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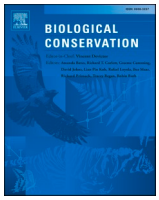

Why facts don't change minds: Insights from cognitive science for the improved communication of conservation research

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ABSTRACT

Conservation scientists increasingly seek to find ways to implement their research for improved policy and practice. However, such efforts may be ineffective, or even counterproductive, if they are based on outdated models of science communication and behavioral change. Insights from fields that study how information is processed in the brain, how and why humans make decisions and take action, and how change spreads across social networks can support and improve existing efforts to translate conservation research into practice and policy. However, little of this research has made its way into the conservation science literature, thus limiting the power of these ideas to influence how research is communicated and how impact is understood. This paper seeks to address this gap by discussing four common myths about how to best communicate science for decision-making, namely, that facts change minds, scientific literacy will lead to enhanced research uptake, individual attitude change will shift collective behaviors, and broad dissemination is best. The article provides four alternative insights that can support effective science communication and impact: engaging the social mind for optimal decision-making, understanding the power of values, emotions, and experience in swaying minds, changing collective behavior, and thinking strategically for biggest impact. If we can understand how people process information, we can design interventions based on the best possible evidence of how humans make decisions for conservation management and policy.

1. Introduction

The call for conservation science to have greater impact on both policy and practice has grown increasingly urgent. Despite the success of conservation science in documenting the extent of the current extinction crisis and other global environmental issues, this vast body of scholarship has had limited effectiveness in terms of safeguarding ecosystems, habitats, and species (IPBES, 2019). To address this concern, researchers increasingly seek to influence both policy and practice by communicating their science to a broad array of stakeholders (Kadykalo et al., 2021a). For example, common dissemination techniques utilized by conservation scientists are: sharing research results on social media (Bombaci et al., 2016), speaking to reporters about conservation issues in the news (Macfarlane and Rocha, 2020), making evidence syntheses available to practitioners (Sutherland et al., 2019), and speaking directly to policymakers about the relevance of their work (Pielke, 2007). While such strategies are well-intended and can require major investments of time and labor, they are often ineffective at generating desired changes in policies or practices (Oliver & Cairney, 2019), and this can lead to deep frustration on the part of researchers (Cooke, 2019).

Scholarship from outside conservation science can help to provide insight into why, and in what contexts, various science communication and dissemination techniques can be effective or ineffective in leading to shifts in attitudes and actions (Oliver & Cairney, 2019; Kearns, 2021). While conservation science is essential in providing the information needed for effective policy and practice, the way that that environmental research is communicated has not often been based on the best possible evidence (Lester and Foxwell-Norton, 2020). Newer models of science communication emphasize the complexity of the social spaces and economic, cultural, and political contexts in which scientific evidence is one of many factors in conservation practice and policy (De Lange et al., 2019; Maas et al., 2019). Further, fields that study how information is processed in the brain (e.g. cognitive science), how and why humans make decisions and take action (e.g. behavioral

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psychology), and how change spreads across social networks (e.g. social network analysis) can offer useful insights to improve existing efforts to translate conservation research into practice and policy.

Because most conservation problems are fundamentally human-driven, addressing them successfully requires a deep understanding of the social, cultural, and behavioral factors at play (Schill et al., 2019; Schmitt et al., 2020). Conservation science, traditionally the domain of natural scientists, is increasingly recognizing the value of the social sciences for its importance in understanding the social, cultural, and political underpinnings of human attitudes and behavior (Bennett et al., 2017). In particular, the disciplines of political ecology and anthropology have been essential in unpacking acceptance of, or resistance towards, various conservation interventions and policies by examining the roles that power, relationships, and culture play in natural resources management (Stone-Jovicich et al., 2018). Similarly, understanding the complex social-economic-political contexts in which conservation managers make decisions can help uncover how and when scientific evidence is taken into account (Kadykalo et al., 2021b).

