

Entertaining Without Endorsing: The Case for the Scientific Investigation of Anomalous Cognition

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Empirical reports in mainstream journals that human cognition extends in ways that challenge the current boundaries of science (anomalous cognition) has been viewed with dismay by many who see it as evidence that science is broken. Here the authors make the case for the value of conducting and publishing well-designed studies investigating anomalous cognition. They distinguish between the criteria that justify entertaining the possibility of anomalous cognition from those required to endorse it as a bona fide phenomenon. In evaluating these 2 distinct thresholds, the authors draw on Bayes's theorem to argue that scientists may reasonably differ in their appraisals of the likelihood that anomalous cognition is possible. Although individual scientists may usefully vary in the criteria that they hold both for entertaining and endorsing anomalous cognition, we provide arguments for why researchers should consider adopting a liberal criterion for entertaining anomalous cognition while maintaining a very strict criterion for the outright endorsement of its existence. Grounded in an understanding of the justifiability of disparate views on the topic, the authors encourage humility on both the part of those who present evidence in support of anomalous cognition and those who dispute the merit of its investigation.

Keywords: psi, precognition, consciousness, anomalous cognition, Bayes's theorem

If there is anything which human history demonstrates, it is the extreme slowness with which the ordinary academic and critical mind acknowledges facts to exist which present themselves as wild facts, with no stall or pigeon-hole, or as facts which threaten to break up the accepted system.

(William James, 1890, pp. 301–302)

Reasonable men may be allowed to differ where no one can reasonably be positive.

(David Hume, 1779, p. 3)

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For over a century, scientists have reported empirical findings suggesting the existence of anomalous cognition¹ in which human thought is claimed to extend in ways that are seemingly at odds with conventional conceptions of science. Hundreds of studies have described positive evidence that, independent of standard channels, thought may be sensitive to future events (precognition), the contents of other minds (telepathy), distant locations (clairvoyance), and may influence physical actions at a distance (psychokinesis). Furthermore, although the effect sizes for these studies are generally quite small and replications variable, as will be discussed, many meta-analyses report positive findings. Not surprisingly the bulk of anomalous cognition studies have been relegated to “parapsychology” journals, however, a number have appeared in top tier mainstream

¹ A variety of names have been offered to categorize the entirety of this class of controversial phenomena, including “psi,” “parapsychology,” and “extra-sensory perception.” We favor the term *anomalous cognition* because it clearly demarcates the defining properties of all the cases under consideration, namely that they reflect cognitive capacities that are not straightforwardly accommodated within our current scientific understanding.

outlets such as *Nature* (Targ & Puthoff, 1974), *Science* (Duane & Behrendt, 1965), *Psychological Bulletin* (Bem & Honorton, 1994), *Journal of Personality and Social Psychology* (Bem, 2011), and *Foundations of Physics* (Radin & Nelson, 1989), and this volume of *Psychology of Consciousness: Theory, Research, and Practice* (Mossbridge & Radin, 2018).

A recent opinion article (Cardeña, 2014) in *Frontiers in Human Neuroscience* succinctly summarized the arguments for entertaining anomalous cognition (what they termed *psi*) and concludes with the following statement signed by nearly a hundred accomplished scientists from over 10 countries:

The undersigned differ in the extent to which we are convinced that the case for psi phenomena has already been made, but not in our view of science as a non-dogmatic, open, critical but respectful process that requires thorough consideration of all evidence as well as skepticism toward both the assumptions we already hold and those that challenge them.

When serious discussion of anomalous cognition occurs in “respectable” journals there is an understandable tendency to view this as evidence of a breakdown in the scientific process. A recent popular magazine title aptly captured this sentiment: “Daryl Bem proved ESP is real which means science is broken” (Engber, 2017). Given that believing in the existence of anomalous cognition is routinely viewed as a symptom of psychopathology (Goulding, 2005; Hergovich, Schott, & Arendasy, 2008), it is no wonder that scientific evidence for such claims would be seen as suggesting a pathology of science.

In this article, we argue that the question of whether it is appropriate for mainstream science to consider evidence for anomalous cognition may be clarified by differentiating between the criteria required to entertain a hypothesis from those entailed in endorsing it. Necessarily the evidence that is sufficient to consider a conjecture must be less than that entailed in accepting it as fact, otherwise we would never investigate anything we did not already know for certain. However, even when evidence is found that supports a particular hypothesis, this does not mean that we must endorse it as true. Rather, the accrual of evidence may simply justify the continued consideration of the hypothesis in question. At the same time, there are some conjectures that seem too implausible to warrant consideration. Few would advocate serious

investigation of tongue-in-cheek speculations such as Russell’s china teapot revolving about the sun (Russell, 1952), Henderson’s flying spaghetti monster (Henderson, 2006), or Dawkins’ invisible pink unicorn (Dawkins, 2006). And there are other suppositions that may have once held merit (e.g., the phlogiston account of fire; Kirwan, 1787), that the accumulation of evidence has since ruled out. In short, the evidence required to seriously consider a conjecture is markedly less than that required to accept it, but that is not to say that all conjectures merit exploration.

