types of beliefs that may qualify as adaptive misbeliefs? My commentary addresses this and other questions through identifying belief in free will as a potential candidate as an adaptive misbelief.

To say that beliefs are untrue, or are "misbeliefs," is to say that the belief in question can be objectively verified; however, beliefs are by definition subjective. Despite the subjective nature of human beliefs, researchers have learned to use the refining process of the scientific method in order to partly uncover "reality." Such is the plight of the social scientist and the beauty of scientific method. At what point, however, do the systematic replications and validations go beyond an understanding of the underlying factors giving rise to beliefs? If science, for example, reliably demonstrates that the sun does not in reality move across the sky, does this change one's belief in how the sun is moving throughout the day? It may do so (based on a faith in science), but such change in belief does nothing to change perception. One's subjective perception of the sun's movement is what is real and is the only view that matters to normal functioning. Therefore, there are times when it may be more adaptive and functional to misperceive than correctly believe.

McKay & Dennet (M&D) suggest that in order to identify a systematically adaptive misbelief, such belief may result from processing "biases" in the sensory system itself. Such an assertion assumes that perception gives rise to (mis)belief. Although this assertion may at times be true, at other times perception and belief may be disconnected (e.g., see above), or (mis)belief may actually give rise to perception (e.g., New Look: Balcetis & Dunning 2006; Bruner 1957). In fairness, disconnects between perception and belief are discussed in M&D's discussion of "alief" and error management theory; nevertheless, their proposed connection between perception and misbelief remains unclear.

A similar point of confusion is found in the distinction M&D make between psychological and biological adaption. It has long been recognized that social psychological factors and biological factors are closely related (for a review see Cacioppo et al. 2000). Because of the complementary nature of social psychological and biological factors in human behavior, making distinctions between the two becomes meaningless without specifying how the two may be connected for a given outcome (e.g., Gailliot et al. 2007).

The lack of clarity in distinguishing between perception and belief, and psychological and biological adaption, becomes apparent as M&D investigate whether religious belief might be a good candidate for adaptive misbelief. If inferring the presence of agents is adaptive, for example, is such adaptability psychological or biological? If such agents cannot be seen and are not real, then what role does perception play? In fact, most of the empirical research in the area cited by M&D (i.e., Pichon et al. 2007; Randolph-Seng & Nielsen 2007; Shariff & Norenzayan 2007) suggest that *alief*, rather than belief, is involved, and that perceptual priming of agency rather than religion per se may be at the root of the behavioral effects found. M&D do acknowledge these possibilities, but fail to extend these possibilities to the search for adaptive misbelief (a point I return to later).

Where M&D's search does take them is to conscious self-deception. Considering their previously implied condition of adaptive misbelief arising from nonconscious perceptual biases, it is unclear why conscious self-deception is even considered, but it does provide a nice segue into positive illusions (i.e., the unrealistic optimism-type), fulfilling the stated requirements for adaptive misbelief. But why stop there? Are there other types of beliefs that could be considered adaptive misbeliefs (e.g., antecedent misbeliefs giving rise to the positive illusions described by M&D)?

One potential candidate may be gleaned from M&D's discussion of religious beliefs, namely a belief in personal agency. Recent social psychological research suggests that one's belief in free will is (or can be) an illusion (for reviews, see Bargh 2008; Wegner 2005); however, other research suggests that the more one believes in personal agency, the more prosocial and hardworking one tends to be (Baumeister et al. 2009; Stillman et al., in press; Vohs & Schooler 2008). Insofar as a belief in free will is a positive illusion (see Bargh & Earp 2009), it may be considered a pre-existing belief for the types of positive illusions discussed by M&D. For example, if one did not believe that control over one's actions was real, then there may be less reason to believe that one has what it takes to survive a life-threatening disease.