However, other social science fields, particularly those focused on understanding human behavior and cognition, have been largely neglected and/or oversimplified in the conservation literatures (Schlüter et al., 2017; Marselle et al., 2021; Nielsen et al., 2021). According to one study, only 0.28 % of papers published in top conservation science journals between 2003 and 2016 addressed issues of human behavior and/or psychology (Selinske et al., 2018). Some conservation scholars have taken note, and there have been important contributions in this area more recently (see Byerly et al., 2018; Bowie et al., 2020; Selinske et al., 2020; Balmford et al., 2021). However, even less scholarship has incorporated insights from cognitive science, which is a field of behavioral science that focuses on how the mind processes knowledge in the brain and makes decisions based on information. Similarly, little of the scholarship focused on information flows – such as how behavior spreads through social networks – has made its way into the conservation literature (though see De Lange et al., 2019). Researchers in these fields have studied, through both lab-based experiments and in-depth empirical work, how humans make sense of new information and how such information is incorporated into decision-making (Kahneman, 2011; Sloman and Fernbach, 2018). They have examined which parts of the brain are stimulated when new information challenges preexisting beliefs and have posited what this means for communicating science (Gorman and Gorman, 2016). And they have developed evidence-based theories to understand how and why some innovations and interventions spread, thus developing new models of social change (De Lange et al., 2019; Centola, 2021). Such studies can shed light on how conservation evidence is perceived and evaluated by stakeholders, which is an area of research that is lacking in empirical work (Kadykalo et al., 2021b).

The limited incorporation of these ideas into the conservation literatures suggests a potential lack of awareness of the value that recent insights from these fields and subfields can offer in terms of how conservation research can have impact in terms of practice or policy. This paper seeks to address this gap by debunking four common myths about the relationship between evidence and human decision-making and providing four alternative insights that can support effective science communication and impact. Seminal scholarship from other fields is presented to demonstrate the evidence-base for these concepts; however, it is notable that few of these have focused on environmental or conservation-related issues. This marks both a major knowledge gap and opportunity for interdisciplinary research on human decision-making for conservation issues.

2. Myths about the relationship between evidence and human decision-making

2.1. Facts change minds

Communication of conservation science (and other STEM fields) has long been grounded in the assumption that more accurate and compelling factual information will significantly shift the way that people think and act on environmental issues (Kusmanoff et al., 2020). However, scholarship in other fields, including policy studies and cognitive science, has demonstrated the limited usefulness of "improved dissemination" of the best evidence for practice and policy (Cairney and Oliver, 2017; Simis et al., 2016). Rather, models of human decision-making in these fields increasingly rely on the concept of bounded rationality, which means that humans consistently make decisions that are satisfactory, rather than optimal, especially when faced with uncertainty (Tversky and Kahneman, 1974; Gigerenzer, 2008). In part, this is due to the disparity between the relatively small amount of information that can be processed in the conscious brain as compared to the brain as a whole (Dehaene et al., 2014).

As such, when making decisions on complex issues, rather than engaging processes in the brain associated with deliberate and logical thought, humans frequently employ heuristics (or subconscious mental "shortcuts"). For example, people are prone to making associative links between unrelated events, are easily primed to accept or refute new information without evidence, and are strongly biased towards seeking out data that are compatible with the beliefs they currently hold (Kahneman, 2011). The more complex and stressful the information, the more likely it is to be processed in parts of the brain such as the insula, ventral striatum, or the amygdala (associated with emotions such as fear or pleasure), rather than in the prefrontal cortex (associated with rational thinking and deliberation) (Gorman and Gorman, 2016). This is because large amounts of information, especially complex information, are cognitively taxing, causing people to make gut-based decisions based on intuitions rather than on hard data (Kahneman, 2011).

Similarly, limitations in the quantity of information humans can absorb and make sense of leads to struggles with processing risk. Humans struggle to make sense of statistics and probability, and are more likely to infer generalizations from individual stories or cases as compared to an evidence-based study that predicts the statistical likelihood of a given event. For example, one experiment after the Exxon oil spill found that people would pay basically the same amount to save 2000 as compared to 2000,000 birds (Desvousges et al., 1993).

This can be especially relevant in terms of the current emphasis on the role of a strong evidence base in conservation decision-making. For example, research on the role of evidence in conservation practice has consistently found that environmental managers are far more likely to draw on common heuristics, such as intuition or opinion, rather than scientific evidence, when making important decisions (Kadykalo et al., 2021a, 2021b), and this is especially the case for more experienced practitioners (Walsh et al., 2014). Having a better understanding of how the brain processes information, especially when contentious and complex issues are involved (e.g. deer culling, farming practices) can help conservation scientists to understand that it can be challenging for practitioners to make optimal decisions based on the best available evidence, due to human tendencies to revert to the use of heuristics when under stress.

