Data gathering ability contributes to visual organization and probabilistic reasoning

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Abstract

Individuals use data gathering methods to inform judgments and behaviors. Effective interaction with the environment depends on these having high accuracy and low noise, but when they become abnormal, aberrant thoughts and perceptions can occur. In this study, we examined if data gathering methods were consistent across tasks that relied on different cognitive abilities, specifically visual perception and probabilistic reasoning. Thirty-four non-clinical participants engaged in the Ebbinghaus Illusion and the Jumping to Conclusions tasks, while also completing questionnaires concerning aspects of delusion formation. A significant, positive correlation was observed between performance on the Ebbinghaus Illusion and the Jumping to Conclusions tasks. Both tasks were negatively correlated with the General Conspiracy Belief Scale. The results suggest an underlying mechanism for data gathering that is consistent across behavioral domains and exists on a continuum in the general population.

Keyword: Psychology
1. Introduction

An essential mechanism contributing to complex human cognition is the ability to adapt and learn with new information. Some mental processes use Bayesian functions when gathering data to alter or maintain hypotheses about the external world, relying on an interplay between the environment and the organism (English et al., 2016; Fawcett and Frankenhuis, 2015). As new data is incorporated, hypotheses are reevaluated, allowing individuals to adjust to changing circumstances. Therefore, the ability to accurately gather data and process coherent stimuli from the environment is instrumental to the proper development of multiple cognitive faculties.

1.1. Prediction error and behavior

Experiential learning in the manner described above is exemplified through the development of an individual’s worldview. Thoughts, manners, and social norms inform future behavior based on patterns of responses and consequences of actions (Jozefowiez and Staddon, 2008). Learning and behavior may not be guided strictly by rewards and consequences, however, but also by Bayesian reasoning (Zhang, 2009). Under this framework, individuals develop hypotheses about their environments from expected outcomes, but continually update their expectations based on the actual outcomes (i.e. adjusting for prediction error). At the neurobiological level, this type of adaptive learning occurs as neural connections strengthen or weaken depending on the outcomes of cellular interactions (Friston, 2005; Schultz and Dickinson, 2000). Highly active synapses form additional dendrites and receptors, increasing the overall efficacy of existing connection and contextual inputs. Likewise, synapses with seldom used connections will degrade, decreasing their efficacy. Because these individual nodes comprise larger networks feeding into conscious processes and behaviors, deficiencies can result in mental health disorders, such as schizophrenia, in which improperly weighted salience placed on stimuli can result in delusions, perceptual aberrations, and other positive symptoms of psychosis (Clark, 2013; Corlett et al., 2009; Hemsley and Garety, 1986; Kapur, 2003; Phillips and Silverstein, 2013; Roiser et al., 2009).

To form and update probabilistic inferences of the outside world, data need to be effectively gathered and analyzed. If prediction errors are not correctly applied, cellular networks may not adjust synaptic integrity appropriately based on contextual inputs, and probabilities of expected outcomes may not generate accurately. When the probabilistic outcomes of certain events or stimuli are inappropriately weighted, salience can be placed on perceptions or thoughts that are not representative of the actual environment. This can result in delusional ideation, in which mal-adaptive beliefs are strongly held in the absence of supporting evidence, and not
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