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Intuitive Biology and Global Challenges: Applying Theoretical Insights for Public Good

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Motivation & Overview

Questions about science literacy and the rejection of scientific consensus are once again in the spotlight, with freshly-ignited international debate over the facts of climate change, and continued controversy around the teaching of evolution. In recent years, cognitive scientists have made valuable contributions to these debates: a now substantial and diverse research field has implicated a range of cognitive, motivational and emotional factors that contribute to science acceptance, and researchers are increasingly concerned with the application of these insights to improve the quality of public debate and science-relevant policy.

In this symposium we focus on a specific strand of this research field – that related to the concepts and intuitions deployed in reasoning about the biological world. A defining feature of our symposium is the inclusion of nascent research programs exploring the role of biological reasoning in newly-emerging domains of public debate (e.g. synthetic biology), alongside more established research areas (e.g. climate change & evolutionary theory). Our core aims are two-fold: to advance key theoretical debates relating to reasoning in the biological domain via the presentation of new empirical data, and to highlight emerging best-practice in translating this basic research into applied tools in both formal learning and informal communication contexts. We are confident that this focus will be of interest not only to researchers in the broader areas of science literacy, reasoning and conceptual change, but also to those interested in the challenge of applying cognitive science research for the public good.

Within this theoretical and applied framework we bring together researchers from a variety of disciplinary backgrounds, including anthropology, philosophy, and psychology, to explore the themes of the symposium from the perspectives of human development, education, cognitive processing, moral reasoning, cultural variation, risk perception, and conceptual knowledge structure.

The symposium will consist of four talks and a panel discussion. **Kelemen** will present cross-cultural evidence for the developmental persistence of teleological biases, and describe the translation of these findings into early-education tools. **Shtulman** will present data on the conceptual prerequisites for understanding evolution, and discuss implications for increasing support for evolution-relevant policies. **Coley & Betz** will present new work on intuitive reasoning about climate change. **Swiney** will present data on the interplay of intuitive biology and moral reasoning in shaping risk perceptions of synthetic biology and discuss related communication challenges. **Blancke** will lead the panel discussion, drawing on his own research bridging cognitive science and public understanding of biotechnology (Blancke et al. 2015). Together the participants have published several dozen papers in the area, including in *PNAS*, *Psychological Science*, *Cognitive Science*, *Cognition*, and *Child Development*.

Kelemen: Purposefully Designing Materials for Teaching Children About Natural Selection

In a world where economies are increasingly fueled by biotechnological responses to rapidly adapting disease pathogens, pesticide-resistant insects, and climate change, understanding evolutionary processes is prerequisite for informed decision-making about bioethical issues. Despite this, the fundamental evolutionary mechanism of natural selection is one of the most misunderstood concepts in science. The roots of these misconceptions can be traced to intuitive cognitive biases emergent in early childhood. In this talk, I will overview evidence from Eastern (e.g. China) and Western (e.g. U.S.) cultures that suggests the universality and developmental persistence of biases to construe nature in terms of purpose and intentional design (e.g. Rottman et al., 2017; Schachner et al., 2017). I will describe the application of these child developmental and adult dual-processing findings to the design of explanation-rich storybooks for teaching elementary school children about adaptation by natural selection. Findings reveal that after analogical discussion of two storybooks, young children accurately and enduringly generalize the theory of

natural selection. Implications for theories of conceptual change and early science education will be discussed.

Deb Kelemen is Professor of Psychological and Brain Sciences and Director of the Child Cognition Lab at Boston University.

Shtulman: Why People Fail to Understand Evolution and Why it Matters

Evolutionary theory underlies several issues of global importance—biodiversity, conservation, antibiotics, chemotherapy, cybersecurity—but studies have shown that the general public misunderstands what evolution is and how evolution works (Shtulman & Schulz, 2008; Shtulman & Calabi, 2013). In this talk, I will explore three conceptual prerequisites for understanding evolution: geologic time, intraspecies variation, and intraspecies competition. All three concepts have been implicated in the discovery of natural selection in the history of science, and I will show that all three concepts explain a significant amount of variance in who understands evolution and who does not. Nevertheless, one concept in particular—intraspecies competition—explains nearly three times as much variance as that explained by the other two concepts combined. I will discuss the implications of these data for improving evolution education, as well as increasing public acceptance of evolution and public support for evolution-relevant policies.

Andrew Shtulman is Associate Professor of Psychology and Chair of the Department of Cognitive Science at Occidental College.

Coley & Betz: Intuitive Thinking Impacts Understanding of Global Climate Change

Although most US citizens believe that climate change is a serious issue, fewer engage in mitigative behaviors. One psychological barrier is lack of understanding of causes and effects (Bord, O'Connor & Fisher, 2000). We examined the extent to which intuitive “cognitive construals” (essentialist, teleological, and anthropocentric thinking, Coley & Tanner 2015) influence understanding of climate change. University students rated agreement with facts and misconceptions (consistent with cognitive construals) about climate change. We found that teleological thinking about the climate was negatively related to understanding the *causes* of climate change while anthropocentric thinking was positively related. Further, we found that essentialist and teleological thinking were negatively related to understanding the *effects* of climate change, while anthropocentric thinking was positively related. We discuss these findings in the context of broader debates about biological reasoning, and consider options for leveraging or mitigating intuitive beliefs to increase sustainable behavior.

Nicole Betz is a doctoral candidate and John Coley is Associate Professor and Director of the Conceptual Organization, Reasoning and Education Lab at Northeastern University.

Swiney: Essentialism, Moral Reasoning, and Evaluations of Synthetic Biology

The field of Synthetic Biology (SB) is already realizing its promise to re-engineer living things from the bottom-up, creating new life forms, drastically changing existing organisms, and heralding a level of human intervention in biology that challenges entrenched distinctions between the evolved and the designed. The cognitive sciences have much to offer the now-urgent public debates about the risks and benefits of such technologies, but cognitive research in this area remains in its infancy (Blancke et al., 2015). I introduce a research program drawing on theories from distinct areas of the cognitive sciences, including intuitive biology, risk perception, and moral psychology, highlighting the rich test-ground that SB provides for investigating the interplay of cognitive processes across these domains. I present data from a series of experiments in which participants evaluate specific SB technologies varying across dimensions such as the source of genetic material and the extent of genetic change. I show that both psychological essentialism and moral purity concerns shape moral judgments and risk assessments of SB, and I explore the unique challenges of applying these insights to public debate about biotechnology.

Lauren Swiney is a cognitive anthropologist and Research Career Development Fellow in the Warwick Integrative Synthetic Biology center.

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