2.2. Scientific literacy is the answer

A second myth that has long permeated the communication of conservation research is that increasing the scientific literacy of conservation professionals and the general public will help to increase the uptake of evidence-based practices (i.e. Walsh et al., 2014). This is based on the theory that increased understanding of scientific knowledge will increase the likelihood of applying such knowledge in everyday life

(Feinstein, 2011; Crowell and Schunn, 2016). However, the relationship between scientific literacy and attitudes towards science is weak; most research in the field of science communication does not support the claim that increasing knowledge will lead to significantly greater appreciation for and support of science (AAAS, 2019; NASEM 2016; Sloman and Fernbach, 2018). Science education scholars have found that increasing knowledge of scientific concepts has little impact on whether a person will take actions based on such knowledge or engage in science-related issues, and cognitive ability and education level are not significantly related to one's likelihood of acting in accordance with scientific consensus (Crowell and Schunn, 2016).

Rather, much research has found that other factors, such as worldview, religion, and political beliefs, have stronger associations in terms of beliefs about science related to controversial issues (Allum et al., 2008; Drummond and Fischhoff, 2017).[1] The more contentious the information, the more likely people are to reject that information as flawed if it contradicts previous beliefs (Gorman and Gorman, 2016). People see data that are compatible with the beliefs they currently hold as more valid than data that could refute those same beliefs. In other words, facts are absorbed into existing beliefs rather than the other way around (Kahan, 2013). In these contexts, higher degrees of science literacy can lead to a small decrease, rather than an increase, in the perceived seriousness of related risk, due to what is known as the "boomerang effect," in which an individual who is presented with a persuasive argument adopts the opposite stance from that intended by the communicator (Kahan et al., 2012). Indeed, some research has found that even just encouraging thinking on a controversial topic can increase polarization, especially if individuals are encouraged to provide reasons for their arguments (Mercier and Sperber, 2011).

Further, scientists, professionals, and other experts (e.g. conservation practitioners) are no less likely than the general public to resort to heuristics when faced with complex decision making (Kahneman, 2011; Gorman and Gorman, 2016). Research has found that the more knowledge one has at one's grasp, the more fine-tuned one's ability to reason (argue), and thus the more able one is to find more counterarguments in service of prior beliefs (Mercier and Sperber, 2017; Drummond and Fischhoff, 2017). Thus, conservation research outputs that are solely focused on increasing scientific or ecological literacy may not result in desired impacts for decision-making or behavioral change if they do not engage with the social, cultural, and political contexts within which such information is shared (Crowell and Schunn, 2016; Sloman and Fernbach, 2018).

2.3. To change social behavior, change individual minds

A third myth has permeated much of the conservation field's approach to communication and impact and is based on two truisms: 1) to change behavior, one must first change minds, 2) change must happen individually before it can occur collectively. The first of these stems from rationalist models of environmental behavior from the 1970s that assumed a linear progression from environmental knowledge to increasing awareness and then action. Such theories posited that environmental education would automatically result in more pro-environmental behavior, thus leading to widescale social change. However, these deficit-style models were debunked as research consistently found that increases in environmental knowledge only rarely translated into changes in behavior or increased advocacy (Kollmuss and Agyeman, 2002; Crowell and Schunn, 2016). Indeed, one study found that providing people with informational narratives on environmental issues reduced one's willingness to take action, as compared to providing no information at all (Morris et al., 2019).

Much early research on pro-environmental behavior was focused on attitudes, beliefs, and actions of the individual (Maniates, 2001). Researchers explored why some people recycled more (De Young, 1990), engaged in pro-environmental consumer behaviors (Soutar et al., 1994), and ate less meat than others (Janda and Trocchia, 2001). To some extent, this hyperfocus the individual has led to a widespread perception that pro-environmental action is a personal choice that stems from one's moral code, despite the overwhelming amount of scholarship that points to the greater relative importance of systemic, social, and economic factors (Schill et al., 2019). Many contemporary environmental education and awareness campaigns are still focused on changing individual attitudes and behaviors, and messages are aimed to persuade individuals of their personal role in environmental stewardship (e.g. "plant a tree," "buy organic") (Maniates, 2001). Similarly, as Marselle et al. (2021) point out, conservation researchers and practitioners emphasize individually-focused interventions, such as education and economic incentives, to the neglect of collective approaches, such as influencing social norms and addressing systemic injustices (see also Byerly et al., 2018).