So the question arises—Where should the line be drawn with respect to hypotheses involving anomalous cognition? In evaluating this question, it is important to recognize that scientists are likely to vary considerably. Many will view anomalous cognition as comparable in inconceivability to orbiting tea pots and flying spaghetti monsters. From this vantage, the serious entertainment of such hypotheses is at best a colossal waste of time, and quite possibly undermines science by regressing it back to the realms of magic and superstition. Others will recognize that many ideas that once seemed far-fetched have since been shown to have merit. Although such scientists may view anomalous cognition as unlikely, they may also appreciate its profound significance were it true. These scientists, among whom we consider ourselves (see also Franklin, Baumgart, & Schooler, 2014), may view at least some hypotheses regarding anomalous cognition as worthy of entertaining, even if they are still far from warranting endorsement. Still others (e.g., Baruss & Mossbridge, 2016; Mossbridge & Radin, 2018) may see the extant data as already sufficient to conclude that anomalous cognition is likely real, and therefore are prepared to endorse such hypotheses at least until compelling evidence to the contrary is mustered.

In the following article, we flesh out the case for entertaining without endorsing anomalous cognition. We recognize that many people’s convictions in this domain are strongly entrenched so it may prove challenging to budge those scientists in either the “don’t entertain” or “already endorse” camps. Nevertheless, perhaps some will be swayed to shift to the middle ground “entertain without endorsing” perspective. More likely, those who already find themselves leaning toward this view may find value

in seeing the arguments for their leanings articulated and may thereby be strengthened in their capacity to defend the investigation of a line of inquiry that routinely invokes ridicule (and worse) from much of the scientific community.

Why Is There Such Disagreement Over Anomalous Cognition?

In seeking to understand why scientists might disagree so vehemently over the proper place that claims of anomalous cognition should receive in science, it is helpful to consider a central insight of Bayes's theorem, which evaluates the weight of new evidence in light of one's prior probabilities. In recent years, Bayes's theorem has primarily been invoked as the basis for alternative forms of statistical analysis (e.g., [Wagenmakers et al., in press](#)). However, in its original formulation, it served to formalize the fact that an individual's subjective probabilities prior to encountering new evidence will reasonably sway how persuaded they should be by additional evidence ([Jeffrey, 1992](#)).

A striking aspect of anomalous cognition is the stark contrast of even well-trained scientists in their priors on the likelihood that it may exist. For example, based on his assessment of its inconsistency with known principles, physicist Sean Carroll estimates that "the probability that some sort of parapsychological phenomenon will turn out to be real at something (substantially) less than a billion to one" ([Carroll, 2008](#)). In contrast, drawing on a similar background physicist/Nobel Laureate Brian Josephson endorses the existence of at least one form of anomalous cognition as probable, and the principles of physics as providing a likely foundation on which it may be grounded, observing, "Yes, I think telepathy exists . . . and I think quantum physics will help us understand its basic properties" (quoted in [Horgan, 2012](#)). It is a straightforward implication of Bayes's theorem that when scientists begin with such vastly disparate priors on the likelihood of anomalous cognition that their appraisal of the evidence will be comparably polarized.

Of course, many factors are likely to contribute to people's priors on the likelihood of anomalous cognition. Personal experiences may well play a role. If one has had a number of experiences that seem to support anomalous cognition, then this may influence their priors. Other

factors may also be important. A characteristic of certain psychological disorders, such as schizotypy, is a belief in paranormal phenomena ([Hergovich et al., 2008](#); [Williams & Irwin, 1991](#)), so certain temperaments may contribute to people's weighting of the evidence. Some might suggest that intelligence may also play a role, and indeed there is some evidence that intelligence is negatively correlated with belief in anomalous cognition ([Musch & Ehrenberg, 2002](#); [Hergovich & Arendasy, 2005](#)). However, entertaining the possibility of anomalous cognition is not limited to the uneducated and foolhardy. A survey of beliefs about anomalous cognition among university professors indicated the majority were open to such phenomena ([Wagner & Monet, 1979](#)). Other surveys have found a positive correlation between education level and beliefs in anomalous cognition ([Emmons & Sobal, 1981](#)), and that beliefs are positively associated with adaptive personality traits such as creativity ([Davis, Peterson, & Farley, 1974](#)) and self-actualization ([Clarke, 1993](#)). Indeed, many important scientists/theoreticians over the last century have publicly acknowledged an openness to anomalous cognition ([Horgan, 2012](#)) including psychologists (William James, Sigmund Freud, and Carl Jung), computer scientist/mathematician (Alan Turing), biologist (Wolfgang Pauli), and physicists (Freeman Dyson and Brian Josephson). In short, many factors likely contribute to people's priors on the existence of anomalous cognition, and although the openness of some may be driven by psychopathology or dim wittedness, there are many intelligent psychologically fit people (including numerous accomplished scientists; [Cardeña, 2014](#)) who believe that anomalous cognition is a real possibility.

