Effects of prediction error size and valence on pain perception

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BACKGROUND

• There exists extensive evidence supporting the modulation of perceived pain by expectation, such as nocebo and placebo effects (Colloca & Benedetti, 2006; Colacurci et al., 2015).

• A recent study by Hird et al. (2019) showed that while expectation is an important factor that modulates pain perception, the extent to which it influences perception changes with different magnitudes of prediction error.

• Hird et al. (2019) propose that there exists a “tipping point,” whereby the influence of expectation on perception becomes smaller (and thus the influence of sensory evidence becomes greater) as the size of prediction error increases.

Figure 1: Tipping point theory, modified from Hird et al. (2019). The graph shows the expected relationship between prediction error and subjective error. Prediction error is the difference between delivered and expected pain intensity, while subjective error is the difference between predicted and delivered pain intensity.

AIMS

• Provide the first replication of the study by Hird et al. (2019) to determine the evidence for the tipping point.

• Determine whether the influence of priors on perception varies according to the valence of the prediction error, and according to individual differences in autistic and alexithymic traits.

METHODS

• 83 adults (19 aut-alex, 16 aut-alex, 13 alex, 35 n/a) participated in the prediction error size task. Participants were IQ- and gender-matched at a group level.

• After applying the exclusion criteria, the final analysis sample consisted of 76 adults (18 aut-alex, 15 aut-alex, 13 alex, 30 n/a).

• Self-report measures: Age, gender, AQ-50, TAS-20, STAI-1, STAI-2, BDI-II, PCS, BPDQ-5, IAS, IAT, IUS-12, FSQ

• Pain stimuli were given electrocutaneously and were individually calibrated prior to the task (2 through 8 out of 15 on a numerical pain scale).

• The prediction error task consisted of 5 blocks of 24 trials, totalling 120 trials.

• The task was explained to participants as a task where the cue, which was a number, predicted the upcoming stimulus intensity.

• Cues 3 through 7 were veridical cues (i.e., prediction error was always 0).

• Cues 2 and 8 were at times non-veridical cues (i.e., for cue 2, prediction error ranged from 0 to 6; for cue 8, they ranged from 0 to 6).

• Data Analysis

Use generalised additive models (GAMs) to assess whether trends observed in Hird et al.’s (2019) data (habituation, cue effect, effect of prediction error size and valence) were also observed in the present study.

Use NLME to replicate Hird et al.’s (2019) analysis strategy.

Use elastic net linear regression to assess whether the modulation of subjective error was also influenced by other nuisance covariates.

CONCLUSION

• The GAM and NLME analyses showed evidence of the tipping point.

• The higher the autistic traits, the less pronounced the effect of cue, meaning that those with high autistic traits were less influenced by the expectation.

• The higher the alexithymic traits, the greater the tipping point (the quartic relationship between prediction error and subjective error) early in the task, but the less pronounced the tipping point becomes later in the task.

• The results suggest that it is alexithymic traits, not autistic traits, that shape the formation of prediction error size and valence affect one's pain perception.

• However, elastic net models including nuisance covariates did not find an effect of either autism or alexithymia (though the non-significant results may be due to lack of power).

• Thus, it is possible that the apparent alexithymia effect is due to its covariance with another trait.

REFERENCES


CONTACT

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