Newer models of human behavior demonstrate the complex interplay between individual choice and complex and adaptive social, ecological, and economic systems (Schill et al., 2019; Schmitt et al., 2020). Modern humans evolved from hunter-gatherer units in Africa where they were often at a physical disadvantage as compared to other species. They were able to not only survive, but to thrive in the face of such handicaps because of their ability to share collective knowledge (Sloman and Fernbach, 2018). Because of this, humans are highly sensitive to the beliefs and actions of those in their immediate social circle (Gorman and Gorman, 2016). While behavioral change can occur at the individual level, broader impacts for conservation typically require a focus on social networks and systems (Marselle et al., 2021). As such, more recent models of human cognition and behavior recognize the importance of social norms and contextual environments on individual choice and perceptions (Schill et al., 2019). Conservation scientists seeking to translate their research into action would be well advised to familiarize themselves with approaches that target social and cultural contexts rather than individual attitude and behavior change.

2.4. Big, broad impact is best

A fourth myth that shapes much of how conservation research is shared with the public is rooted in the belief that reaching bigger, global audiences is superior to smaller, local publics. In other words, the more that one's research is shared across different networks – and the faster it does so – the more it is seen as having an impact. This trend is connected to the "medialization of science," which describes the increasing perceived value that mass media has on how scientists think about sharing their work to influence public opinion (Weingart, 1998, 2012). For example, altmetrics (or alternative metrics), which track online activity related to published research (e.g. number of tweets), have become an increasingly popular and validated way for academics to demonstrate extra academic engagement with their scholarship. Similarly, a common assumption among researchers and higher education administration is that the value of public-facing messaging increases with the relative impact of the media outlet (Koh et al., 2016). In other words, a mention on BBC World Service is perceived to be of greater value as compared to an op-ed in the local farmer's paper (De Semir, 2010).

However, new research using tools such as social network analysis questions the value of high visibility and quickly spreading ideas for generating change (Buskens, 2020). This scholarship suggests that there is a significant difference between information sharing and knowledge transfer, and that while big media platforms and social media can provide reach (getting an idea "out there") they are not effective in the spread of innovations, social norms, or cultural movements (Centola, 2021). Such findings can also explain how resistance to new information or behavioral change occurs in geographical and social clusters, as these

[1] Though see Pennycook et al., 2022 for a recent challenge to this body of literature.

can face enduring opposition if they challenge established beliefs and existing social norms. Knowledge on a subject has limited influence unless it is shared in one's social network and increasing amounts of information or marketing can increase resistance towards products or ideas that are not yet perceived to be socially acceptable (Centola, 2021, see also Sarewitz, 2004). One example of environmental messaging that led to a "boomerang effect" was the framing of climate change as a national security issue for the skeptical segment of the public, which rather than appealing to existing concerns, lead to backlash as the information was perceived as manipulative and misleading (Kusmanoff et al., 2020).

These findings underscore the importance of thinking strategically about the publics that one wishes to influence with research. While research diffusion through mass media can help spread awareness and reach, research that results in change in practice or policy requires a different set of dissemination approaches (Toomey et al., 2019). Researchers who seek to have impact with a specific group of people should strive to improve their understanding of how information and ideas are shared within relevant networks, not just which messages would be most effective. For example, scholarship suggests that engaging with small, regional news outlets rather than national or global media can be a more effective way for scientists to reach new publics (De Semir, 2010).

2.5. Summary

The myths described above put into question conventional practices of sharing scientific information for extra-academic impact and are relevant for understanding why relevant and robust evidence does not always (or often) influence decision-making, even when it is provided in accessible formats. While such findings may be disconcerting for conservation researchers who seek to influence policy and practice with fact-based narratives, highlighting these myths can provide such researchers with a more realistic (rather than idealistic) view of how their science will be received by relevant audiences and encourage the seeking out of alternative approaches (Fig. 1). Towards this aim, the remainder of this article focuses on potential solutions for more effective ways to incorporate new information for enhanced conservation decision-making.