Proposing a belief in free will as a candidate for adaptive misbelief does bring to the forefront the previously discussed question of the connection between perception and belief. Insofar as the choices one makes are the result of nonconscious thinking instigated by the environment and resulting from our evolutionary past (Bargh 2008), belief in free will and nonconscious perception do not line up. Nevertheless, rational choice and conscious self-regulation are also thought to be intricately linked to the evolution of human cognition (Baumeister 2008), in which case belief may be able to feed back into perception. Such a possibility would help explain how humans, despite being mostly unaware of the various messages presented to them from the environment, can successfully navigate through their environment in order to accomplish their personally activated goals. In fact, recent research has found that people can go beyond nonconsciously regulating their responses to *consciously* perceived stimuli, to preconsciously controlling the impact of *nonconsciously* perceived stimuli on their responses (i.e., being differently influenced by subliminal primes depending on current nonconscious motivations; Randolph-Seng 2009). In this way, an adaptive misbelief, such as a belief in free will, may actually become true as human cognition evolves.

You can't always get what you want: Evolution and true beliefs

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Abstract: McKay & Dennett (M&D) convincingly argue against many proposals for adaptively functioning misbelief, but the conclusion that true beliefs are generally adaptive does not follow. Adaptive misbeliefs may be few in kind but many in number; maladaptive misbeliefs may routinely elude selective pruning; reproductively neutral misbeliefs may abound; and adaptively grounded beliefs may reliably covary with but not truthfully represent reality.

In critiquing proposed examples of adaptive misbelief, McKay & Dennett (M&D) aim to confirm the assumption that, via evolution, humans "have been biologically engineered to form true beliefs" (sect. 1, para. 2), and conclude that the exchange rate between fitness and truth "is likely to be fair in most circumstances" (sect. 15, last para). We agree with their critiques (Murray & Moore 2009; Schloss 2007), but the conclusion does not follow.

First, even if many proposals for adaptive misbelief fail, this does not tell us whether adaptive misbeliefs spawned in situations M&D acknowledge as credible are common or, as they claim, limited to "certain rarefied contexts" (sect. 15, last para). For instance, the promiscuous attribution of agency and teleology, or the manifold positive illusions that may be accounted for within error management theory (Johnson 2009) are extraordinarily plentiful, persistent, and influential. Other kinds of positive illusions, from the placebo effect to magnifying the virtues of beloved people, places, nations, and traditions – consistent with proposals

for resource commitment strategies – may be even more plentiful and powerful. And contrary to M&D's tempting suggestion, such positive illusions are not restricted to subjective beliefs that are "not likely to be rudely contradicted by experience" (sect. 14, para. 3). Many of these widespread beliefs entail almost delusional denials of repeated experience. Notions that Eros lasts forever, this time it's real, and (as the sappy song says) "When we're hungry, love will keep us alive" are effective and virtually ubiquitous catalysts for reproductive pairbonding. But by non-reproductive periods of the human life cycle, those Romeos whose romantic illusions have not killed them, have oft' yielded to the wisdom of Friar Lawrence: "These violent delights have violent ends, and in their triumph die…Therefore love moderatedly: long love doth so. Too swift arrives as tardy as too slow." Yet another category altogether, unexamined by M&D, is selection for cognitive extravagance independent of problem-solving utility (Miller 2000; 2001). But even granting M&D's conclusion that there are just a few families of adaptive misbelief, we don't yet know enough about their natural history to determine how many species there are or what their carrying capacities and competitive coefficients are relative to true beliefs.

Second, even if reproductively beneficent misbeliefs are rare and most misbeliefs have costs, this does nothing to tell us how well evolution ultimately avoids such costs. Indeed, M&D elegantly acknowledge that functional normativity does not entail statistical normality: In evolution, forgivable malfunctions may be common and achieving proper function may be "positively rare" (sect. 3, para. 5). Thus, even if truth is the evolutionary target as M&D maintain, design constraints, by-product associations, and historical contingencies may make it one that cognition has a low probability of hitting.

Third, many kinds of beliefs – from debates over quantum theory to discussions of metaphysics – have no clear reproductive relevance at all. How, and whether, such beliefs are related to cognitive mechanisms that have been selected for veracity is uncertain (Cromer 1993; Wolpert 2000). What does not seem uncertain is that manifold beliefs do not influence behaviors or the behaviors they do influence are not reproductively salient. Belief-forming mechanisms generate variety that, analogous to neutral polymorphisms (Kimura 1991), may be unpruned by the adaptive consequences of their truth or falsity. Indeed, the capacity for some degree of cognitive licentiousness may itself be an adaptation to the "uncertain futures problem" (Plotkin 1997; Wagner 2005).