This line of reasoning suggests that scientists will reasonably differ in their appraisals of the likelihood that anomalous cognition may exist, which in turn will impact how they weigh the evidence with respect to entertaining anomalous cognition as a reasonable topic of study and endorsing it as a phenomenon that is likely to be true. We argue that this range of appraisals of individual investigators is likely to be healthy for the field as it helps insure that some will continue to diligently explore these contentious phenomena whereas others will cautiously prevent the field from prematurely advocating an overhaul of its scientific worldview. Although

individuals may usefully vary in the criteria that they hold both for entertaining and endorsing anomalous cognition, we suggest that the field as a whole would be well served if more researchers and editors adopted a liberal criterion for entertaining anomalous cognition while maintaining a very strict criterion for the outright endorsement of its existence.

The Case for Entertaining Anomalous Cognition

So why is the case for anomalous cognition any more deserving of scientific entertainment than orbiting tea pots or flying spaghetti monsters? The arguments for its entertainment come from three main sources: personal experiences, extant scientific evidence, and lessons from the investigation of other contentious domains. When considered collectively, we argue the case is sufficient to justify those scientists so motivated (based on their particular Bayesian priors) to pursue research on these topics and editors to publish such work. Importantly, as will be discussed in the following section, we argue that until extraordinary evidence is found, the publishing of work on anomalous cognition should be presented with great caution, not as demonstrating that it does exist but merely as evidence that it might.

Personal Experiences

Science is rightfully skeptical of putting too much faith in individual personal reports as people are notorious for distorting experience and embellishing it with personal theories and expectations. It is therefore appropriate that we be wary of phenomena when they are exclusively based on anecdotes of personal experiences. At the same time, it is notable just how pervasive reports of episodes of anomalous cognition are in virtually all surveys that have sought to assess them in the public arena (Moore, 2005).

Although personal experiences can be suspect, they are also a common source of inspiration for scientists. From creativity to perception (even illusions), scientists' personal experiences serve as guiding motivation for the pursuit of particular hypotheses. Anecdotally one of us attended a meeting of many well-known members of the anomalous cognition community and

queried a number of them regarding how much they believed in anomalous cognition and why. In many cases, personal experiences contributed to their openness to the phenomena (see also Baruss & Mossbridge, 2016). In other words, personal experiences with apparently anomalous cognition may substantially alter scientists' Bayesian priors regarding the likelihood that it may exist.

Notably, William James, arguably history's most successful scientist at drawing on his own personal experiences to make informed conjectures about mental processes, drew on personal experiences in justifying his willingness to entertain anomalous cognition. In reflecting on his observations of the performance of a medium who seemingly demonstrated clairvoyance, James (1896) observed,

We all, scientists and nonscientists, live on some inclined plane of credulity. The plane tips one way in one man, another way in another; and may he whose plane tips in no way be the first to cast a stone! As a matter of fact, the trances I speak of have broken down for my own mind the limits of the admitted order of nature. (James, 1896, p. 320)

In making the case for science's consideration of psychic phenomenon James critically recognized the important place that personal experiences have in tipping the plane of credulity, or in other words, in setting one's Bayesian priors. For James, the experiences that he had observing seemingly paranormal events were sufficient for him to seriously entertain the possibility that science might ultimately need to be reformulated to accommodate such phenomenon.

Needless to say, such experiences may carry little or no evidentiary weight for those who have not had them. However, science has always flourished when competing scientific hypotheses are vetted in the light of evidence. Although personal experiences are rarely sufficient to accept conjectures as fact, they have always been and should remain an important source of scientific hypotheses and motivation for scientists to pursue evidence that can test those hypotheses.

Extant Evidence

It is notable that there have been many hundreds of studies that have attempted to rigorously address the four main types of anomalous

cognition. Evaluation of this evidence is surely affected by one's subjective priors, but it can also inform people views regarding the merit of continued entertainment of this topic. Indeed, many of those familiar with the evidence find it difficult to entirely dismiss it out of hand. Although there have been cases of sloppy research designs, the community of researchers working in this domain have been sensitive to many sources of scientific artifact, pioneering techniques such as the double-blind procedure (Watt & Nagtegaal, 2004), preregistration (Watt & Kennedy, 2015), and the publishing of null results (adopted as a policy by the Parapsychological Association in 1975).

Furthermore, in several domains of anomalous cognition, meta-analyses have been conducted that consider all available research, and in each case the majority of these meta-analyses have been interpreted as indicating small but significant effects. To help readers understand the evidence on which individuals familiar with the extant evidence base their subjective probabilities, we provide the z scores and p values of the meta-analyses as reported from the original papers, when available. If p values were not reported in the original paper, they were either retrieved from a secondary source or computed. One-tailed p values were converted to two-tailed.²

