Teleology and the Intentional Actions of Supernatural Agents

by

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Candidate's Statement

I, Andrew Roberts, state that this thesis has not been submitted for a higher degree to any other university or institution. This thesis is my own composition, all sources have been acknowledged, and my contribution is clearly identified in the thesis. Ethics approval was obtained from the Macquarie University Human Research Ethics Committee (HREC) for the empirical research contained within this thesis. The HREC reference number is 5201800087.

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Abstract

Adults have an enduring tendency to endorse teleological explanations of the natural world, where objects are explained with reference to some purpose or function. Research currently suggests that teleological and non-teleological beliefs about nature can, and do, co-exist, and that endorsement of teleological explanations of nature is positively related to a belief in the existence of supernatural agents. However, questions remain regarding exactly what aspect of belief in supernatural agents underlies the positive relationship, and how this can be reconciled with findings of an enduring teleological bias. Given that teleology is thought to develop from an understanding of intentionality, it was hypothesised that after controlling for other aspects of belief in supernatural agents, belief in the intentionality of supernatural agents should positively predict explicit teleological endorsement of the natural world, and that for non-religious individuals there should be a divergence of implicit and explicit teleological beliefs. In this study, participants were asked to judge as true or false a series of teleological explanations of biological organisms and natural non-living objects under either speeded or un-speeded conditions. After controlling for belief in the existence of supernatural agents, the belief that supernatural agents intentionally interact with the world positively predicted explicit teleological endorsement of natural non-living objects. For non-religious individuals, rates of implicit endorsement were significantly higher than explicit endorsement, whereas for highly religious individuals there was no significant difference between the two. These results are interpreted as being consistent with an intention-based theory of teleological reasoning, and help to reconcile the finding of a positive relationship between teleological endorsement and belief in supernatural agents with those of an enduring teleological bias. Theoretical implications of these findings are discussed, and several avenues for future research are identified from questions raised as a result of the current study.

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Introduction

To say that "the chair exists for sitting on" seems to be stating the obvious, yet this statement is true only insofar as being sat on was the intended function that the individual who designed the chair had in mind at the time. This form of explanation, where something is explained with reference to its function, purpose, or goal, is known as teleological reasoning (Hempel & Oppenheim, 1948; Kelemen, 1999a; Lombrozo & Carey, 2006). What is interesting about teleology is not its use in explaining the existence of human-made artefacts such as chairs, but rather its use in explaining the natural world. Just as teleological explanations of artefacts are true only if the stated function accurately reflects an agent's prior intentions, the statement "clouds rain so that plants can grow" is true only if allowing plants to grow was the intended function of a cloud raining. The question that arises then, is why do people endorse such explanations?

In the past two decades, a new field of research known as the cognitive science of religion (CSR), has sought to understand the science behind why, globally, the vast majority of individuals (Pew Research Center, 2012) believe in the existence of supernatural agents such as ghosts, ancestor spirits, or gods (e.g., Atran, 2002; Boyer, 1994, 2002). A fundamental tenet of CSR is that belief in supernatural agents arises as a by-product of ordinary cognitive processes, such as the ability to reason about the minds of other humans (Barrett & Lanman, 2008). As the cognitive processes of the neurotypical population are, by definition, ordinary, a belief in supernatural agents is argued to be intuitive and natural for most individuals. Not only does this by-product perspective account for the fact that most people believe in the existence of supernatural agents, it also accounts for the remarkable cross-cultural similarities in these beliefs. One striking cross-cultural similarity is that gods are always conceptualised as having minds and of being capable of acting in accordance with

their mental states to bring about desired outcomes (Tremlin, 2006). Put simply, gods are always conceptualised as intentional agents.

Just as a belief in supernatural agents is intuitive and natural for most, so too is the use of teleological reasoning. Not only do children readily explain the natural world in terms of function (Kelemen, 1999b, 1999c), but this tendency persists, at least implicitly, throughout adulthood (Kelemen & Rosset, 2009), and is, at best, inhibited, rather than fully extinguished by formal education (Casler & Kelemen, 2008; Kelemen, Rottman, & Seston, 2013). Importantly, there exists a positive relationship between belief in supernatural agents and endorsement of teleological explanations of the natural world (Kelemen et al., 2013). Self-identified religious individuals also describe important life events in teleological terms to a greater extent than non-religious individuals do (Banerjee & Bloom, 2014; Heywood & Bering, 2014). The relationship between belief in supernatural agents and endorsement of teleological explanations of the natural world is not surprising. Just as scientifically *warranted* teleological explanations of human-made artefacts imply the intentions of an agent, so too do scientifically *unwarranted* teleological explanations of the natural world. As such, it has been argued that teleological explanations of nature constitute a quasi-religious belief (Kelemen, 2004).

However, while belief in supernatural agents and endorsement of teleological explanations of nature are positively related, questions remain. Firstly, what is it about belief in supernatural agents that is predictive of scientifically unwarranted teleological explanation? For example, belief in God is complex, and entails more than just a belief that God "exists" (see Huber & Huber, 2012). Secondly, if a teleological bias persists throughout adulthood, how can this be reconciled with findings of a positive relationship between belief in supernatural agents and teleological endorsement? It is possible that non-religious individuals are less biased towards teleological explanations in comparison to religious

individuals. Is it also possible that the difference between implicit and explicit teleological

endorsement is moderated by belief in supernatural agents? Finally, might the reconciliation

of a teleological bias and the positive relationship between belief in supernatural agents and

teleological endorsement of the natural world differ according to exactly what is being

explained? The current research seeks to answer these questions, and in doing so, advance

the present understanding of the relationship between belief in supernatural agents and

endorsement of scientifically unwarranted teleological explanations of nature.

Theoretical Basis of Teleology

In order to understand the relationship between endorsement of scientifically

unwarranted teleological explanations of nature and belief in supernatural agents, it is first

necessary to understand the theoretical basis of why people are inclined to endorse such

explanations. In approaching this question, it is important to clearly define what is meant by

the word "*why*". Dennett (2017, pp. 38–43) makes the distinction between the "teleological

why" and the "mechanistic why". According to Dennett, the teleological why equates to the

question "what for?", whereas the mechanistic why equates to the question "how come?". In

understanding why people endorse teleological explanations, the question should therefore be

"how come people endorse teleological explanations?" rather than "what are teleological

explanations for?", as the latter question ultimately leads to a teleological explanation of

teleology.