3. Solutions that can support effective science communication and impact

3.1. Engage the social mind for optimal decision-making

While our brains are not optimized to make the best possible decisions most of the time, where humans do have an advantage is in group settings. The human mind evolved through collaboration, enabling larger and more complex social groups (Dunbar, 1992; Sloman and Fernbach, 2018). Research has found that people are much better at arguing for their point of view than they are at making logical conclusions based on evidence (Mercier and Sperber, 2011). Because of the cognitive strain required to fully think a problem through, people resort to superficial justifications for their actions unless challenged. Therefore, group dynamics – especially groups that incorporate diversity of thought – are essential for improving our ability to solve problems and find solutions. Studies have consistently found that people are more likely to find true answers to logic-based problems in group settings as compared to when tasked with solving the same problems individually (Evans et al., 1993; Maciejovsky and Budescu, 2007). Group discussions have been found to help people improve argumentation skills, become less polarized when confronted with arguments that challenge their own, and reduce confirmation bias (Mercier and Sperber, 2011, 2017; Sloman and Fernbach, 2018). Thus, efforts to include evidence in conservation decision-making may be most successful if channeled through group structures, such as workshops or meetings. For example, in a review of locally-based conservation approaches, Danielsen et al. (2005) found the "group discussion method" to be strikingly more effective than other approaches (e.g. participating in wildlife monitoring) for empowering stakeholders to participate in collaborative natural resource governance.

However, groups that are made up of only like-minded individuals (e.g. echo chambers) can reduce the gains in reasoning that are observed in collective settings, leading to groupthink, where arguments will not be critically evaluated (Henriques, 2020). These findings provide additional support for the value of inter- and trans-disciplinary research collaborations, especially when such collaborations explicitly build in mechanisms for direct and regular interaction between group members with different perspectives. For example, Caudron et al. (2012) describe a research collaboration between scientists and managers tasked with conserving native brown trout in the French Alps. Scientists and managers collaboratively developed research questions, collected data, analyzed results, and coauthored presentations and publications, thus facilitating a back-and-forth flow of ideas. In this and other examples of

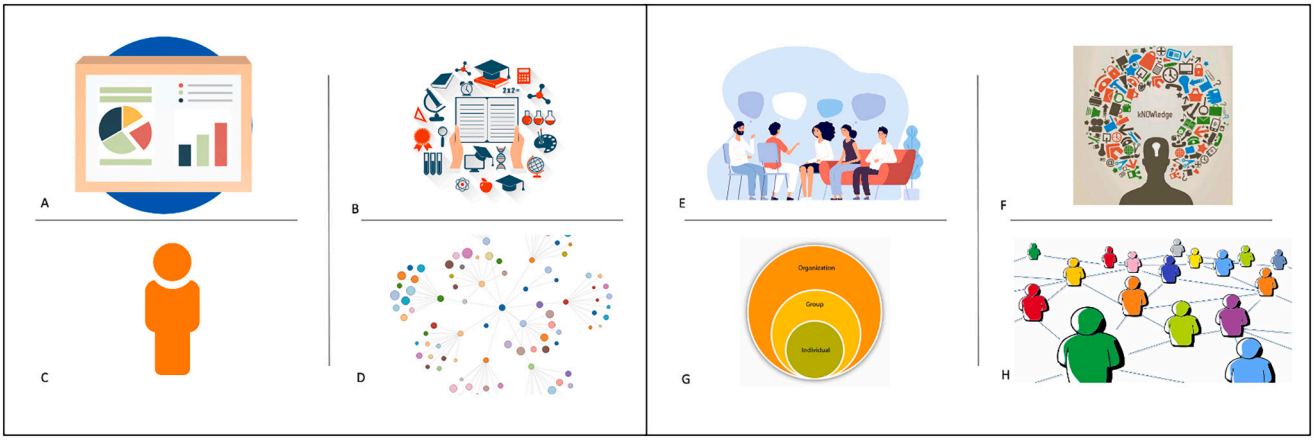

Fig. 1. Myths about the about the relationship between scientific evidence and human decision-making: (A) Facts change minds, (B) Scientific literacy will lead to enhanced research uptake, (C) Individual attitude change will shift collective behaviors, and (D) Broad dissemination is best. Four alternative insights that can support effective science communication and impact: (E) Engage the social mind for optimal decision-making, (F) Understand the power of values, emotions, and experience in swaying minds, (G) Change collective behavior, and (H) Tap into social connectivity for the biggest impact.

extra-academic research partnerships, the power of group intelligence emerges beyond what each individual is capable of (Sloman and Fernbach, 2018).