Precognition

In the domain of precognition meta-analyses have showed generally significant effects. For forced-choice precognition experiments in which participants guess random outcomes (e.g., dice throws) before they occur, one meta-analysis showed a significant effect (Honorton & Ferrari, 1989; 248 studies from 1935 to 1987 [trimmed sample], $z = 6.02$, $p = 2.2 \times 10^{-9}$) while another meta-analysis evaluating data taken after the time window of the first meta-analysis showed nonsignificance if a two-tailed p test is applied (Storm, Tressoldi, & Di Risio, 2012; 25 studies from 1987 to 2010, $z = 1.92$, $p = .05$) but reported that the effect size was consistent with the first meta-analysis. Psychophysiological experiments in which bio measures reveal an anticipation of unknown events have shown a statistically significant effect (Mossbridge, Tressoldi, & Utts, 2012; 26 studies, $z = 5.3$, $p = 5.7 \times 10^{-8}$, random effect

size; $z = 6.9$, $p = 2.7 \times 10^{-12}$, fixed effect size). Finally, two meta-analyses have investigated the recent paradigms developed by D. Bem (Bem, 2011), which utilized time-reversed versions of standard psychology experiments (e.g., presenting an additional study phase of a memory experiment after the test phase). One meta-analysis (Galak, LeBoeuf, Nelson, & Simmons, 2012) reported null effects (19 studies, $z = 1.7$, $p = .08$, random effect size). However, a later larger meta-analysis (Bem, Tressoldi, Rabeyron, & Duggan, 2015), which included all of the studies considered in Galak et al. plus many more, reported highly significant findings (90 studies, $z = 6.4$, $p = 1.2 \times 10^{-10}$).

Clairvoyance

To the best of our knowledge no comprehensive meta-analyses exist of "remote viewing", the clairvoyance technique developed for the U.S. intelligence services and military to attempt espionage on military targets. But academic researchers have developed their own "forced-choice" techniques, which involve guessing targets hidden from the subject, the classic example being Zener cards. A meta-analysis compiling forced-choice clairvoyance research showed significant results (Storm et al., 2012; 38 studies from 1987 to 2010, $z = 3.07$, $p = 2.14 \times 10^{-3}$). An earlier meta-analysis also showed significant results; however, interpretation is more difficult due to a restricted selection

² It should be noted that these meta-analyses did not use equivalent methodologies and caution should be employed for direct comparisons. Also, the list appearing in this article is not comprehensive. A full list of all meta-analyses on psi done before 2006 is available in (Bösch et al., 2006). That paper reports that before 2006, out of 13 meta-analyses, 11 had reported evidence for psi whereas two had reported null results. We have attempted to locate meta-analyses papers post-dating 2006. One meta-analysis published since 2006, which is not reported in the text, is an evaluation of dream psi studies (Sherwood & Roe, 2013). This meta-analysis reported positive overall evidence for psi (1st dataset [Maimonides]: $r = 0.33$, 95% CI: 0.24 to 0.43, second dataset (post-Maimonides): $r = 0.14$, 95% CI: 0.06 to 0.22) but covered multiple domains: precognition, telepathy, and clairvoyance. Dividing up the results by domain (such as is done in the main text of our commentary) leaves the dream results statistically weaker and indistinguishable from 0. The reported effect size ranges of the study are: $r = -0.34$ to 0.07, median = -0.04 for precognition, $r = -0.27$ to 0.80, median = 0.10 for telepathy, and $r = -0.49$ to 0.63, median = 0.25 for clairvoyance. Meta-analytic z scores were not reported.

of studies that investigated clairvoyance and precognition in a single study (Steinkamp, Milton, & Morris, 1998; 22 studies from 1935 to 1997, $z = 2.81$, $p = .005$).

Ganzfeld Telepathy

Meta-analyses have had mixed outcomes with regard to the Ganzfeld telepathy paradigm, in which a physically isolated sender tries to send information about randomly chosen target pictures to a sensory deprived receiver who attempts to describe those images and subsequently to identify them from a forced choice array. Two meta-analyses of this paradigm reported overall significant effects (Rosenthal, 1986; 28 studies from 1974 to 1981, $z = 6.60$, $p = 4.1 \times 10^{-11}$; Bem & Honorton, 1994; 11 studies postdating 1986, $z = 2.89$, $p = .04$; Storm, Tressoldi, & Di Risio, 2010; 29 studies from 1997 to 2008, $z = 5.48$, $p = 2.13 \times 10^{-8}$) whereas one meta-analysis failed to find a significant effect (Milton & Wiseman, 1999; 30 studies from 1991 to 1996, $z = 0.70$, $p = .48$).

Psychokinesis

In the domain of psychokinesis, meta-analyses have found significant effects for individuals attempting to influence the outcome of random-number generator machines (Radin & Nelson, 1989; 597 studies, $z = 15.76$, $p = 7.3 \times 10^{-55}$) and dice throws (Radin & Ferrari, 1991; 59 studies, $z = 3.19$, $p = 1.4 \times 10^{-3}$, homogeneous studies using balanced target protocols). One later meta-analysis also found a significant effect for random number generators but argued the result could be due to publication bias (Bösch, Steinkamp, & Boller, 2006; 380 studies, $z = 2.47$, $p = .014$, random effect size; $z = -3.67$, $p = 2.4 \times 10^{-4}$, fixed effect size).