It could be argued that scientifically unwarranted teleological explanations are simply

a form of anthropomorphism, whereby the natural world is perceived as intrinsically agentive

(see Guthrie, 1993). For example, an anthropomorphic view of clouds could conceivably

lead to endorsement of the statement "clouds rain so that plants can grow". However, it

seems improbable that endorsement of the statement "the chair exists for sitting on" would be

the result of taking an anthropomorphic view of a chair. Therefore, while the explanation of

teleology as anthropomorphism has a certain appeal, it is unlikely to account for all forms of teleological reasoning. Broadly speaking, two theories have been proposed as to why people are inclined to endorse teleological explanations. However, it will be argued that the two theories answer very different questions, and that ultimately, one gives a teleological explanation of teleology.

        Intuitive biology. The first theory of teleological reasoning, which has come to be known as *Selective Teleology* (ST), arose from efforts to explain children's seemingly intuitive understanding of biology. Keil (1992) argues that this includes notions such as inheritability and growth, which are specific to biological organisms. Two closely related variants of ST theory have been proposed: Firstly, the theory that from a young age, children are equipped with a knowledge-acquisition device in the form of a "teleological-design stance" (Keil, 1992, 1995), and secondly, the theory that teleological and essentialist assumptions form the core of a "living-things module" (Atran, 1995). Both variants of ST theory essentially posit that teleological explanations are triggered by encountering objects which appear to have some functional utility. Teleology is said to be "selective" in the sense that for both adults and children, teleological reasoning should be limited to human-made artefacts and the properties of biological organisms. For example, ST theory predicts that adults and children should endorse teleological explanations such as "chairs are for sitting on" and "eyes are for seeing", but not explanations such as "cats are for chasing mice" or "clouds rain so that plants can grow", which refer to whole biological organisms and natural non-living objects, respectively.

        Both variants of ST theory argue that the proper domain of teleology is in explaining the biological world, and that although artefacts clearly have functional utility, this is secondary to biology. One aspect in which the two variants differ, is that Atran (1995) claims that only later in development through exposure to one's culture does the actual

domain of the living-things module expand to include artefacts. Keil (1992, 1995), however, claims that biological properties and artefacts are differentiated by the direction of their function, with the function of biological properties being self-focused, and human-made artefacts being other-focused. For example, according to Keil, the properties of a biological organism, such as its eyes, are intuitively understood as serving a function for the biological organism itself (i.e., seeing). This contrasts with how human-made artefacts are intuitively understood, wherein the function of the artefact - for example, a chair existing to be sat on - serves not the artefact itself, but another entity.

According to Keil (1992, p. 127), adopting a teleological-design stance which makes salient the notion of function, allows a more valuable level of analysis than that afforded by adopting a purely physical stance. Admittedly, the question these theorists were addressing was not the origin of teleological thought, but how children are able to differentiate biological and non-biological kinds. However, an issue with both variants of ST theory is that they answer a "what for", rather than a "how come" question. That is, by asserting that teleology exists so that people can differentiate biological and non-biological kinds, these theories propose that teleology itself has a function, and in doing so, offer a teleological explanation of teleology.

Intuitive psychology. The second theory of teleological reasoning, known as *Promiscuous Teleology* (PT), argues that teleology develops not in relation to an understanding of biology, but as a consequence of thinking in intentional terms to explain the behaviour of agents (Kelemen, 1999a, pp. 286–291). It has been argued that a useful strategy for predicting the actions of agents is to:

> Treat the object whose behaviour is to be predicted as a rational agent; then you figure
>
> out what beliefs that agent ought to have, given its place and purpose. Then you
>
> figure out what desires it ought to have, on the same considerations, and finally you

predict that this rational agent will act to further its goals in the light of its beliefs.

(Dennett, 1987, p. 17)

This strategy of thinking in intentional terms to explain the behaviour of agents is thought to be over-generalised, due to an inherent need to make sense of the world, to explain things other than the behaviour of agents (Kelemen, 1999b, 1999a). Therefore, the theory of intention-based teleology is "promiscuous" in the sense that it predicts that children (and to some extent, adults) will endorse functional explanations, not just for biological properties and human-made artefacts, but for whole biological organisms and natural non-living objects.

Co-Existence Perspective

  Teleological bias in children. From a young age, infants are sensitive to the intended functions of tools, and from 30-months, appear to have developed something which approximates an adult-like teleology in their understanding of human-made artefacts. After exposure to an adult using a novel tool to achieve a goal, when then asked to achieve the same goal and presented with the original tool in addition to one which is physically similar and equally suited to achieving the goal, 24-month-old infants tend to choose to use the original tool (Casler & Kelemen, 2007). From around 30-months, if subsequently asked to achieve a different goal but presented with the same two tools, infants will choose the tool which was not previously used to achieve the original goal (Casler & Kelemen, 2005). These results suggest that 24-month-old infants are sensitive to the intended function of human-made artefacts, and that in the case of 30-month-olds, these intended functions are seen as mutually exclusive; if the function of a certain tool is to achieve X, it is not also used to achieve Y. As Kelemen (1999b) notes, this sort of reasoning is also present in adults, who, for example, would say that dishwashers are for cleaning dishes, regardless of whether the dishwasher is in working order.

Of more interest than human-made artefacts, is how children view and understand natural objects, as this is where the predictions of ST and PT differ. Initial support for ST theory was provided by Keil (1992, p. 130), who investigated the explanatory preferences of kindergarten and second-grade children. The children were presented with teleological and physical explanations for why plants and emeralds were green in colour. The teleological explanation stated that "It is better for plants/emeralds to be green and it helps there be more plants/emeralds", whereas the physical explanation stated that "It is because there are little tiny parts in plants/emeralds that when mixed together give them a green color". According to ST theory, children should avoid teleological explanations for natural non-living objects such as emeralds. Keil found that second-grade children preferred the teleological explanation for plants, but the physical explanation for emeralds, with kindergarten children having no clear preference but trending in the same direction. Although providing tentative support for ST theory, as Kelemen (1999b) noted, the interpretation that children are selective in their teleology is problematic for two reasons. Firstly, if a teleological-design stance is innate, then the absence of evidence for selective teleology in kindergarten children is surprising. However, absence of evidence should not be taken as evidence of absence, as it is possible that the task was too abstract for these children. Secondly, the wording of the explanations may have confounded the results. When adults engage in teleological reasoning for artefacts, they would rarely, if ever, say that the artefact has a certain property because it is "better" for that artefact, or because it "helps there be more" of that artefact. Therefore, the wording of the explanations may have biased the children towards endorsing physical explanations for the emerald.

