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Research Award Brief

"Deep Irrationality" in Perception and Cognition: Antibayesian Updating When Expectations are Defied (2017-2019)

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Research Question: How 'rational' is the learning process?

Interdisciplinary Approach: This project combines behavioral experiments with a philosophical analysis of learning models to determine whether we integrate new information in a way that obeys the principles of rational inference.

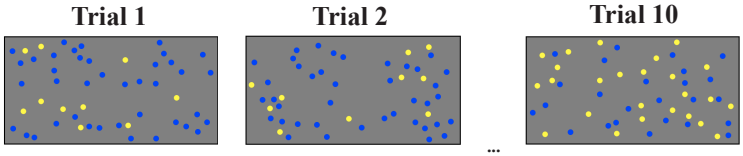
Potential Implications of Research: The results will help us understand when it is that we learn how we 'should' learn, and when we do not; this may differ across learning contexts, and could thereby help us improve learning in different domains.

A fundamental challenge when learning new information is determining how to integrate such information into our pre-existing body of knowledge. Such integration can be a kind of 'two-way street': On one hand, new information can revise our prior beliefs about the world, and even change our mind about preconceived notions we might have; on the other hand, our prior beliefs about the world can change how we interpret new information in the first place. For example, suppose you had read several studies suggesting that smoking was unhealthy for you, and then you saw a new study reaching an unclear conclusion, reporting some helpful effects and some harmful effects of smoking. If you already had good evidence that smoking was unhealthy, you might focus on the negative aspects of the new study and conclude that it was largely in line with your prior belief.

Classical and contemporary approaches in statistics and decision theory tell us how exactly these kinds of inferences 'should' work in principle — how best to let new information change our prior beliefs while also allowing our prior beliefs to influence our interpretation of new evidence. Fascinatingly, recent theoretical and experimental advances in computational psychology have suggested that our minds carry out these inferences *in practice* the way they 'should' proceed *in principle*. These findings have led to new theories of human psychology, which suggest that our minds are fundamentally "rational" or "optimal" learning systems.

Our project, however, explores phenomena that seem to defy this pattern — cases where our minds react to new evidence in a way that is *opposite* what would be expected if we are taking a 'rational' approach. Following the above analogy, this would be like hearing about a new study on the mixed health effects of smoking and inferring that it was actually very favorable for smoking. Does the mind ever behave in this strange-seeming way? Some early results in our project suggest so.

Instead of studying opinions about public health issues such as smoking, we have been investigating more fundamental processes in the mind, such as our visual experience of the world. For example, suppose you saw two groups of objects on a computer screen (some blue circles and some yellow circles) and were asked to judge which group had more — and, over many instances, you learned that there are typically more blue objects on the screen than yellow objects. If, later on, you then saw a roughly equal number of blue and yellow circles, which would you conclude had more? A 'rational' approach would be to answer that there are more blues, since you can't quite tell which has more but you know that there are usually more blues. However, we found that people consistently do the *opposite*: They answer that there are more yellows!



This suggests that people may combine prior expectations and new evidence in ways that fail to be captured by the dominant models of cognition as an 'optimal' process. By studying when learning is optimal and when it is not, we hope to better understand how learning works — and perhaps even tackle the age-old question of whether and when we behave 'rationally'.

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