In considering the surprising number of positive outcomes of these meta-analyses, it is reasonable to ask why, if these effects are real, have researchers been unable to distil any of these paradigms into procedure that can produce consistent compelling findings on demand. Indeed, the magician James Randi has offered a million-dollar prize for a robust demonstration of any form of anomalous cognition, yet no prizes have yet been awarded. As will be discussed, the current absence of such incontrovertible evidence is one reason why these meta-

analyses are in our view insufficient to warrant endorsing any of these phenomena as real. However, it is also important to keep in mind what incontrovertible evidence entails in the context of effects that, if they exist at all, are almost certainly quite small. In physics, it is appreciated that very important phenomena can nevertheless be extraordinarily weak and thus require great efforts with teams of researchers to discern beyond a reasonable doubt. Nobody in physics would allow a magician to play a crucial role in adjudicating the existence of any of its important but difficult to discern phenomenon (e.g., the Higgs Boson). Indeed, the organization overseeing the Randi prize (managed by an individual who is not himself a scientist) has not considered testing various experimental paradigms, such as unconscious precognition, currently used in scientific research of anomalous cognition (Carter, 2007).

The difficulty of incontrovertibly documenting small subtle effects is further illustrated by the more general challenges that psychology has faced in unequivocally documenting many of its more conventional findings. For example, an investigation of individual attempts to replicate a hundred published findings from three prominent psychology journals found that less than 40% were replicated at conventional levels of significance (Open Science Collaboration, 2015). Importantly, however, this does not mean that the approximately 60% that did not replicate are necessarily invalid (e.g., Gilbert, King, Pettigrew, & Wilson, 2016). Individual studies, particularly those involving small effects effect sizes, can fail to replicate for a host of reasons other than that the originally investigated phenomenon does not exist.

An alternative approach for discerning the robustness of individual psychological findings is to get multiple researchers to attempt to replicate the same finding. A series of such replication efforts has been sponsored by the journal *Perspectives in Psychological Science*. In each case, 15–25 teams of researchers from around the world attempted to replicate well known findings. Of the five studies (Finkel, Rusbult, Kumashiro, & Hannon, 2002; Rand, Greene, & Nowak, 2012; Schooler & Engstler-Schooler, 1990; Sripada, Kessler, & Jonides, 2014; Strack, Martin, & Stepper, 1988) so far investigated by these efforts (Alogna et al., 2014; Bouwmeester et al., 2017; Cheung et al., 2016;

Hagger et al., 2016; Wagenmakers et al., in press) only one (Schooler & Engstler-Schooler, 1990) was successfully replicated (Alogna et al., 2014) and even here the findings were smaller and more delimited than originally observed (Schooler, 2014b).

Researchers can also reasonably disagree about the magnitude of concern that multiple failures to replicate individual studies pose for the field of psychology. If the protocols used in such studies do not adequately match those entailed in the original investigation, then repeated failures to replicate are not particularly meaningful. Indeed, interpretation of the degree to which such replications failures speak to the overall soundness of extant psychological findings may be another case in which scientists' subjective Bayesian priors influences their assessment of the evidence. Nevertheless, given the challenges that conventional psychological studies have faced when so closely scrutinized, it is perhaps notable that meta-analyses of studies replicating anomalous cognition paradigms have fared as well they have (Utts, 1991).

Lessons from history. The history of scientific inquiry is riddled with cases of conjectures that were originally viewed as outlandish but ultimately gained widespread scientific acceptance.

Numerous examples of claims that were initially dismissed but now are widely recognized include Copernicus' account of heliocentrism (Weinert, 2009), Darwin's theory of evolution (Hull, 1973), the effects of hypnosis (James, 1890), continental drift (Oreskes, 1999), the bacterial theory of ulcers (Meuler, 2011), quantum entanglement (Buhrman, Cleve, & Van Dam, 2001), and the absence of ether (Goldberg, 1970).

The lessons of history suggest that initial scientific skepticism is often a signature of revolutionary ideas that ultimately prove of merit. As Max Planck (Planck & Rusk, 1950) observed: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." Of course, for every observation or theory that was initially reacted to with scientific disbelief but later prevailed, there are many others that ultimately were found to be deserving of their initial skepticism. Thus, as will be discussed, the disbelief that

anomalous cognition currently faces in the scientific community is an important consideration in preventing it from crossing the threshold of being genuinely endorsed. However, the lessons of history suggest that such skepticism should not prevent it from being seriously entertained, at least by those willing to do so.

In addition to the many theories and phenomena that initially faced skepticism but are now generally endorsed, there are an even more radical set of modern conjectures that many serious scientists and philosophers currently consider viable possibilities worthy of entertainment. In the domain of physics, scientists have speculated and sought evidence for a host of ideas that seem as outlandish as anomalous cognition. The apparent impact of the act of observation on the collapse of the wave function have led some physicists to speculate that consciousness itself may play a crucial role in the realization of reality (Wigner, 1967) or the equally unfathomable suggestion that with every observation the universe branches off into multiple parallel universes (Everett, 1957). The remarkable precision with which a host of universal constants correspond to exactly what is necessary for life to exist has led to speculations that we may exist within a near infinitude of universes with different constants (Carter, 2011), or even that we may live in a simulation (Bostrom, 2003). Computer scientists and philosophers are concerned that machines may ultimately become conscious and destroy the human race (Bostrom, 2002), or that we will be able to download our consciousness into computers and exist forever (Koch & Tononi, 2008).