Subsequent research strongly supports PT theory in showing that children do not restrict teleological explanations to biological properties and human-made artefacts. When shown pictures of objects and asked, "What's the X for?", compared to university

undergraduates, four- and five-year-old North American children offered a significantly greater number of teleological explanations for natural non-living object parts and wholes, and a marginally significant amount more for biological wholes (Kelemen, 1999b, study 1). When asked whether these objects were "made for something" or "not made for anything", the difference in endorsement between children and adults for natural non-living object parts and wholes remained significant (Kelemen, 1999b, study 2), suggesting that children were not just answering in terms of an object's possible use, but viewed these objects as existing for an intended function. North American children aged between seven- and ten-years-old show comparable tendencies, with teleological explanations for the properties of natural non-living objects endorsed at levels significantly above chance, whereas university undergraduates overwhelmingly reject these in favour of physical-reductionist explanations (Kelemen, 1999c). Similar results have since been obtained with British children (Kelemen, 2003; Kelemen & Diyanni, 2005), showing that the tendency to endorse teleological explanations of the natural world is also present in Western societies that are more secular than North America. Clearly, contrary to the predictions of ST theory, children do not restrict teleological explanations to biological properties and human-made artefacts. Instead, consistent with the predictions of PT theory, children liberally endorse teleological explanations of natural non-living objects and whole biological organisms.

Although there is little support for the first prediction of ST theory, there is some support for the second prediction of Keil's (1992, 1995) theory; that endorsement of teleological explanations for biological properties and artefacts should be contingent upon the direction of function. When shown diagrams of analogous biological and artefact parts (for example, thorns on a rose and barbs on a wire), three-year-old children are able to recognise that thorns serve a function for the rose itself, whereas barbs do not serve a function for the wire (Keil, 1995, p. 130). Additionally, North American children from ages eight to ten, as

well as adults, have been found to endorse teleological explanations for the properties and behaviours of biological organisms at levels significantly above chance, but only when those explanations are self-, rather than other-serving (Kelemen, 1999c). Similar results have been obtained with British children (Kelemen, 2003), showing that just as the tendency to endorse teleological explanations for things other than human-made artefacts and the properties of biological organisms is present in Western societies that are more secular than North America, so too is the sensitivity to the direction of function.

Teleological bias in adults. Although the previously mentioned studies have uncovered differences in teleological endorsement between children and adults (Kelemen, 1999b, 1999c, 2003), subsequent research has found that under certain circumstances, adults show child-like teleological tendencies. In order to inhibit the tendency to interpret the world in terms of function, it may be necessary to learn that there is an alternative explanation. Casler and Kelemen (2008) found that in Romani adults – a group with great variability in levels of formal education – those with low levels of education displayed a pattern of teleological endorsement for other-serving biological properties which did not differ significantly from North American first- and second-grade children (see Kelemen, 1999c, study 2). Endorsement of teleological explanations for natural non-living objects showed a similar pattern, with Romani adults of low level of education endorsing these explanations to a similar degree as North American first-, second-, and fourth-graders. Casler and Kelemen (2008) also found that an individual's years of formal education was a negative and highly significant predictor of endorsement of unwarranted teleological explanations, accounting for over a third of the variance in endorsement. Furthermore, when age was added to the regression model, years of education remained a highly significant predictor. Thus, it seems there is nothing intrinsic about adulthood which leads people to reject teleological explanations, as adults who lack a formal education display child-like teleological tendencies.

Although Casler and Kelemen's (2008) results show that formal education is negatively associated with unwarranted teleological endorsement, this does not necessarily mean that a teleological bias can be extinguished through education. When semantic and conceptual knowledge is impaired as a result of Alzheimer's disease, elderly individuals tend to accept an increased number of unwarranted teleological explanations in comparison to an age-matched control group (Lombrozo, Kelemen, & Zaitchik, 2007). Similarly, when responding under speeded as opposed to un-speeded conditions, neurologically healthy adults endorse a significantly higher number of inappropriate teleological explanations for natural phenomena (Kelemen & Rosset, 2009). This effect has even been observed in actively publishing academics in the physical sciences, who reject a high proportion of these explanations when given time to consider their responses (Kelemen et al., 2013). These findings suggest that a teleological bias persists throughout adulthood, and that the role of formal education may simply be to provide alternative explanations, which the individual may express, given time. When the knowledge resulting from formal education is impaired, or when not given time to generate and consider alternative explanations, an enduring child-like teleological tendency is evident in adults.

However, the picture appears more nuanced still, as not all scientifically unwarranted teleological explanations are endorsed to the same extent by adults. For example, North American undergraduates have been found to endorse unwarranted teleological explanations for biological organisms more than for natural non-living objects (Kelemen, 1999b, study 2; Kelemen & Rosset, 2009, study 1). Furthermore, in a speeded compared to un-speeded decision-making task, adults displayed increased endorsement of other-serving teleological explanations for natural phenomena, yet self-serving teleological explanations were endorsed to an equivalent degree regardless of the condition of the decision-making task (Kelemen & Rosset, 2009, study 2). This suggests that whereas self-serving teleological explanations are

believed explicitly, other-serving teleological explanations are believed only implicitly into

adulthood. Given that teleological reasoning is thought to develop from an understanding of

intentionality (Kelemen, 1999a, pp. 286–291), these results are not surprising. As the only

things with intentions are biological organisms, and since the properties of biological

organisms are seen as having self-serving functions (Keil, 1995, p. 130), it follows that

teleological explanations which satisfy either of these two criteria should be especially

compelling.

      Intentionality heuristic. Although patterns of teleological endorsement in children,

and to some extent adults, suggest a tendency to view the natural world in terms of function,

PT theory rests on the claim that this is a result of the over-generalisation of thinking in

intentional terms (Kelemen, 1999a, pp. 286–291). This is closely related to the notion of an

"intentionality heuristic". According to Rosset (2007, 2008), it is not whether intentions are

perceived, but whether alternative explanations are available, which determines whether

something is ultimately judged to be the result of an agent's intentions.

      There is ample evidence in support of the argument that from a young age, children

are not only sensitive to the intentions of other agents, but attribute intentions to non-agents.

