Changes in the Use of Prior Semantic Knowledge Relative to Sensory Information in Patients in Acute Psychosis and Psychotic Remission and the Link to Hallucinations: A Longitudinal Approach

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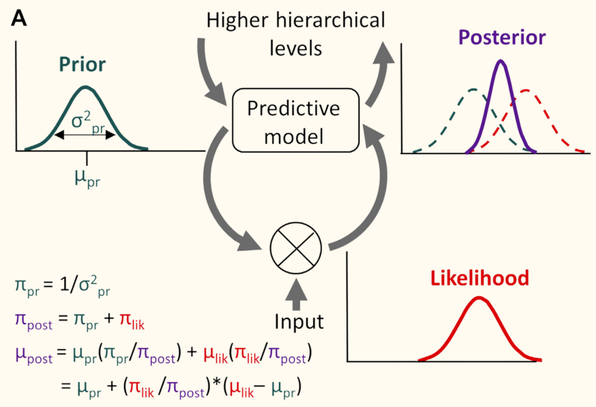
Background

Schizophrenia is associated with a wide range of language alterations[1,2]. Interestingly, the recent predictive coding account does not only provide a testable theory for the explanation of positive symptoms in schizophrenia[3,4], but is also one of the most promising theories of language processing[5,6]. Experimental evidence of the predictive coding account of psychosis is inconsistent; therefore, a hierarchical approach has been put forward, which suggests an overweighing of sensory likelihood at lower levels (e.g., early sensory processing areas) due to increased dopamine activity causing aberrant salience and potentially leading to delusions, while an overweighting of prior beliefs at higher levels, potentially caused by altered glutamatergic receptor signalling, and potentially leading to hallucinations[3]. This study therefore addresses the following questions:

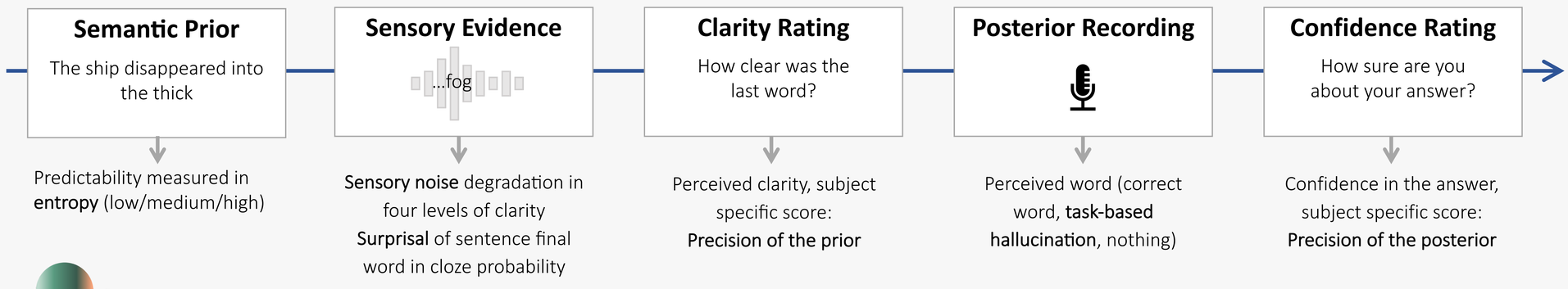
(1) How does the use of prior knowledge relative to sensory information change in a predictive language task when patients with schizophrenia transition from acute psychosis to psychotic remission?

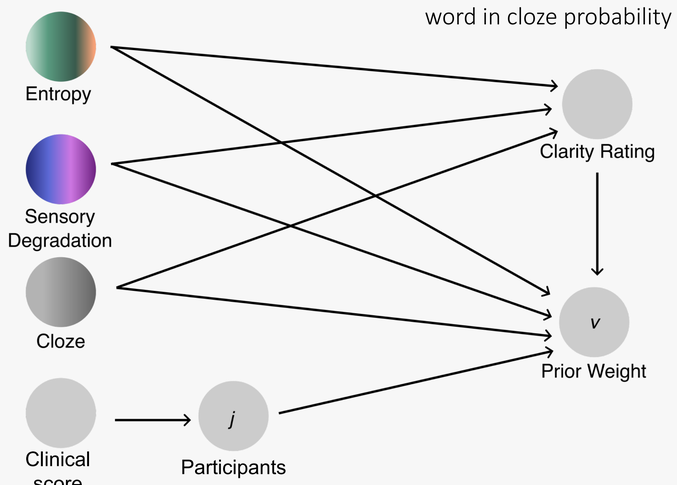
(2) Is an overreliance on prior semantic knowledge linked to specific symptoms in a state of acute psychosis or remission?