It is notable in considering the domains in which some of the most radical scientific speculations are currently being made that they often relate in one way or another to issues surrounding the topic of consciousness. This is likely not a coincidence. The capacity of a three-pound organ to generate the entirety of our phenomenological world is a mystery without parallel. The so-called "hard problem" of consciousness (Chalmers, 1995, 1996) is widely recognized as quite possibly the most challenging enigma that scientists face, as to date there are no agreed upon accounts, and it is not even clear what a solution to it might look like. Some philosophers (Chalmers, 1995) and physicists (Penrose, 1994) have speculated that consciousness may correspond to some fundamental aspects of

physics of which we, as of yet, have little evidence for what it might be. In this context, it is notable that anomalous cognition, which entails consciousness extending in ways that are not currently understood, shares as its common denominator, the mysterious role of consciousness. Given that we so fundamentally lack a clear understanding of what consciousness is and how it exists in the physical world, it seems presumptuous of us to claim that we can have great confidence about what constraints science necessarily imposes upon it.

Of course, the fact that serious scientists and philosophers are willing to entertain a host of seemingly unfathomable conjectures in no way guarantees that they will prove to have scientific merit. The lesson from history is that many such conjectures are ultimately found lacking. But some have proven viable and, in such cases, led to revolutionary advances. These advances have fostered not only our general understanding of the world but also have led to countless important practical benefits. If there is any merit to claims of anomalous cognition, it seems likely that it could be of great value. For example, the U.S. government has already invested millions of dollars, with some remarkable reported accomplishments in attempting to harness clairvoyance to detect adversaries' military installments (McMoneagle, 2015); though it should be noted the program was ended in 1995 with contradictory reports of its effectiveness and a conclusion that operational use was not worth supporting (Mumford, Rose, & Goslin, 1995). Similarly, precognition may be a possible alternative explanation, in addition to other possibilities suggested by researchers such as ultra low frequency radiation or foreshocks, for how animals detect future natural disasters such as earthquakes (Grant & Halliday, 2010; Yamachi, Uchiyama, Ohtani, & Ohta, 2014). If humans have the ability to have noninferential premonitions of upcoming disasters (as precognition research suggests), further research could enhance safety and protect lives.

More generally, the discovery that consciousness extends in time and space in ways that are not currently conceptualized by science would revolutionize the way we conceive of ourselves and our place in the universe. Compelling demonstrations of anomalous cognition could reveal unappreciated channels by which consciousness extends in nature. If precognition exists, it could

revolutionize the way we think about the arrow of time, and even causation itself. Psychokinesis might suggest the existence of unknown forces in nature, and/or speak to the causal role of consciousness in the natural world. The demonstration of telepathy and clairvoyance could portend a profound shift in our appreciation of the connection that we hold with each other and the world around us. Ultimately, it is impossible to fully anticipate the impact that any incontrovertible evidence of anomalous cognition would have on science, however, the very fact that it is currently viewed as impossible by many illustrates the gravity of the scientific revolution that it would herald.

Of course, the investigation of anomalous cognition, if it does not exist, might be viewed as a serious opportunity cost for researchers who could have spent their time and resources otherwise. Indeed, researchers (and particularly junior ones) would be well advised to avoid dedicating all of their energies to this clearly risky topic. However, this is a choice that individual scientists, based on their Bayesian priors can make for themselves. Furthermore, as we will discuss, even if a rigorous investigation of anomalous cognition ultimately comes up empty-handed, it may help to elucidate the artifacts of science that contributed to the many reports of positive anomalous cognition findings. Since the inception of science, researchers have made their own choices in what topics to gamble on: Some have paid off and some have not. No one should be forced to study these contentious topics, but if individual scientists are so inclined they should be able to do so unimpeded by the ridicule that can be leveled against researchers in this area. The price of overlooking anomalous cognition if it does in fact exist, seems extraordinarily high.

In short, in contrast to orbiting tea pots and flying spaghetti monsters, the prospect that some form of anomalous cognition is real is seriously entertained by a substantial number of scientists, associated with a significant body of supporting evidence, and would have huge implications if true. Even if many in the scientific community view its likelihood as exceedingly low, given these considerations it seems anomalous cognition is deserving of continued careful investigation by qualified researchers who are willing to entertain it.

The Case for Not Yet Endorsing Anomalous Cognition as Bona Fide Phenomena

Although, for the reasons outlined above, we argue that anomalous cognition is deserving of serious consideration as a conjecture worthy of entertainment, we contend that it is far from reaching the threshold of being considered a real phenomenon, and further that this threshold should be set quite high. Here we review the reasons why we believe science as a field, while encouraging the entertainment of the conjectures of anomalous cognition, should be extremely cautious in characterizing findings as anything more than furthering the importance of additional research.