After witnessing an adult perform three failed attempts at achieving a goal, 18-month-old

infants were found to re-enact the intended act but not the failed attempts, despite never

having witnessed the intended act (Meltzoff, 1995). However, in the same study, after

viewing a machine perform the same three unsuccessful attempts at the goal, infants did not

re-enact the intended act. Meltzoff (1995) concluded from these results that infants interpret

the actions of adults in terms of intentions, but they do not adopt this intentional stance when

interpreting the actions of "things". However, an absence of imitation does not necessarily

imply an absence of perceived intention. From a young age, infants will direct their gaze

according to where an adult is looking (Scaife & Bruner, 1975), yet 12-month-old infants

also direct their gaze based on the orientation of a novel object, as long as that object's movements are contingent upon the infant's movements and vocalisations (Johnson, Slaughter, & Carey, 1998). Furthermore, in a paradigm similar to that used by Meltzoff (1995), 15-month-old infants have been shown to imitate the intended outcome of the actions of an animated stuffed toy, even when that stuffed toy's actions ultimately failed to achieve its intended goal (Johnson, Booth, & O'Hearn, 2001). Similarly, when the perceived "goals" of animated shapes on a computer screen do not justify the shapes' actions, infants tend to fixate on the shapes longer than when the goals do justify their actions (Csibra, Gergely, Bíró, Koós, & Brockbank, 1999; Gergely, Nádasdy, Csibra, & Bíró, 1995). These studies not only show that infants attribute intentions to adults, but that from 12-months-old, infants also attribute intentions to non-agents.

Just as there is evidence of child-like teleological tendencies in adults, the tendency to perceive intentions in non-agents also persists into adulthood. In an early demonstration of this, Heider and Simmel (1944) showed participants four simple shapes moving on a screen and asked them to describe what they had seen. Rather than describing the physical movements of shapes, participants attributed intentions to the shapes, which were used to explain their movements. Other evidence for an intentionality heuristic in adults comes from the study of memory. As deeper processing of information leads to increased recall (Craik & Lockhart, 1972; Lockhart & Craik, 1990), if it takes effort to overcome an initial judgment of "intentional", then judging something as accidental should result in increased recall compared to judging something as intentional. Rosset (2007, 2008) capitalised on this phenomenon by presenting participants with statements which varied in terms of valence (pleasant or unpleasant) and intentionality (intentional or unintentional), and then manipulated whether participants responded to each statement in terms of its valence or intentionality. For those judging the intentionality of statements, more unintentional than

intentional statements were recalled, whereas the opposite pattern emerged for those responding in terms of valence. Rosset's results suggest that it takes effort to inhibit the "intentional" response and to judge statements describing even typically accidental situations as unintentional.

The notion that an early-developing teleological tendency persists throughout life, regardless of whether it is acted upon, is conceptually similar to the recently proposed Logical Intuition dual-process model of reasoning (De Neys, 2012). According to the Logical Intuition model, multiple automatic responses to stimuli are generated in parallel with one another (De Neys, 2012; also see Pennycook et al., 2015). For example, when presented with a syllogistic reasoning task and asked to judge the logical validity of an argument, an automatic response is generated for both a belief in the conclusion, and also the logical validity of the argument (Howarth, Handley, & Walsh, 2016). It is the presence or absence of a conflict between these automatic responses which is believed to determine whether effortful thought is subsequently engaged (De Neys, 2012). Since endorsement of teleological explanations has been shown to increase when adults do not have time to inhibit their responses (Kelemen & Rosset, 2009; Kelemen et al., 2013), from the Logical Intuition perspective, at minimum, two intuitive responses would be expected. If, as Kelemen (1999a) has argued, teleology results from an over-generalisation of thinking in terms of intentionality, the first of these intuitive responses would be to judge objects and events as intentionally caused. The second intuitive response may be any number of intuitions which conflict with the first response. As actively publishing academics in the physical sciences have been shown to endorse fewer inappropriate teleological explanations than university undergraduates (Kelemen et al., 2013), one such conflicting intuitive response may involve a physical-reductionist view of nature. However, regardless of which other conflicting intuitions co-exist, from a Logical Intuition perspective, whether teleological explanations are

endorsed depends not upon whether intentions are perceived, but whether alternative responses are generated, so that the teleological response may be inhibited.

Summary. Two theories have been proposed as to why people endorse teleological explanations. The first, ST, argues that a "teleological-design stance" itself has a function: to allow an intuitive understanding of biological kinds (Keil, 1992). The second, PT, argues that teleological reasoning develops in relation to an understanding of intentionality (Kelemen, 1999a). The evidence suggests not only that an intentionality heuristic is present early in life (Gergely et al., 1995) and persists throughout adulthood (Rosset, 2007, 2008), but that patterns of teleological endorsement are consistent with predictions of PT theory. Specifically, children are liberal in their teleology, endorsing functional explanations not just for biological properties and human-made artefacts, but for natural non-living objects and whole biological organisms (Kelemen, 1999b, 1999c). Furthermore, in the absence of formal education (Casler & Kelemen, 2008), erosion of semantic knowledge (Lombrozo et al., 2007), or time-pressure to respond (Kelemen & Rosset, 2009; Kelemen et al., 2013), adults display a pattern of teleological endorsement remarkably similar to children. Put simply, teleological and non-teleological beliefs about nature can, and do, co-exist in the one mind.

Teleology and Religious Belief

Given that teleological reasoning is thought to develop from an early understanding of intentionality which is then over-generalised (Kelemen, 1999a), the notion of agency is central to teleology. This is simply because the only things capable of having intentions are things with minds, and the only things with minds are agents. However, as geometric shapes are perceived as having intentions by both infants (Gergely et al., 1995) and adults (Heider & Simmel, 1944), the perception of intentions is clearly not evidence for the presence of an agent. Furthermore, because the future function of an object or event can only be used to explain its current state if the current state was previously intended to fulfil that future

function, teleological explanations necessarily imply the intentions of an agent (Hempel & Oppenheim, 1948). That is, just as "chairs exist for sitting on" is true only if the chair existing to be sat on was the prior intention of an agent who designed the chair, the statement "clouds rain so that plants can grow" is true only if plants growing was the intended function of the cloud raining. The difference between these two teleological explanations is that whereas the former implies the intentions of a natural agent (a human), the latter implies the intentions of a supernatural agent.