Human diversity in terms of gender, race, and socioeconomic background, among other factors, can provide similar gains in collective decision-making (Smith et al., 2017). Research on the importance of diversity in group settings has found improved financial performance, increases in innovation, and better team communication (Gomez and Bernet, 2019). However, such gains require decision-making structures that support equitable participation from all group members, where people are free to disagree or offer alternative perspectives (Lorenzo et al., 2017). In other words, more than policy reports or evidence syntheses, people need frequent conversations, debate, and diversity of thought and experience for optimal decision-making. The human mind is a social mind, and we live in a community of knowledge in which we depend upon one another to think effectively to support complex and productive action (Sloman and Fernbach, 2018).

3.2. Understand the power of values, emotions, and experience in swaying minds

As described earlier in this paper, early models of human decision-making were largely based on assumptions of rationality and optimization; in other words, that one makes the best decisions when one has access to the best information. However, since the 1970s, and increasingly over the last two decades, the fields of behavioral economics and neuroscience have converged to embrace more holistic models that emphasize the role of emotion, values, and instinct rather than that of information (Naqvi et al., 2006; Schill et al., 2019). Such models increasingly note the importance of affect as a crucial tool in effective decision-making. For example, studies with patients who have had damage to the frontal lobes of the brain, which is responsible for emotional response and control, revealed that these individuals had much greater difficulty making practical decisions as compared to before the damage (Manes et al., 2002). Most strikingly, these patients' intellect and ability to retrieve knowledge pertinent to the situation was unimpaired by the damage, thus leading the researchers to conclude that the decision-making deficits were due to the inability to use emotion to determine what was in one's own best interest (Bechara et al., 2000).

Similarly, personal experience and embodied knowledge is thought to play a valuable role in determining the choices one makes. Although intuitive-based judgements can lead people astray in areas in which they lack depth of understanding, this fallacy of intuition dissipates with true expertise. In such contexts, instinct can lead to better outcomes, and research has found that intuitive decisions based on experience are often better than those that are carefully thought through and analyzed (Mercier & Sperber, 2017). For example, instinct will often cause novice chess players to make errors, as the correct move is often not the one that immediately "feels right." But chess grandmasters demonstrate mastery in speed chess, as their split-second "instinct" about which move to make is based on recognition of patterns too rapid to process deliberatively. To put this in conservation terms, practitioners with decades of experience in a specific social-ecological system would be well-placed to put forward their own expertise as a basis for decision-making as a crucial form of "evidence" (Adams and Sandbrook, 2014). This is an important finding to consider, as even as there is more attention paid to the value of alternative forms of knowledge based on collective and individual experience, such as Traditional Ecological Knowledge and Local Ecological Knowledge, such knowledge systems are still considered less valid than scientific knowledge in many academic circles (Adams and Sandbrook, 2014; Kadykalo et al., 2021b).

The importance of emotion, experience, and intuition in decision-making also points to the value of creative approaches to communication in the conservation realm. As discussed earlier, fact-based narratives can lead to a boomerang effect if they challenge pre-conceived notions and beliefs. In contrast, emotional messages through stories and storytelling have been more effective in shifting attitudes and leading to pro-social feelings and actions (Ma, 2020). While stories can be vehicles for delivering factual evidence, they differ from fact-based narratives in how they are structured and often rely on the journey of a character(s) and their overcoming of challenges. Stories invoke different cognitive processes than facts; studies have found that oral storytelling can trigger parts of the brain in the listener associated with personal experience, a state known as "narrative transportation" (Green and Brock, 2000). Because stories tend to be more enjoyable to listen to as compared to undiluted facts, it is thought that they can reduce the incidence of negative thoughts and feelings that are often generated with controversial information (Green and Brock, 2000). Similarly, research has found that stories are more "sticky" than facts, enabling us to conjure them quickly in instances where decision-making is needed (Heath and Heath, 2007). As such, evidence framed through stories may provide an alternative and useful approach by heightening cognitive processes that rely on emotion, thus serving as an impetus for action-taking. For example, Leslie et al. (2013) describe how locally-led photography and film were used to tell the story of recovery of the Cabo Pulmo reef in Baja California Sur, Mexico, leading to a major reversal in how the land surrounding the reef was to be developed.

