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Triangulating Surprise: Expectations, Uncertainty, and Making Sense

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* = symposium organizers; presenters listed alphabetically by first author.

Triangulating Surprise

Surprise is a ubiquitous phenomenon that both draws on cognition and affects cognition, in a number of different ways. For example, in artificial intelligence an agent in a changing and imperfectly-known environment has been argued to need a surprise mechanism to survive. This symposium brings together researchers in education, computer science, cognitive psychology, and business to explore the relationship between surprise and cognition, and how it might be harnessed across domains.

We will open with a touchstone challenge: How can surprising information be recruited to promote learning? (Munnich & Ranney) Then we will explore several perspectives on surprise, ranging from violation of expectations created through repetition (Loewenstein) to a focus on the information content of surprising events (Maguire & Maguire), to the apparently conflicting roles surprise may play in judgment (May, Smith-Rodden, & Ash). Our final speakers (Foster & Keane) will synthesize these approaches, and present a broad framework for future research on surprise within the cognitive sciences.

Munnich and Ranney: Learning from Surprise

Given evidence that surprising events can catalyze sense-making and belief revision, how might educators,

journalists, etc., harness surprise to promote deeper understanding? We will present research from our own and others' labs on the links between surprise and long-term belief revision. With modest surprise, there may be little or no belief change, but conditions that heighten surprise—engaging foresight, or providing striking facts, episodes, or explanations—yield dramatic belief revisions as people seek coherence (e.g., due to as few as seven surprising statistics, a 400-word text, or a brief video on global warming's mechanism; see HowGlobalWarmingWorks.org). We will then turn to emerging theories of surprise, upon which this symposium's subsequent talks will elaborate, for insight into how surprising events can be used to foster more coherent beliefs and understanding.

Ed Munnich (Associate Professor of Psychology) and Michael Ranney (Professor of Education and Psychology) investigate explanation, numeracy, and scaffolding incorporation of surprising information in education and media (e.g., Munnich, Ranney, & Song, 2007).

Loewenstein: Surprise and Social Influence

Surprises garner attention, and can prompt shifts in understanding. They can serve as signals to learn and to be creative. Less noted is that, as a result, surprises can serve to persuade others by leading them to shifts in understanding. This social outcome rests on generating surprise in others. Surprising someone intentionally requires either calling upon an expectation they already have or teaching them a new expectation that you then violate. The second approach, teaching a new expectation, provides flexibility to craft surprises that result in novel, targeted shifts in

understanding. One result, when surprises are played out repeatedly and on a large scale, is that surprise can lead to shaping the content of culture. I will discuss effects of surprising narratives generated with the repetition-break plot structure (Loewenstein & Heath, 2009). This plot structure teaches an expectation with initial, repeated events. Then it applies a contrasting event to generate surprise. The result is narratives that tend to be liked, tend to be persuasive, and tend to be socially selected.

Jeffrey Loewenstein (Associate Professor of Business Administration) examines how analogy, categories, and vocabularies shape thinking, acting, and organizing.

Maguire and Maguire: Surprise as Randomness Deficiency

Traditional theories assume surprise only occurs when prior expectations have been disconfirmed. We propose however that surprise is the result of a continual representation-updating process. Rather than making precise predictions about the future, people acknowledge the presence of uncertainty in their representations, and rely on observations to adjust their knowledge. The surprisingness of an event is related to the level of adjustment it causes (Maguire, Maguire, & Keane, 2011).

Developing this theme, we quantify surprise as the randomness deficiency of an observation relative to an existing explanatory model. The identification of a pattern in supposedly random data suggests the existence of an underlying structure where none was anticipated, a discrepancy that results in an urgent representational updating process. We suggest that people rely on surprise rather than probability theory to judge likelihood and make decisions.

Rebecca Maguire (Lecturer and Programme Director in Psychology) and Phil Maguire (Director of Computational Thinking Programme) study surprise, conceptual representation and algorithmic information theory.

May, Smith-Rodden and Ash: Hindsight Bias and the Role of Surprise in Judgment

Upon learning the outcome to a situation or event, people often incorrectly remember predicting the given outcome as more likely. These hindsight bias effects have been replicated in a wide variety of judgment tasks and content domains. Some theories have proposed that surprising outcomes should lead to larger effects and others predicted that surprising outcomes should decrease or reverse effects. More recently, it has been argued that hindsight bias is not a single phenomenon, but rather a set of independent phenomena that depend on the type of memory cues, representation updating processes, and heuristics involved in different types of judgment tasks. The results of a series of experiments investigating the effects of surprising outcomes on judgments of outcome likelihood, trust, and confidence will be presented to illustrate the different roles surprise plays in judgments based on metacognitive cues and comprehension cues.

Ross May (Post-doctoral Researcher), Martin Smith-Rodden (Adjunct Professor), and Ivan Ash's (Associate Professor of Psychology) research has brought focus among competing theories of surprise in hindsight bias.

Foster and Keane: The Surprise Experience

Although often not explicitly divided as such, "The Surprise Experience" can be separated into three phases: (i) noticing the surprise, (ii) an emotional response to the surprise, and (iii) a cognitive response; an attempt to understand why the surprising event occurred. In this final talk of the symposium, we take a brief look back at existing theories of surprise, and describe the different emphasis placed on these three phases in each. We also present the metacognitive explanation-based (MEB) theory of surprise. This theory proposes that experienced surprise reflects the level of difficulty of constructing or retrieving an explanation for why a surprising outcome may have occurred (see also Foster & Keane, 2013). Surprise has been identified in artificial intelligence as a possible mechanism for identifying learning events. As such, we discuss whether there may be dependencies between the type of response, or combination of responses, to the surprise experience, that consequently affect what subsequent post-surprise cognitive processes are activated, such as learning or hindsight bias.

Meadhbh Foster (PhD candidate) investigates surprise from a cognitive perspective with Mark Keane (Chair of Computer Science), who has published numerous articles in cognitive science, including work on analogy, surprise, case-based reasoning, and creativity.

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