Supernatural agents. Due to the quasi-religious nature of teleological explanations of the natural world, the relationship between endorsement of these explanations and belief in supernatural agents has recently been explored. Despite Piaget's (1964) claim that children are artificialists who believe that the natural world is created by humans, research has shown that children are more likely to explain the natural world as being created by God than by humans, and more likely to explain artefacts as being created by humans than by God (Evans, 2001; Kelemen & Diyanni, 2005). In children, both the generation of open-ended, and endorsement of closed-ended teleological explanations of natural phenomena, share a significant positive relationship with belief in intelligent design (Kelemen & Diyanni, 2005). Furthermore, after controlling for the age of the child, Kelemen and Diyanni (2005) found that the relationship between belief in intelligent design and teleological responses to open-ended questions about the origins of natural phenomena, was as strong as the relationship between belief in intelligent design and the generation of explicitly agentive answers to the origins of natural phenomena (i.e., "God").

In adults, a positive relationship exists between belief in supernatural agents and endorsement of teleological explanations of life events. Individuals who believe in God tend to endorse statements such as "there is order in the universe", at a greater rate than individuals who do not believe in God (Banerjee & Bloom, 2014). This study found that

even ardent atheists endorsed teleological explanations of life events significantly above

floor-level. Similar findings have been obtained using a qualitative approach, where

individuals who believed in the existence of God explained significant life events in more

teleological terms than non-believers (Heywood & Bering, 2014). Similar to the findings by

Banerjee and Bloom (2014), even non-believers generated some teleological responses to life

events, with others reporting that they were consciously aware of such intuitions, yet

inhibited them. These results show that while teleological endorsement of life events and

belief in God are positively related, an explicitly stated disbelief in God does not equate to an

absence of unwarranted teleological reasoning.

Certain religious beliefs have also been shown to positively predict endorsement of

teleological explanations of nature in adults. Using a decision-making task in which

participants judged teleological explanations of nature under speeded or un-speeded

conditions, after controlling for the condition of the task, belief in the existence of souls was

found to positively correlate with rates of teleological endorsement (Kelemen & Rosset,

2009). Furthermore, belief in supernatural agents has been found to positively predict

endorsement of unwarranted teleological explanations of nature. From four groups of

participants, Kelemen et al. (2013) randomly allocated individuals to either a speeded or un-

speeded decision-making task in which scientifically unwarranted teleological explanations

of nature were judged as either "true" or "false". The four groups of participants included

university undergraduates, a community sample, humanities academics, and actively-

publishing academics in the physical sciences. After controlling for the condition of the

decision-making task and belief in God, belief that "Nature is a powerful being" was a

significant and positive predictor of endorsement of scientifically unwarranted teleological

explanations in all groups, with belief in God also a significant predictor in the college and

community samples. Taken together, these studies suggest a positive relationship between

notions of disembodied agency and teleological endorsement, yet the exact nature of this

relationship remains unclear.

The Current Study

      Supernatural intentionality. A reasonable question to ask in response to the results

by Kelemen et al. (2013), is exactly what "belief" in supernatural agents entails. A belief that

God exists undoubtedly involves many closely related beliefs, some of which may even be

necessary for the belief in God itself. For example, it has been argued that despite often

explicitly stated views to the contrary, people are implicit dualists and view the mind and

body as separate (Bloom, 2007; Stanovich, 1989). Arguably, without at least an implicit

acceptance that the mind can exist independently of the body, it would be impossible to

believe in the existence of disembodied minds known as gods. There are also many other

beliefs which commonly co-occur with a belief in gods, such as the belief in an afterlife

which is determined by the quality of behaviour on Earth. This belief itself implies numerous

other necessary beliefs: that some supernatural agent holds their own beliefs about what is

acceptable behaviour, is capable of perceiving people's behaviour, wants people to conform

to their standards of acceptable behaviour, and is both capable and willing to enforce these

standards. Clearly, belief in a supernatural agent, whether it be God or "Nature as a powerful

being", entails far more than a belief in the existence of that agent.

      If teleology stems from an understanding of intentionality which is then over-

generalised to include non-agents (Kelemen, 1999a, pp. 286–291), the aspect of a belief in

God or Nature as a powerful being which should logically predict teleological endorsement,

is the belief (or perception) that these supernatural agents are *agents who intentionally*

interact with the world. This interpretation of the relationship between belief and teleological

endorsement is actually supported by the results from Kelemen et al. (2013), who found that

belief in Nature as a powerful being was a stronger predictor of scientifically unwarranted

teleological endorsement than belief in God. As the former item explicitly emphasises an agent that acts in accordance with their intentions (i.e., a powerful being) whereas the latter does not, it is possible that rather than belief in the *existence* of Nature as a powerful being, the perception of supernatural intentionality is what predicts endorsement of scientifically unwarranted teleological explanations of nature. By not isolating this aspect of belief which is central to PT theory, prior research has taken a broad view of what it means to believe in supernatural agents. Based on the underlying theory, it should be expected that after controlling for other aspects of belief in supernatural agents, the aspect of belief which should positively predict explicit teleological endorsement is the notion that supernatural agents intentionally interact with the world.

Reconciling co-existence with belief. It is also unclear how the co-existence of teleological and non-teleological beliefs about the natural world (Casler & Kelemen, 2008; Kelemen & Rosset, 2009) can be reconciled with findings of a positive relationship between belief in supernatural agents and unwarranted teleological endorsement (Banerjee & Bloom, 2014; Heywood & Bering, 2014; Kelemen et al., 2013). On the surface, the notion of co-existence seems slightly contradictory to a positive relationship between unwarranted teleological endorsement and belief in supernatural agents. If a teleological bias is innate, this implies that all neurotypical individuals, whether at the upper-, middle-, or lower-end of the religiosity spectrum, should find teleological explanations of the natural world compelling. Conversely, if there is a positive relationship between belief in supernatural agents and teleological endorsement, this implies that not *all* neurotypical individuals find these explanations equally compelling. However, these findings can be reconciled in two ways.

Firstly, assuming the term "innate" does not imply a dichotomy of neurotypical if present, and impaired if absent, it would be possible for innate tendencies to vary along a

continuum within the neurotypical population. There is a strong empirical basis for making such a claim, with mentalising ability being an example of an innate tendency which is known to vary within the neurotypical population (Baron-Cohen et al., 2014; Norenzayan, Gervais, & Trzesniewski, 2012). Therefore, it is possible that the tendency to reason teleologically is innate, in that from an early age it arises naturally and without formal training, but that variation in the strength of this innate tendency is predictive of individual differences in supernatural agent beliefs; specifically, differences in the degree to which the intentions of supernatural agents are perceived in the environment.