3.3. Change behavior to change minds

The human mind is a social mind that is embedded in social, cultural, and ecological contexts, and as such is wired to act in accordance, rather than in conflict, with social cues and values in one's environ (Schill et al., 2019). Insights from behavioral science suggest that rather than attempting to change individual attitudes to change behavior, it may be more effective to change social environments to make it easier for individuals to opt into socially-desirable behaviors (Dolan et al., 2012). Programs that use "green defaults" (e.g. automatically enrolling customers in renewable energy sources) have been shown to be far more successful than providing information about the benefits of such programs, even among individuals who do not claim to be concerned about environmental issues such as climate change (Byerly et al., 2018; Kaiser et al., 2020).

Such programs play on the power of social norms and values, which are essential for understanding the widespread adoption of certain pro-environmental behaviors across social groups and the absence thereof among others (e.g. vegetarianism in India versus Russia). For example, one study used three types of messaging approaches to foster energy-conservation among California residents (Nolan et al., 2008). One approach highlighted factual information about the environmental and social benefits of energy conservation techniques, a second emphasized the monetary benefits, and a third focused on the energy-saving practices of their neighbors. The researchers found that while the third approach, which tapped into perceptions of social norms, was the only one to have any significant effect on the energy consumption practices of the household. In this regard, recent scholarship on conservation framing can be essential in developing messaging that influence how people perceive and respond to a given issue (Kusmanoff et al., 2020). Such framing can reflect understanding of how certain statements and approaches may appeal to different social or cultural values, evoke social norms, and/or trigger certain heuristics, thus influencing attitudes and behaviors (Kusmanoff et al., 2020).

Information is grounded in both perception and action, thus learning processes are deeply associated with the physical experience of the learner (Fugate et al., 2019). Changing physical and social environments to support desired actions can lead to behavioral changes in beliefs, identities, and future actions (Lauren et al., 2019; Nash et al., 2019). In other words, rather than changing minds to change behaviors, this body of scholarship suggests that the mere process of participating in new actions can shift one's perceptions about issues connected to that behavior. For example, research has found that participating in small proenvironmental actions in one area (e.g. recycling) can serve as an

entry point to other types of environmental behaviors (e.g. donating to environmental groups), especially if individuals are primed to think about their existing behaviors as evidence that they are someone who cares about environmental issues (Lauren et al., 2019). Similarly, evaluations of conservation-focused citizen science programs emphasize the importance of highlighting the value of the experience and the potential direct conservation impact of the project, rather than on factual information alone (Dean et al., 2018). Towards this aim, conservation scientists should aim to frame research findings in terms of action and one's environ, thus tapping into the role that social cues, cultural values, and direct engagement play in influencing individual attitudes and behavior.

3.4. Tap into social connectivity for the biggest impact

Previous articles have pointed to the value of studying change movements for creating shifts in conservation (Johns, 2007), and the study of how information and ideas spread can provide relevant insights for conservation researchers (De Lange et al., 2019). Recent research in social network analysis has found that while novel ideas that are disseminated across large, unstructured networks (e.g. Twitter) may spread more quickly, such information flows rarely result in widespread behavior change (Centola, 2021). Rather, this research suggests that change starts and spreads in the peripheries of societies, where new ideas take hold among smaller social networks by means of strong social ties, which then connect to other social networks, and then eventually they are adopted by the centers (Centola, 2018, 2021). These findings have relevance for how researchers spread the word about innovative ideas. For example, networks in agricultural innovations have been found to be more effective at spreading sustainable innovations through geographically-close farming networks, such as farmer to farmer advice and peer discussion groups, rather than disseminating messages broadly (Skaalsveen et al., 2020). Such programs are based on this theory of social connectivity, where the adoption of new ideas often relies upon one farmer seeing how another is applying a novel technique (Kansanga et al., 2021).

