Jürgen Kornmeier

Jürgen Kornmeier is head of the Institute for Frontier Areas of Psychology and Mental Health (IGPP) in Freiburg, Germany, with research interests in perception, altered states and consciousness.

Career

Jürgen Kornmeier studied biology and mathematics at Albert-Ludwigs-University Freiburg, then gained a doctorate degree in 2002. His doctoral work investigated brain mechanisms on changing perceptions of ambiguous pictures using electroencephalography (EEG). He held several postdoctoral assignments from 2002 until 2008 and acted as deputy leader at University Eye Clinic Freiburg.

Kornmeier joined the Institute for Frontier Areas of Psychology and Mental Health (IGPP) in Freiburg, Germany as a research fellow, obtaining an advanced university teaching qualification in 2013. He served as an instructor within the biology faculty, then took over the IGPP directorship in 2022.

His research interests cover visual perception, perceptual instabilities and their neural correlates, altered states of consciousness and consciousness studies – all facilitated by means of EEG recordings, artificial intelligence applications together with quantum theoretical considerations.

Ambiguous Stimuli

ERP Ambiguity Effects

Earlier research by the IGPP group had identified major differences in brain responses at 200 and 400 milliseconds elicited by ambiguous versus unambiguous stimuli. These came to be known as 'ERP Ambiguity Effects'. The Kornmeier and Joos study tested whether this effect would extend beyond simple geometrical patterns to encompass emotional ambiguity. The experiment compared brain responses evoked by ambiguous cube stimuli (low-level ambiguity) and those elicited by ambiguous emotional faces (high-level ambiguity). Emotional ambiguity was manipulated regarding mouth curvature variations that created different degrees of emotional ambiguity. Results replicated the effects for geometric stimuli. Very similar patterns were obtained with emotional faces, indicating that these effects generalize across different types of high-level ambiguities.[1]

Predictive Processing

An experiment was designed by Kornmeier and colleagues to test whether predictions generated from perceptual patterns automatically influence the processing of a current stimulus. Ambiguous Necker lattices and unambiguous variants were used. Brain responses and reaction times were measured while manipulating what had been seen before in the immediate past by the participants. In Experiment 1, brain responses to physically identical stimuli differed significantly depending on whether the immediately preceding stimuli had been ambiguous or unambiguous. Effect sizes were between 0.24 and 0.62, while p-values were significant, ranging between 0.0007 and 0.02. Reaction times also differed as a function of previous context, though this information was irrelevant to the task.

Experiment 2 found that mere symbolic telling of participants what would appear next was not enough. Effects only emerged after several presentations of the actual stimuli. Differences in brain responses emerged already at the third stimulus ($p = 0.016$). This supports the notion that integration of previous perceptual information into current processing happens automatically and inevitably influences the present.[2]

Pareidolia

Mayer and Kornmeier examined wildlife camera pictures sent by a hunter that appeared to reveal abnormal objects: a small human-like figure with skull-like features and an unclear white shape in the air. Close study revealed the ‘humanoid’ was actually a jay bird, whose typical throat marks had been taken for eyeholes while the white shape was a bug flying very near to the camera lens.

This is a textbook case of pareidolia – the tendency to see meaningful patterns in random stimuli and the biased interpretation caused by prior expectations (the individual had recently seen media coverage of the Atacama mummy, setting up an expectation that biased perception). The study goes some way toward unpacking how sensory paucity, memory, and cultural knowledge intermix in visual processing, particularly of low quality or ambiguous imagery.[3]

Perceptual Reversals

Kornmeier and Mareike Wilson studied whether perceptual reversals of the ambiguous Necker cube stimuli that were called 'spontaneous' could actually be taken at face value as truly spontaneous. Brain activity signature components were looked for. This was done by comparing those evoked during perceptual stability against those shortly preceding reversal events.

For ambiguous stimuli, the earliest differences between reversal and stability trials occurred approximately one second prior to reversals at bilateral parietal brain regions. Traces stayed alike until about 1,100 milliseconds pre-reversal. They became maximally different at 890 milliseconds ($p = 7.59 \times 10^{-6}$, Cohen's $d = 1.35$) and then stayed divergent until just a little time before the end of the stimulus. No such patterns appeared in control stimuli where there was no ambiguity.

Artificial neural network analysis reached 59% accuracy in eight out of fifteen participants - this was compared to a control accuracy level of 52%. Localization of brain sources identified the parahippocampal place area as most significantly different ($p = 3.96 \times 10^{-5}$). Perceptual reversals are therefore considerably less spontaneous than they are subjectively experienced to be. Destabilization processes unfold over extended timescales.[4]

Retroactive Priming

Wilson et al. carried out an exploratory study on behavioral and brain correlates of forward and backward affective priming paradigms. Thirty-one subjects completed both with concomitant recording of brain activity.

In the case of forward priming - when an emotional word preceded an emotional image - subjects responded significantly faster to matching trials than mismatched trials ($p = 0.0004$). A comparison of brain activities elicited by these conditions indicated significant differences at right parietal regions between 600-900 milliseconds after target onset.

But in the backward priming condition - target before prime (as per Bem's 2011 controversial precognition publication) - no statistically significant differences in reaction times were observed ($p = 0.12$). Results from brain activity for backward priming were substantially weaker, shorter in duration, and less significant than forward priming effects. Single-trial brain data neural network classification yielded only chance-level results for both conditions. The study provides firm replication of the forward priming effect but does not support the previously reported precognitive backward priming effect.[5]

Michael Duggan

Literature

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Endnotes

Footnotes

- 1. Joos et al. (2019).

- 2. Joos et al. (2020).
- 3. Mayer & Kornmeier (2014).
- 4. Wilson et al. (2023).
- 5. Wilson et al. (2025).