A second, and more likely possibility, is that a teleological bias is present across the spectrum of religiosity, and that this bias conflicts with explicitly held beliefs in non-religious individuals. This would be consistent with results showing that even ardent atheists endorse unwarranted teleological explanations significantly above floor-levels (Banerjee & Bloom, 2014), and that although actively-publishing academics in the physical sciences reject a considerable proportion of these explanations when given time to consider their responses, they show a significant increase in endorsement when under time-pressure to respond (Kelemen et al., 2013). The co-existence of two or more conflicting beliefs is not only discussed in the dual-process theory literature (e.g., Franssens & De Neys, 2009; Pennycook, Fugelsang, & Koehler, 2012), but also within CSR in the context of implicit theistic beliefs in self-identified non-religious individuals. For example, priming non-religious individuals with supernatural concepts has been shown to increase pro-social behaviour, despite an explicit disbelief in the supernatural (Hitzeman & Wastell, 2017; Shariff & Norenzayan, 2007).

To try and reconcile the co-existence perspective with findings of a positive relationship between belief in supernatural agents and unwarranted teleological endorsement, the current study employs a decision-making task adapted from Kelemen et al. (2013), in

which participants judge the truth or falsehood of a series of teleological explanations of the natural world under either speeded or un-speeded conditions. In line with previous research (e.g., Kelemen & Rosset, 2009), higher rates of teleological endorsement should be expected in the speeded compared to the un-speeded condition, reflecting the co-existence of implicitly held teleological beliefs with potentially conflicting explicitly held beliefs. However, if neurotypical adults are implicit theists – at least in the sense that they endorse teleological explanations of nature which imply the intentions of a supernatural agent – then it follows that there should be a divergence in rates of implicit and explicit teleological endorsement for individuals who reject notions of supernatural intentionality.

Of particular interest is the possibility that the link between teleological explanations of the natural world and belief in supernatural agents is not due to intrinsic notions of intentionality in nature, but rather due to cultural exposure to such ideas. According to Atran and Henrich (2010), with the development of language capabilities, early humans were at risk of being misled by those who would misrepresent themselves to the social group, using easy-to-fake verbal signals of commitment. Consequently, an adaptive strategy would have been to attend not only to verbal signals, but to costly hard-to-fake behavioural signals of commitment (Henrich, 2009). Evidence suggests that one of the strongest predictors of whether a person explicitly expresses a belief in a specific supernatural agent is the extent to which they were exposed as children to credibility enhancing displays (CREDs) of religious commitment by their caregiver(s) (Lanman, 2012; Lanman & Buhrmester, 2016; Maij et al., 2017). Due to the quasi-religious nature of scientifically unwarranted teleological explanations of the natural world, it is possible that exposure to CREDs may result not only in an increased belief in the existence of specific supernatural agents, but also of scientifically unwarranted teleological endorsement. However, if teleology results from an over-generalisation of thinking in intentional terms, and if the perception of intentionality is what

drives the positive relationship between belief in supernatural agents and unwarranted teleological endorsement, then this relationship should remain after controlling for exposure to CREDs.

Not all nature is equal. Just as "belief" is a broad concept, so too is "nature". As Kelemen (1999a) has argued that teleology is based on an understanding of intentions, it follows that endorsement of teleological explanations referring to natural non-living objects, which under *no* circumstances are capable of having their own intentions, should be more strongly related to the perception of supernatural intentionality compared to endorsement of teleological explanations referring to biological organisms, which under some circumstances *are* capable of having their own intentions. To understand why this should be so, one only has to consider the example offered at the beginning of this thesis which contrasted teleological explanations of human-made artefacts with natural non-living objects. There is no reason why endorsement of the statement, "the chair exists for sitting on", should relate to belief in supernatural agents, as this statement implicates a human agent which would be capable of having intentions. However, there is reason to expect that endorsement of the statement, "clouds rain so that plants can grow", should relate to a belief in supernatural agents, as under no circumstances are clouds capable of having intentions. Therefore, it should be expected that the moderating effect of perceived supernatural intentionality on the difference between implicit and explicit teleological endorsement, should be stronger for explanations which offer no scientifically plausible source of intentions, compared to explanations which do.

Covariates of belief. Belief in the existence of supernatural agents has also been linked to several factors which could potentially underlie the relationship with teleology. Cross-culturally, gods are conceptualised as having minds and of being capable of acting in accordance with their mental states to bring about desired outcomes (Tremlin, 2006). As

such, the extent to which one considers the mental states of other humans has been implicated

as a factor which positively correlates with a belief in the existence of supernatural agents

(Norenzayan et al., 2012). Although there is mixed support for this finding (e.g., Reddish,

Tok, & Kundt, 2016; Vonk & Pitzen, 2017), one reliable finding is that individuals with high

functioning Autism Spectrum Disorder (HFASD) express less belief in a personal god

compared to neurotypical controls (Caldwell-Harris, Murphy, Velazquez, & McNamara,

2011; Norenzayan et al., 2012). As HFASD is characterised by an impairment in the ability

to reason about the minds of other humans (Baron-Cohen, 1995; Baron-Cohen, Leslie, &

Frith, 1985), this supports the argument that belief in supernatural agents requires the ability

to reason about minds. As teleological explanations of the natural world imply the presence

of an intentional agent, it is therefore conceivable that the extent to which people consider the

mental states of others could underlie both a belief in supernatural agents and endorsement of

scientifically unwarranted teleological explanations of nature.

The extent to which an individual engages in effortful analytical thought has also been

implicated as a factor relating to belief in gods. Analytic cognitive style is often assessed

through self-report measures such as the Need for Cognition Scale (Cacioppo, Petty, & Kao,

1984), and performance-based tasks such as the Cognitive Reflections Test (CRT) (Thomson

& Oppenheimer, 2016) and Base-Rate Conflict (BRC) tasks (e.g., De Neys & Glumicic,

2008). These performance-based measures of analytic cognitive style are based on the idea

that individuals vary in their ability and motivation to inhibit intuitive responses in cases of

conflict. As a belief in gods is argued to be intuitive and natural for the neurotypical

population (e.g., Barrett, 2004; Boyer, 2002; Tremlin, 2006), disbelief, it is argued, can be

cognitively effortful (Norenzayan & Gervais, 2013). As such, the tendency to engage in

effortful analytic thought has been identified as a possible path to disbelief.