In this sense, social networks are key both for openness to change as well as resistance to it. As discussed earlier, messages that are spread broadly can lead to backlash if they are perceived to deviate from norms and values within one's social group. Rather, the broad uptake of new ideas requires support among a social network, which then connects to other social networks. For example, renewable industries have found success when concentrating adoptions in a localized area (e.g. solar panels on most homes in a single neighborhood rather than spreading the same number across a city), as this triggers a sense of social norm and support (Curtius et al., 2018). Key here is also the idea of redundancy, where the more individuals from one's own network who adopt a given innovation or belief, the more likely one is to follow suit. The riskier the idea or innovation, the more redundancy is needed in one's social network for a person to adopt a new behavior. Because of this, trying to sway those in publicly visible positions (e.g. politicians) to adopt stances on controversial science topics may not be effective, as the stakes may be too high for them to deviate from their base of support (Centola, 2021). However, this research also suggests that influencing from the bottom-up may increase receptivity among policy-makers. For example, one study developed a marine debris curriculum for elementary school students, who then participated in youth-led civic engagement events to which local officials and voters were invited (Hartley et al., 2021). The study found that engagement in the events (hearing from the children about their concerns) increased concern and policy support among both officials and voters, regardless of political affiliation.

Conservation scientists can utilize these approaches by thinking more strategically about how to target their message to the social networks they wish to influence, rather than seeking to disseminate new ideas to the largest group of people possible. For example, it may be a better investment of a conservation researcher's time to focus on how results from a given study could be applied in a specific context with a select group of stakeholders (e.g. a particular protected area), rather than trying to spread the word across multiple contexts and to an undetermined number of people (e.g. an entire network of protected areas). People accept new ideas because their friends, colleagues, and family members do. Thus, it is essential to understand which social structures are likely to support sustained cooperation in a given decision-making process, as well as to identify how and by whom information flows (see De Lange et al., 2019).

4. Conclusion: This article may not change your mind

As argued above, decades of research in multiple fields have demonstrated the limited effectiveness of scientific evidence for shifting social norms, creating uptake of new behaviors, or even generating effective solutions. Thus, instead of placing the blame on the so-called "receivers" of evidence, this body of scholarship can help us to understand that information will generally be processed sub-optimally in the brain, particularly in complex scenarios common in conservation decision-making. Most attitudes and behaviors regarding conservation decision-making are not based on the rational evaluation of evidence, but determined instead by a host of contextual, social, and cultural factors and values. Therefore, providing additional information – even in accessible formats - is not likely to lead to significant changes.

Similarly, it is questionable whether an evidence-based article such as this one will serve to change minds, as accepting the claims above may challenge one's prior beliefs about science communication, and perhaps even one's sense of how the world works. Attitudes and beliefs are highly resistant to change, and scientists are as prone as anyone else to "seeing what we believe" (Gorman and Gorman, 2016). As Thomas Kuhn wrote of the structure of scientific revolutions, "Because scientists are reasonable (people), one or another argument will ultimately persuade many of them. But there is no single argument that can or should persuade them all. Rather than a single group conversion, what occurs is an increasing shift in the distribution of professional allegiances" (Kuhn, 1962, p. 158). As such, rather than changing individual minds, where this article may be most useful is in sparking discussion, particularly among more junior researchers and students of conservation science. Those who have read this piece in full and perhaps explored some of the studies and references mentioned throughout were likely curious about these ideas in the first place. Such individuals may suggest reading the article for their weekly research group meeting, thus introducing the concepts to others in a relatively low-stakes environment and engaging in a diverse group discussion that has been shown to be so productive for the collective evolution of knowledge.

The synthesis above is meant to inspire further reflection and research on the intersection between conservation and cognitive science. New scholarship in this area will not only be important for the conservation science community, but also for cognitive and behavioral scientists whose work has frequently been critiqued due to its over-reliance on studies with a small percentage of the human population, namely, participants from western, educated, industrialized, rich and democratic (W.E.I.R.D.) countries (Henrich et al., 2010). As biodiversity conservation is a global project and is particularly important in tropical regions of the world, studies across a diversity of human societies can lead to a more culturally informed view of the cognitive science of decision-making (Tam and Milfont, 2020; Nielsen et al., 2021).

Facts will not always change minds, but there is promise that other things will, including creating spaces for group dialogue and debate, targeting emotions and embodied knowledge, embracing multiple perspectives, altering environments to create new behaviors, and being strategic about whom we seek to target with our message. We need to provide training for our students in cognitive and behavioral science, as human attitudes and actions are both the primary cause of and the solution to the current conservation crisis (Nielsen et al., 2021). If we can understand how people process new information, we can design communication interventions that make it easier for groups and

individuals to make the best use of scientific evidence. Let us move beyond communication models that have been long debunked in other fields into a new era based on the best possible evidence of how humans make decisions for conservation management and policy.

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