Finally, M&D's conclusion requires the falsity not only of the above ways in which selection fails to exclude misbelief, but also of the more global but controversial thesis that nothing at all about the process of natural selection serves to favor truth-conducive cognitive tools (Churchland 1987; Plantinga 2002; Stich 1990).

On selectionist accounts of the origin of mind, beliefs and belief forming mechanisms are selected by virtue of their capacity to support adaptive behavior or internal states. Thus, belief forming mechanisms will be selected when they yield (i) a representational model that orients organisms towards adaptive behaviors, and/or (ii) a correlational source of arousal or inhibition that serves to motivate adaptive (or inhibit maladaptive) behavior. The question then becomes: Are models that are true better at orienting organisms towards adaptive behaviors, or are true beliefs better at arousing effective desires for adaptive behaviors? From what we know about the action of natural selection, the most prudent answer may be: "There is no reason to think so."

Why is there no reason to think so? Because (in science, and in belief generally) models need only to "save appearances" in order to be successful. Consider the task of designing "thinking" robots for a competition in which the winners were duplicated (with minor program variations) for future competitions. While one would surely seek to program competing robots to form beliefs that provided an isomorphic "map" of the external environment, would one further seek to program beliefs about that environment that were true? Not obviously. Indeed, there are numerous ways of programming the robot to "conceptualize" its environment that, while representationally biased or even radically false, are nonetheless (a) appropriately isomorphic and (b) reliably adaptive behavior-inducing. Such programs would be adaptive.

What is true of programmed learning robots is true of selection-designed cognition. Dennett has aptly commented, "Lying behind, and distinct from, our reasons are evolutionary reasons, free-floating rationales that have been endorsed by natural selection" (Dennett 2006a, p. 93). Our reasons (in better moments) are truth-seeking; natural selection's are fitness seeking. We cannot know if, in achieving its reasons, selection allows us also to achieve ours.

Of course, one might respond that just because our belief-forming mechanisms are liable to error in these domains does not mean that they are routinely or irremediably unreliable (after all, we often discover our errors, like the cognitive biases mentioned above). But this offers little reassurance, since the seeming discovery of error relies on comparing beliefs to other beliefs which, for all we know, are comparably unreliable, though perhaps for different reasons.

Richard Dawkins has commented that "however many ways there are of being alive, it is certain that there are vastly more ways of being dead" (Dawkins 1996, p. 9). The same is true of being right and wrong. Natural selection is immensely effective at weeding out ways of not being alive. It is unclear how well it fares in culling ways of not believing truly.

Culturally transmitted misbeliefs

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Abstract: Most human beliefs are acquired through communication, and so are most misbeliefs. Just like the misbeliefs discussed by McKay & Dennett (M&D), culturally transmitted misbeliefs tend to result from limitations rather than malfunctions of the mechanisms that produce them, and few if any can be argued to be adaptations. However, the mechanisms involved, the contents, and the hypothetical adaptive value tend to be specific to the cultural case.

Most of humans' beliefs, or at least most of their general beliefs, are acquired through communication. I owe my beliefs that I was born in Cagnes-sur-mer, that Washington is the capital of the US, that mercury is a metal, that dodos are extinct, that stagflation is bad, and so on ad indefinitum, not to my own perceptions and inferences on those matters, but to the words of others. Are these beliefs "grounded" in McKay & Dennett's (M&D's) sense, that is, "appropriately founded on evidence and existing beliefs" (target article, sect. 1, para. 2)? Not on relevant evidence and beliefs available to me. I hold these beliefs because I trust their sources (or, anyhow, trusted them at the time I formed the beliefs). My trusting of sources may itself be founded on appropriate evidence of their trustworthiness, but quite often it is founded rather on my trust of yet other sources that have vouched for them; for instance, I trusted the textbooks I read because I trusted the teachers who vouched for them, and I trusted the teachers because I trusted my parents who vouched for them. Needless to say, the authors of the textbooks themselves were just reporting information from yet other sources.

Of course, however long the transmission chain, communicated beliefs may be vicariously grounded in appropriate