The unreliability of scientific findings. As noted, in recent years there has been increasing appreciation that published findings in a host of conventional domains including psychology (Open Science Collaboration, 2015), medicine (Ioannidis, 2005; Ioannidis & Trikalinos, 2005; Kaplan & Irvin, 2015) and biology (e.g., Jennions & Møller, 2002) are less robust than originally assumed (Schooler, 2011; Protzko & Schooler, in press). Although as noted, failures to replicate do not necessarily imply that the original findings were errant (Gilbert et al., 2016), the increasing appreciation of the challenges of scientific replication has fostered the burgeoning field of metascience (Schooler, 2014a), in which the lens of science is directed toward science itself and the sources of scientific artifact that may contribute to spurious findings. A central potential source of unreliability is that scientists can unwittingly engage in a variety of practices—collectively known as p-hacking (Simmons, Nelson, & Simonsohn, 2011, 2014)—that include selective reporting of findings, conditions, and experiments, or post hoc selection of covariates, data exclusion rules. Such techniques, which may be fostered by journals' reluctance to report null findings and the "publish or perish" attitude of academia, appear to be widely applied in science (e.g., John, Loewenstein, & Prelec, 2012; Fanelli, 2010) and may be an important source of unreliable findings (Simmons et al., 2011).

The increasing appreciation that the scientific method is capable of unwittingly introducing artifacts than can produce false positive effects

is especially relevant to anomalous cognition findings that seem so implausible to many. Although, as noted, the community of researchers working in this domain have been sensitive to many sources of scientific artifact, there are still reasons to be concerned that positive findings may be a product of p-hacking and other sources of scientific error (Bierman, Spottiswoode, & Bijl, 2016; Simmons et al., 2011; Wagenmakers, Wetzels, Borsboom, Kievit, & van der Maas, 2015). Indeed, if the evidence for anomalous cognition ultimately proves to be illusory, it will be an exemplary case of how an entire field of study was generated through faulty scientific practices.

The consequences of incorrectly endorsing anomalous cognition as real. In addition to reasons to be skeptical of extant findings of anomalous cognition, there are also serious concerns about prematurely promoting evidence that treats anomalous cognition findings as factual. As noted, the genuine existence of any form of anomalous cognition would fundamentally challenge core assumptions in science. Marcello Truzzi (1978) once observed, "Extraordinary claims require extraordinary evidence." This sentiment, which aptly captures the Bayesian notion of the importance of weighing one's priors into the evaluation of evidence, seems an extraordinarily sensible maxim when it comes to the endorsing of any form of anomalous cognition as a real phenomenon. Although there are good reasons to entertain the possibility of anomalous cognition, and even to speculate about possible mechanisms that could potentially account for it, great caution should be taken in overturning long established premises when that is not absolutely positively required.

Although it would be a colossal oversight to ignore anomalous cognition if it actually exists, there are also great costs to concluding that it is a real phenomenon if it is not. As noted a common symptom of a host of psychopathologies is an endorsement of paranormal phenomena. Although the causal role that such beliefs may play in encouraging delusional thinking is not established, it seems quite plausible that scientific claims of demonstrating anomalous cognition could encourage people to engage in irrational beliefs and potentially harmful actions. The general public is all too susceptible to unsupported claims that are presented as having a scientific basis. Prematurely presenting evi-

dence for anomalous cognition as demonstrating its existence could further a lax criterion on the part of the public and foster other currently ungrounded beliefs. More generally the credibility of science depends on its capacity to discern fact from fiction. If the field endorses bogus claims as genuine, its credibility takes a hit. The greater the false claims, the greater the hit. Thus, it is of significant importance that the field be extremely wary of promoting as fact, extraordinary claims before those claims are supported by extraordinary evidence.

Establishing the criteria for endorsing anomalous cognition. Although the criteria for endorsing anomalous cognition should (in our view) be held extraordinarily high it should not be insurmountable. With sufficient effort it should be possible to establish anomalous cognition as real if it exists and follows the same principles as other observable phenomena.³ Although researchers will likely disagree on precisely what level of evidence is required for the field to endorse anomalous cognition, we offer the following set of guidelines as a starting point for what a reasonable set of criteria may entail:

1. Careful evaluation of design by skeptics and supporters prior to the initiation of the protocol;
2. Preregistration of protocol including data analysis using both standard and Bayesian procedures;
3. A computer implemented procedure using locked code that cannot be tampered with;
4. A procedure that can be carried out by participants without interaction with experimenters as it takes place;
5. Off-site logging of data;
6. Careful independent analysis of data by multiple statisticians blind to condition;
7. Analysis of data must reveal highly significant results when analyzed using both standard and Bayesian procedures;
8. The resulting protocol must itself be replicated by numerous independent laboratories; and
9. Ideally the protocol should be transformed into a paradigm that can have demonstrable real world outcomes for example, predicting stock market (Franklin et al., 2014).

The above conditions are not being offered here as criteria for the publication of research on anomalous cognition, which we believe should be evaluated according to the same standards as conventional areas of science. Rather, we propose them as a starting point for a reasoned discussion by researchers with differing perspectives regarding the type of evidence that would be required by the field to endorse any form of anomalous cognition as likely real. Ultimately the history of science suggests that if sufficient evidence were to accrue, some would go to their graves disbelieving, but eventually the zeitgeist would change. In this decidedly contentious case, researchers would presumably find scientific theories to accommodate the new understanding, and anomalous cognition would no longer be anomalous. As James (1896) observed, “Science, like life, feeds on its own decay. New facts burst old rules; then newly divined conceptions bind old and new together into a reconciling law” (p. 320).

