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Systems thinking and environmental concern

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ABSTRACT

Systems thinking is thought to facilitate complex decision-making, but relatively little is known about its psychological underpinning. We present three studies that situate a measure of the construct in relation to other dispositional measures that have received more attention in environmental psychology and by testing whether the mindset predicts behavior in a set of novel decision making tasks. In Study 1, we find that systems thinkers tend to believe in scientific consensus, recognize risks posed by climate change, and support policy interventions to address climate change; systems thinking was negatively related to conspiracist and free-market ideation. In Studies 2 and 3 we find that systems thinkers ascribe more value to the natural world — both in monetary terms as well as on social and ecological grounds. The findings suggest that models of environmental cognition can be improved by measuring peoples' tendency to engage in systems thinking.

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1. Introduction

The majority of climate scientists agree that the global climate is changing, largely as a result of human activity, and that these changes pose a significant long-term threat to humans and the natural world (Allison et al., 2009; Anderegg, Prall, Harold, & Schneider, 2010; Freudenburg & Muselli, 2010). Scientists and policy makers have an obligation to communicate with the public about these risks and to advocate for a wide range of interventions: targeting "low-level" individual behavior change as well as "high-level" societal reform (Pachauri, Meyer, & Core Writing Team, 2014). Nevertheless, recent polling suggests that roughly a third of the US population denies the reality of climate change, and that only half of citizens agree as to its anthropogenic origins. Moreover, the percentage of climate change deniers has increased in the past several years (Leiserowitz, Maibach, Roser-Renouf, Smith, & Dawson, 2013).

Researchers have identified a number of reasons for climate change skepticism, including a general rejection of science (Diethelm & McKee, 2009; Jacques, Dunlap, & Freeman, 2008; Lewandowsky, Oberauer, & Gignac, 2013), which may be related to the misrepresentation of scientific evidence in the media or by powerful interest groups (e.g., Boykoff, 2007; Jacques et al., 2008; Oreskes & Conway, 2011), conspiratorial thinking (Lewandowsky et al., 2013; Sunstein & Vermeule, 2009; van der Linden, 2015), an unwavering belief in the power of laissez-fair financial markets (Collomb, 2014; Heath & Gifford, 2006; Kahan, Jenkins-Smith, & Braman, 2011; Lewandowsky et al., 2013), and political ideologies (Dunlap & McCright, 2008; Hamilton, 2011; McCright & Dunlap, 2011).

These foundations for climate change denial are made possible, in part, by the inherent complexity and scale of the global ecosystem. Contrary to the experience of most people in history, modern electrical wiring, indoor plumbing, central heating and other mechanisms for controlling our local environment have rendered critical resource flows (e.g., of water and electricity) invisible (Mayer & Frantz, 2004). The relative invisibility of the stocks and flows of environmental resources may contribute to the public's lack of careful consideration about the role of these resources in sustaining natural systems (Sterman & Sweeney, 2007; Sweeney & Sterman, 2007).

Instead, people are more likely to have experiences that seem to contradict a simple conception of global warming. For instance, despite the fact global temperatures are rising, it still gets cold in winter, and there is a tendency to conflate *weather* and *climate* (Gutro, 2005; Hulme, 2009). One disturbing example of such behavior came from Senator Jim Inhofe, chair of the U.S. Senate Committee on Environment and Public Works, who threw a

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snowball onto the Senate floor in February of 2015 to illustrate his view that the global climate was not warming (Plautz, 2015). Although illustrations of rising temperatures are available, these relatively abstract and more psychologically distant representations of aggregated information may be less persuasive to many people than personal anecdotes (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013; Spence, Poortinga, & Pidgeon, 2012).

One way that journalists and policy makers have simplified discussions of the global ecosystem is to use economic, cost-benefit terms, which often portray a straightforward trade-off between sustainable environmental policies and economic growth (Shaw & Nerlich, 2015). This practice represents an additional hurdle to mobilizing support for mitigating the dangers of climate change, as people tend to prioritize immediate economic issues (employment, budgets, taxes, trade) over long-term environmental issues (e.g., in a September 2015 poll of US adults, 35% of respondents identified some aspect of the economy as their primary concern facing the country, whereas only 2% named the environment; Gallup, 2015; Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Rosenthal, 2015). Depicting the relationship between the global ecosystem and the economy on a single dichotomous continuum is reductionist, failing to recognize the many inherent benefits of promoting the health of the natural world (Williams, Patterson, Roggenbuck, & Watson, 1992).

As an antidote to more common and pervasive modes of thinking about the natural world, scholars from diverse fields suggest promoting a *systems thinking* mindset (Checkland, 2012; Espejo, 1994; Meadows & Wright, 2008).