There is a large literature base showing that an analytic cognitive style is negatively related to belief in gods and supernatural beliefs more broadly. After controlling for demographic variables and individual differences in cognitive ability, analytic cognitive style, as measured by performance on the CRT and BRC, is a significant negative predictor of religious beliefs (Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012). Furthermore, this is not just a case of reduced accuracy in these tasks for religious compared to non-religious individuals, as a negative relationship between religious belief and reaction time on performance-based measures of analytic cognitive style has been observed (Pennycook, Cheyne, Koehler, & Fugelsang, 2013). Specifically, reaction time differences for stereotypically answered incongruent compared to congruent base-rate problems is negatively correlated with religious belief (Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2014). These results suggest that non-religious individuals are less inclined to give their immediate response, and this is due, at least in part, to increased conflict monitoring compared to religious individuals. As teleological reasoning is argued to be an intuitive response which is, at best, inhibited, it makes sense that people with a more analytic cognitive style may be better at, or more willing to inhibit this response, compared to those who are less analytic.

Threat to personal control. A final question to consider is whether the nature of the decision-making task used by Kelemen et al. (2013) could have confounded the results of the study. According to compensatory control theory, a perceived lack of personal control can result in a temporarily heightened need for structure and intolerance to ambiguity in one's environment (Ma & Kay, 2017), which then motivates a search for alternative external sources of control (Landau, Kay, & Whitson, 2015). One manifestation of this threat to personal control is a temporary increase in self-reported belief in God (Kay, Moscovitch, & Laurin, 2010). As participants cannot control the rate at which statements are presented in a speeded decision-making task (e.g., Kelemen & Rosset, 2009; Kelemen et al., 2013), it is

possible that the decision-making task itself threatens the perception of personal control. As teleological explanations of the natural world imply the intentions of a supernatural agent, increased endorsement of these explanations in a speeded compared to un-speeded decision-making task, could potentially be due to teleological explanations functioning as an alternative external source of control.

Summary

The tendency to endorse scientifically unwarranted teleological explanations of the natural world develops early in life (Kelemen, 1999b), and persists, at least implicitly, throughout adulthood (Casler & Kelemen, 2008; Kelemen & Rosset, 2009). As all teleological explanations imply the presence of an agent, teleological explanations of the natural world constitute a quasi-religious belief (Kelemen, 2004). Studies investigating the link between belief in supernatural agents and unwarranted teleological explanations have uncovered a positive relationship between the two (e.g., Banerjee & Bloom, 2014; Kelemen et al., 2013). However, three major issues remain unresolved. Firstly, what is it about belief in supernatural agents that is predictive of teleological endorsement? Secondly, how can the co-existence of teleological and non-teleological explanations of nature be reconciled with a positive relationship between belief in supernatural agents and teleological endorsement of the natural world? Finally, given that the components of the natural world are heterogeneous with respect to being capable of having intentions, does the relationship between implicit and explicit teleological endorsement and belief in supernatural agents depend upon what in the natural world is being explained?

Foundational Hypotheses

Hypothesis one. Consistent with the co-existence perspective, it is hypothesised that teleological explanations of nature should be endorsed at a higher rate when individuals are

not given a chance to inhibit their responses (i.e., implicit endorsement), compared to when they are given a chance to inhibit their responses (i.e., explicit endorsement).

Hypothesis two. As only biological organisms are capable of having intentions, it is hypothesised that teleological explanations of biological organisms should be endorsed more than those of natural non-living objects.

Central Hypotheses

Hypothesis three. It is hypothesised that after controlling for other aspects of belief, the difference between implicit and explicit teleological endorsement should be moderated by the belief (or perception) that supernatural agents intentionally interact with the world. Specifically, explicit teleological endorsement should be positively related to perceived supernatural intentionality, and the difference between implicit and explicit teleological endorsement should be larger for individuals who reject notions of supernatural intentionality, compared to those who accept notions of supernatural intentionality.

Hypothesis four. It is hypothesised that the relationship between implicit and explicit teleological endorsement and perceived supernatural intentionality should itself be moderated by whether the teleological explanation refers to a biological organism or natural non-living object. Specifically, the moderating effect of perceived supernatural intentionality on the difference between implicit and explicit teleological endorsement should be stronger for explanations referring to natural non-living objects than for biological organisms.

Exploratory Hypotheses

Hypothesis five. As teleological explanations imply the intentions of an agent, it is hypothesised that the extent to which individuals think about the mental states of others should positively predict teleological endorsement.

Hypothesis six. As teleological reasoning is thought to be intuitive and effortless, it is hypothesised that the extent to which individuals enjoy engaging in effortful analytic thought should negatively predict rates of teleological endorsement.

Hypothesis seven. Putting participants under time-pressure to respond in a decision-making task may trigger a need for compensatory control. Therefore, it is hypothesised that the relationship between being under time-pressure to respond and increased teleological endorsement, will be partially mediated by increased anxiety, intolerance to ambiguity, or need for structure in the environment.

Method

Participants

A total of 138 participants (71% female) enrolled in a first-year psychology course at a large Australian university self-selected into the study in exchange for course credit. To be eligible to take part in the study, participants were required to be native English speakers and have normal or corrected-to-normal vision. Ages for the entire sample ranged from 17 to 45, although this distribution was positively skewed ($M = 19.40$, $SD = 3.80$). The most common affiliation was Christianity (40.60%), followed by Agnosticism (18.80%) and Atheism (15.90%), indicating that this sample was roughly representative of the broader Australian population in terms of religious affiliation (Australian Bureau of Statistics, 2017).

Materials

Explanation judgement task. Participants were presented with 100 statements, one at a time, and were told they represented "explanations for various things in the world". The 100 statements, adapted from Kelemen et al. (2013), were comprised of 30 scientifically unwarranted teleological test items and 70 control items, to which participants responded either "true" or "false". The 70 control items included 10 true teleological explanations (e.g., "Schools exist in order to help people learn new things"), 10 false teleological explanations (e.g., "Houses have doorbells in order to make dogs bark"), 20 true causal explanations (e.g., "Magnets stick together because their poles attract"), and 30 false causal explanations (e.g., "Saturn is a planet because it has rings surrounding it"). The 30 test items included 15 scientifically unwarranted teleological explanations about biological organisms (e.g., "Trees produce oxygen so that animals can breathe"), and 15 scientifically unwarranted teleological explanations about natural non-living objects (e.g., "The Earth has an ozone layer in order to protect it from UV light").