Sterzer et al 2018, Biological Psychiatry

Methods





Prior probability of the prediction → cloze probability of the word the person uttered

Influence of new evidence (right or wrong) and prior information (cloze probability of the uttered word) → prediction error

$$Pm_i|n_i = Pm_i + \frac{1}{vi+1}(\delta m_i, n_i - Pm_i)$$

The posterior probability of the word that has been perceived.

$$log(vj) = \beta 1j[i] + \beta 2j[i] * \mathrm{channels}i + \beta 3j[i] * \mathrm{entropy}i + \beta 4j[i] * \mathrm{cloze}_{\mathrm{pu}i} + \beta 5j[i] * \mathrm{clarity}i$$

$$\beta kj = \alpha kj + \gamma k\mathrm{spq}j$$

$$\alpha kj \sim N(0,0.2)$$

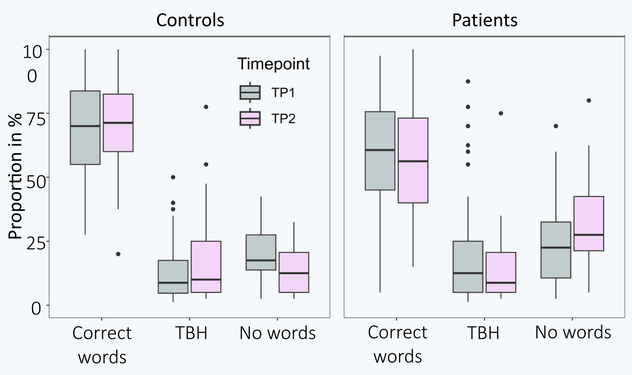
$$\gamma k \sim N(0,0.2)$$

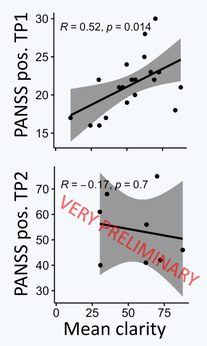
Participants

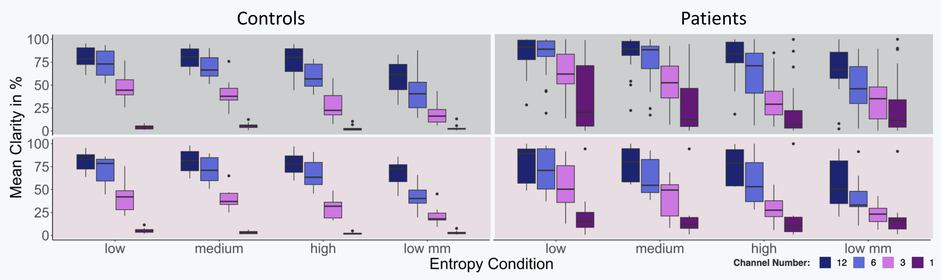
	Time point 1	Time point 2
	Patients	
N (F/M)	6/15	1/8
Age (SD)	36.9 (10.7)	39.2 (10.9)
PANSS total	80.8 (15.9)	54.7 (14.1)
PANSS positive	21.1 (3.3)	12.9 (3.4)
PANSS negative	20.8 (6.6)	17.1 (5.6)
PANSS general	38.9 (8.8)	24.7 (6.7)
	Controls	
N (F/M)	6/7	5/6
Age (SD)	33.3 (13.3)	31.4 (12.2)

