, meaning that the recent past is a good predictor of the near future. Internal mode may help to smooth noisy inputs but relying on predictions about the world that are integrated from the sequence of previous experiences.💡

🧠 In the brain, these stabilizing internal predictions may be conveyed by feedback that modulates neural processing via recurrent connections that travel all the way back to early levels of sensory analysis, including V1 and even the LGN!

👀 Relying on internal predictions may therefore come at a cost: When the world changes unexpectedly, internal predictions may override external information, leading to circular and false beliefs that persist despite evidence to the contrary.

🤷 To make this worse, our data show that humans have a hard time telling whether their perception is caused by external data or internal predictions! Recurrent neural processing thus creates a credit assignment problem that challenges metacognition and reality monitoring.

🛟 This is where bimodal inference comes to the rescue: Between mode fluctuations may generate unambiguous error signals that align perception with the current state of the environment in iterative test-update-cycles.

💭 During external mode, perception is decoupled what we believe to know. This may help to update internal representations via feedforward encoding. During internal mode, perception is constrained by predictive feedback that can be tested against reality.

🖥️ Our computational analyses confirm that two processes are necessary for bimodal inference: the integration of sensory information over time, and slow oscillations in the perceptual impact of external inputs vs. internal predictions that are shaped by preceding choices.

🧠 We think this is exciting news for the field of computational psychiatry, where symptoms such as delusions and hallucinations are explained by alterations in the balance between feedforward and feedback processing – a balance that may be learned & updated via bimodal inference!

🚀 In future work, we will test whether bimodal inference may answer one of the many open questions in computational theories of psychosis: how people jump to conclusions based on little amounts of data but stick with them despite a lot of new evidence to the contrary.

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🙌 Many thanks also to our reviewers and the team at @PLOSBiology, who helped us a lot in improving this manuscript!

🤝 If you are wondering whether bimodal inference is hiding in your data, feel free to reach out: We are currently looking for collaborators on an #OpenScience project to test bimodal inference across cognitive domains, time & in relation to psychopathology!