Although the threshold for endorsing anomalous cognition should be set very high, in our view it is well worth the effort to determine if it can be reached. If it can, then science will be revolutionized. If it cannot, then anomalous cognition will serve as a canonical example of

³ Some have speculated that although anomalous cognition is real it may never be demonstrable within the boundaries of science. For example, the physicist Freeman Dyson, suggested that anomalous cognition requires “strong emotion and stress,” which is “inherently incompatible with controlled scientific procedures.” He thus concludes that “paranormal phenomena are real but lie outside the limits of science” (quoted in Horgan, 2012). Others have proposed that though amenable to scientific inquiry, anomalous cognition effects may be mediated by the beliefs of the experimenter (Wiseman & Schlitz, 1997) the influence of which may themselves be underpinned by anomalous cognition phenomena. If we are to entertain the possibility of anomalous cognition, then we must also consider the possibility that it may apply to the scientific process itself (Schooler, 2011). However, if it does then this too may have testable consequences (Lucadou, Römer, & Walach, 2007; Schooler comments in Protzko and Schooler, in press; Wiseman & Schlitz, 1997). The search for a scientific grounding for anomalous cognition may require great ingenuity and appreciation of the multiple levels at which it may apply. However, if such efforts fail to find compelling evidence, some will surely continue to believe in its existence as they do in religion, spirituality and other metaphysical phenomena that may be forever outside the ken of science. There may well be truths beyond the realm of science, but this is a possibility, like subjective Bayesian priors that each person must evaluate for themselves.

the faulty narratives that can be constructed with the artifacts of science.

General Conclusions: On the Need for Humility

The suggestion that human cognition uses yet unknown channels to anticipate the future, sense the contents of other minds, conceive of the happenings of distant places, or alter physical objects is decidedly the stuff of science fiction. On many occasions science fiction has come true, but more often it hasn't. Ultimately, science is capable of sifting fact from fiction, but this ability does not happen overnight. Ideas begin as conjectures and with the accumulation of evidence are gradually resolved toward rejection or endorsement. Skeptics will argue that anomalous cognition has had its opportunity for resolution. Researchers have been conducting studies on what has been alternatively referred to as psychic abilities, paranormal abilities, ESP, and psi for over a century. According to this view, anomalous cognition has been entertained and the fact that we find ourselves more than a century later still debating whether there is anything to it should be grounds enough to let go of wishful thinking and move on.

We acknowledge the persuasiveness of the above arguments and recognize that reasonable people can hold this view. However, what we find unreasonable is the further assertion that this is the only defensible position that scientists can have on the topic. In particular, when it comes to entertaining anomalous cognition, we believe a strong argument can be made for the continued consideration of the possibility that the mind may extend in time and space in ways that seemingly transcend the current boundaries of science. With a less skeptical set of subjective Bayesian priors one can reasonably look at the extant research as providing suggestive evidence that some forms of anomalous cognition really might exist. As noted, many meta-analyses have indicated small yet highly significant effects. Although, in our view, far from sufficient to make firm conclusions, these significant effect size estimates amassed over hundreds of studies are large enough to counter the oft cited refrain that there is no evidence whatsoever for claims of anomalous cognition. In the context of recent demonstrations of the challenges of replicating more conventional psycho-

logical findings, the generally positive outcomes of meta-analyses of anomalous cognition studies suggest that the ambiguity of a century of science on this issue could be a product of extremely small effect sizes that are difficult to discern with individual studies. If so, then larger studies conducted by organized teams of researchers may provide evidence not available to prior generations of researchers. In addition, the effects may be more evident with the introduction of more sensitive procedures such as psychophysiological measures (Radin, 2015) and implicit assessments (Bem, 2011) that do not require participants to make seemingly impossible judgments. From this view, the jury on anomalous cognition is still out. If so, it would be an oversight of historical proportions to ignore the possibility of scientific findings that could revolutionize the way we think about the mind and its relationship to the physical world.

Fortunately, discerning the probability that science will eventually endorse some forms of anomalous cognition is not a matter on which we need agree. Those that see this as a promising endeavor should be allowed to pursue their investigations and publish their findings, and those that see it as a waste of time can devote their efforts elsewhere. What is needed is a willingness on the part of scientists with varying perspectives to recognize the existence of alternative defensible positions, and the consequent need to maintain humility in the consideration of these issues. Those who report evidence in support of anomalous cognition need humility in presenting their findings in a manner that acknowledges the contentiousness of their claims, and the consequent caution that is required in their interpretation. Those who dispute the possibility of anomalous cognition need humility in recognizing that scientists are sometimes wrong about what is impossible. Grounded in humility, scientists with varying beliefs on the likelihood of anomalous cognition can move forward in discerning whether it can be substantiated by science or must remain a fascinating conjecture that may forever capture our speculations but nothing more.

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