PANSS: Positive and Negative Symptom Scale

Performance Results

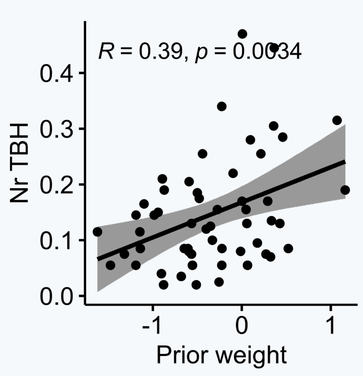


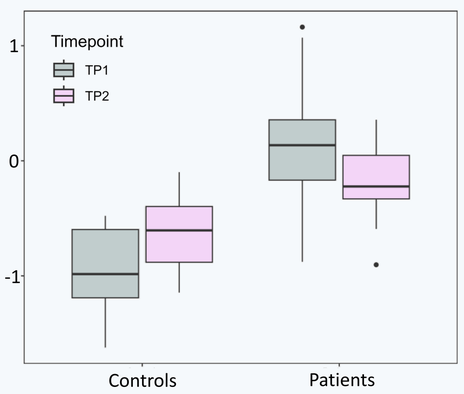




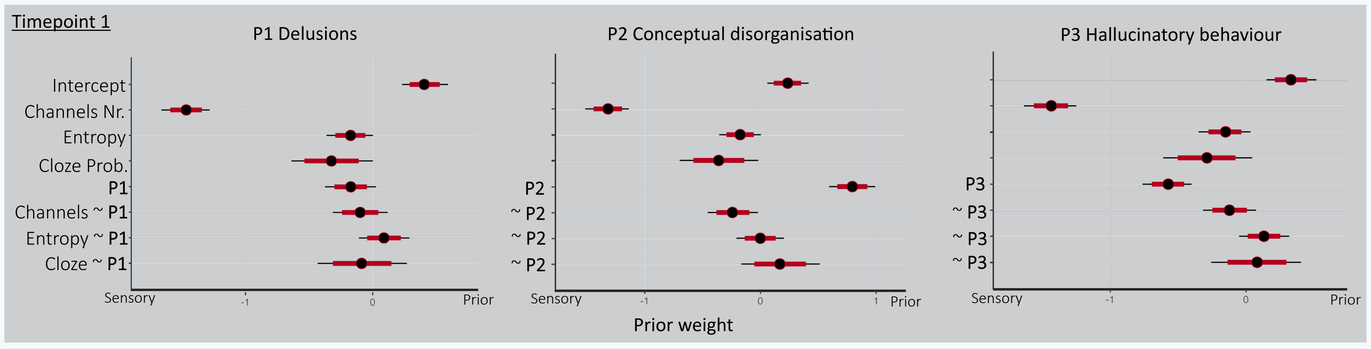
- → Patients show slightly more task-based hallucinations (TBH) during acute psychosis, but much more variance
- → Higher positive symptoms are linked to higher clarity rating in acute psychosis, but not in remission
- → Patients show more variance in clarity rating across levels of entropy and degradation compared to controls

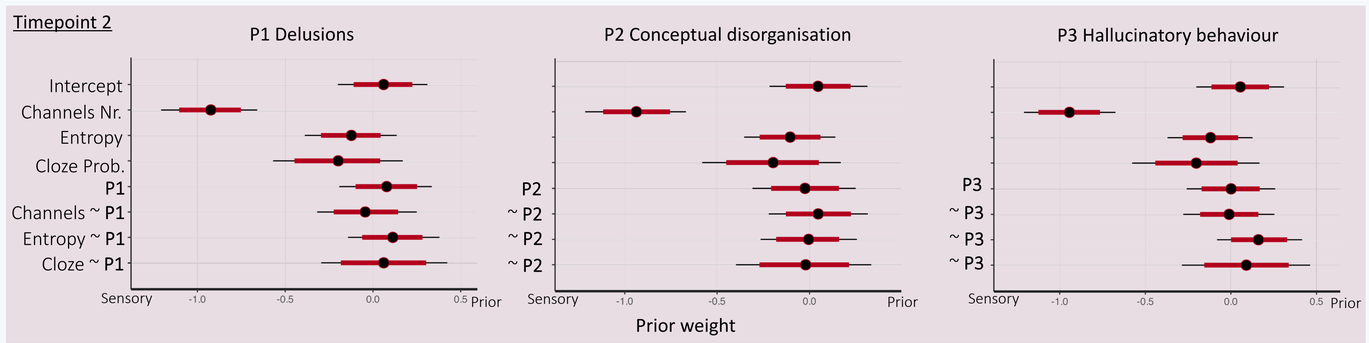
Modelling Results





- → Proportion of task-based hallucinations (TBH) are linked to strength of the prior weight across all participants and timepoints
- → Patients generally overweight the prior compared to controls, but the overweighting of the prior seems to normalise during remission
- → Specific positive symptoms are linked an over/underweighting of the prior: hallucinatory behaviour (and delusions) are linked to an underweighting; whereas conceptual disorganisation is linked to an overweighting
- → The imbalance normalises in timepoint 2, the state of remission.





Conclusion

This study provides quantified evidence for a general overweighting of prior beliefs during a psychotic state in chronic schizophrenia, which normalises during psychotic remission. Importantly, the prior weight is differently impacted by different positive symptoms, providing a mechanistic explanation underlying different psychotic symptoms.

Reference

1. Brown, M., & Kuperberg, G. R. (2015). A hierarchical generative framework of language processing: linking language perception, interpretation, and production abnormalities in schizophrenia. *Frontiers in Human Neuroscience*, *9*, 643.
2. de Boer, J. N., Linszen, M. M., de Vries, J., Schutte, M. J., Begemann, M. J., Heringa, S. M., ... & Sommer, I. E. C. (2019). Auditory hallucinations, top-down processing and language perception: a general population study. Psychological medicine, 49(16), 2772-2780.
3. Sterzer, P., Adams, R. A., Fletcher, P., Frith, C., Lawrie, S. M., Muckli, L., ... & Corlett, P. R. (2018). The predictive coding account of psychosis. Biological psychiatry, 84(9), 634-643.
4. Fletcher, P. C., & Frith, C. D. (2009). Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia. Nature Reviews Neuroscience, 10(1), 48-58.
5. Kuperberg, G. R., & Jaeger, T. F. (2016). What do we mean by prediction in language comprehension?. Language, cognition and neuroscience, 31(1), 32-59.
6. Lupyan, G., & Clark, A. (2015). Words and the world: Predictive coding and the language-perception-cognition interface. Current Directions in Psychological Science, 24(4), 279-284.

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DFG Deutsche Forschungsgemeinschaft

DGNR Deutsche Gesellschaft für Neuroradiologie e.V.

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