1.1. Systems thinking

Systems thinking emphasizes that causes and their effects are often less straightforward than one might intuitively expect. Such a mindset is thought to facilitate the understanding of systems and events as emerging from a dynamic array of interrelated factors, which can have both expected and unintended consequences (Meadows & Wright, 2008). Although there is some disagreement over exactly what *systems thinking* refers to (see Buckle Henning & Chen, 2012), there are several core tenets of the construct that are widely endorsed: They include an emphasis on holism (as opposed to reductionism), an expanded conception of causality (i.e., an appreciation of the fact that a vast array of interacting variables are often responsible for specific outcomes in complex systems), and recognition that systems are constantly changing in predictable and unpredictable ways (Checkland, 2012; Espejo, 1994; Richmond, 1993; Sweeney & Sterman, 2007).

However, despite the broad and interdisciplinary interest in systems thinking, there has been relatively little work on the psychological underpinnings of the mindset: a small number of studies showing that many people do not naturally engage in intuitive systems thinking (Dawidowicz, 2012; Rozenblit & Keil, 2002; Sweeney & Sterman, 2007), but that the principles of systems thinking can be taught — mostly in a corporate or managerial context (Fazey, 2010; Kim, Akbar, Tzokas, & Al-Dajani, 2014; Maani & Maharaj, 2004; Sterman, 2010).

1.1.1. The Systems Thinking Scale

One notable attempt to address this gap in the literature is the development of an instrument designed to measure an individual's tendency to engage in systems thinking, the Systems Thinking Scale (Davis & Stroink, 2016; Thibodeau, Frantz, & Stroink, 2016). The Systems Thinking Scale includes 15 items that are designed to measure core tenets of the mindset along a single continuous dimension (very low to very high in systems thinking). For instance, the survey asks participants to report on the degree to which they conceptualize problems holistically (e.g. 'ultimately, we can break all problems down into what is simply right or wrong'; reverse scored) and recognize the dynamic patterns of change (e.g. 'everything is constantly changing') and interwoven causal relationships that are hallmarks of complex systems (e.g. 'when I have to make a decision in my life, I tend to see all kinds of possible consequences to each choice'). Both prior and present work have found that the scale is reliable (e.g. in the present studies, we find that the scale exhibits high internal consistency—Cronbach's α is about 0.8 for each of the three samples). The relatively brevity and simplicity of the instrument differentiates it from alternative approaches to measure individual differences in systems thinking (e.g., Sweeney & Sterman, 2007).

Initial work with the instrument has revealed differences in how systems thinkers represent complex problems like environmental dilemmas (Davis & Stroink, 2016) and social issues (Thibodeau, Winneg, Frantz, & Flusberg, 2016), and how people approach problems that require creative thinking (Randle, 2014). Thibodeau et al. (2016), for example, found that systems thinkers tend to recognize longer chains of causality in attributing responsibility for specific outcomes. Importantly, this instrument was designed to measure an intuitive systems thinking mindset (what is sometimes called "Soft" systems thinking, as opposed to more deliberate systems thinking that is aided by computational models and other tools – cognitive and technological – that are more likely to be taught in a course on the topic).

1.1.2. Related constructs

There is significant work on a number of constructs that are theoretically related to *systems thinking*. For instance, *holistic thinking* is a construct that has emerged from the literature on cross-cultural psychology (e.g., Choi, Koo, & Choi, 2007; Nisbett, Peng, Choi, & Norenzayan, 2001) and *relational thinking* is a construct that has been studied more extensively in the context of analogical reasoning and problem solving (e.g., Rottman, Gentner, & Goldwater, 2012; Vendetti, Wu, & Holyoak, 2014). Both emphasize holistic over reductionist styles of reasoning. *Holistic thinkers* tend to recognize distal consequences of events and decisions more readily than non-holistic thinkers (e.g., that a mass layoff will have immediate effects on the personal finances of individuals but may also have long term effects on the social environment of a community). *Relational thinkers* tend to focus on causal relationships between elements of a domain, as opposed to more salient superficial features of the domain, when thinking through complex problems (e.g., recognizing that the structure of an atom is similar to the structure of the universe despite their marked dissimilarity in size; Rutherford, 1911).

Previous work has also studied when, how, and why people justify the social systems in which they live (e.g., Jost, Banaji, & Nosek, 2004). According to *system justification theory*, people are drawn to rationalizing current sociopolitical practices and states (the *status quo*) because of a social and psychological need to see the existing social order as desirable (good, fair, natural). For instance, people tend to anticipate that likely events are more desirable than unlikely ones (e.g., people tend to like a presidential candidate more as their likelihood of winning an election increases; Kay, Jimenez, & Jost, 2002).

In addition, prior work has found that *systems thinking* is related to more general dispositional tendencies (see Thibodeau et al., 2016): Systems thinkers also tend to see the world as complex (i.e., have adopted a more complex *lay epistemology*; Hofer, 2000), like to think deeply about problems (score higher on a measure of *need for cognition*; Cacioppo, Petty, & Kao, 1984), and are more *open* to new ideas and experiences (McCrae, 1996); on the other hand, *systems thinking* was found to be anti-correlated with a tendency to

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