Explanations were presented to participants in one of two conditions: un-speeded or speeded. In the speeded condition there was a 3200ms time-limit in which to respond to each explanation, which was determined by Kelemen et al. (2013) to be two standard deviations above the average reading time for these explanations. Although all test items were presented, three of the items for natural non-living objects were not included in the analysis, as their teleological status was questionable (e.g., "Earthquakes happen because tectonic plates must realign"). The removal of these three items was planned, and consistent with Kelemen et al. (2013). The reason for their presentation during the experiment was simply to ensure consistency across blocks. The full list of statements is shown in Appendix A.

Centrality of religiosity scale (CRS). To examine the unique effect on teleological endorsement of perceiving the intentional actions of supernatural agents, the Centrality of Religiosity Scale (CRS) was included. The CRS is a measure of religiosity which is non-specific to any one religion (Huber & Huber, 2012). The full 15-item measure (CRS15) includes five subscales, each with three items: Intellect (e.g., "How often do you think about religious issues?"), Ideology (e.g., "To what extent do you believe that God or something divine exists?"), Public Practice (e.g., "How often do you take part in religious services?"), Private Practice (e.g., "How often do you pray?"), and Experience (e.g., "How often do you experience situations in which you have the feeling that God or something divine intervenes in your life?").

Although the full CRS15 measure was administered, the 10-item version (CRS10) which contains two items in each subscale was used for all relevant analyses. The reason for using the CRS10 instead of the CRS15, was that the two items in the Experience subscale of the CRS10 specifically referred to perceiving the intentional actions of a supernatural agent, whereas the third item included in the CRS15 referred only to perceiving the presence of a

supernatural agent. As such, the Experience subscale of the CRS10 more closely tapped the experience of perceiving the intentions of a supernatural agent.

The Intellect, Ideology, and Experience subscales were scored from 1 (*never/ not at all*) to 5 (*very often/ very much so*), whereas the Private Practice subscale was scored from 1 (*never*) to 8 (*several times a day*), and the Public Practice subscale from 1 (*never*) to 6 (*more than once a week*). Both the Private and Public Practice subscales were then re-coded into a five-point scale. The total score for the CRS10, as well as for each subscale, was obtained by calculating the mean of the relevant items, such that scores had a potential range of 1 to 5 (Huber & Huber, 2012). The CRS10 ($\alpha = .95$) and CRS15 ($\alpha = .97$) showed excellent internal consistency, which is similar to the reported norms for both versions of the measure.

Credibility enhancing displays (CREDs). The extent to which individuals witness credibility enhancing displays (CREDs) of religious commitment by their caregiver(s) during childhood has been shown to positively predict religiosity during adulthood (Maij et al., 2017). Therefore, to explore the extent to which teleological endorsement is innate rather than learned, the CREDs measure by Lanman and Buhrmester (2016) was administered. This measure includes seven items (e.g., "To what extent did your caregiver(s) live a religiously pure life?"), which were scored on a scale from 1 (*to no extent at all*) to 7 (*to an extreme extent*). The overall score on the measure was obtained by taking the mean of all seven items, such that scores had a potential range of 1 to 7. The CREDs measure showed excellent internal consistency ($\alpha = .95$), which is similar to previously reported reliability for this measure ($\alpha = .92$) (Lanman & Buhrmester, 2016).

Need for closure (NFC). An individual's intolerance of ambiguity has previously been linked to their tendency to require compensatory control (Ma & Kay, 2017). The ambiguity intolerance subscale of the Need for Closure (NFC) measure by Kruglanski, Atash, De Grada, Mannetti, and Pierro (2013) includes nine items (e.g., "I'd rather know bad news

than stay in a state of uncertainty"). All items were scored on a 6-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*), with the total score calculated as the sum of all nine items, such that scores had a possible range of 9 to 54. Internal consistency for this measure was adequate ($\alpha = .80$), which is similar to reported norms (Webster & Kruglanski, 1994).

Personal need for structure (PNS). An individual's need for structure in their environment has also been linked to their need for compensatory control. The Personal Need for Structure (PNS) measure by Neuberg and Newsom (1993) includes 11 items (e.g., "It upsets me to go into a situation without knowing what I can expect from it"), two of which were reverse coded. Responses were made on a scale from 1 (*strongly disagree*) to 6 (*strongly agree*). After reverse scoring the relevant items, a total score was obtained by summing all 11 items, such that scores had a potential range of 11 to 66. Internal consistency for this measure was adequate ($\alpha = .78$), and similar to previously reported norms (Neuberg & Newsom, 1993).

Subjective anxiety. As a threat to personal control should result in increased anxiety (Landau et al., 2015), participants rated their anxiety on a sliding scale from 0 to100 at the beginning and the end of the study. A difference score was calculated from the post- minus pre-rating, such that a higher score represented an increase in anxiety during the experiment. Scores therefore had a potential range of -100, representing the maximum decrease in anxiety, to 100, representing the maximum increase in anxiety throughout the task.

Need for cognition scale (NCS). Given that a negative relationship between religiosity and analytic cognitive style has previously been demonstrated (Gervais & Norenzayan, 2012; Pennycook, Cheyne, et al., 2012), and due to the quasi-religious nature of scientifically unwarranted teleological explanations, it seems reasonable to expect a negative relationship between analytic cognitive style and teleological endorsement. To assess this possibility, the Need for Cognition Scale (NCS) developed by Cacioppo and Petty (1982)

was administered. This measure includes 18 items (e.g., "I would prefer complex to simple problems"), nine of which are reverse-scored. Responses were made on a 9-point Likert-scale from -4 (*very strongly disagree*) to 4 (*very strongly agree*). After reverse-coding the relevant items, the total score was obtained by summing all 18 items, such that scores had a potential range of -74 to 74, with higher scores representing a more analytic cognitive style. Previously reported internal consistency for the NCS is excellent ($\alpha = .90$) (Cacioppo et al., 1984), and while the internal consistency obtained in the current study was slightly lower than what was previously reported ($\alpha = .85$), reliability was still acceptable.

Empathy quotient (EQ). The extent to which an individual empathises with others, as measured by the Empathy Quotient-Short (EQ) (Wakabayashi et al., 2006), has been shown to positively relate to both a belief in God (Norenzayan et al., 2012) and teleological explanations of life-events (Banerjee & Bloom, 2014, study 2). As teleological explanations of nature imply the intentions of a supernatural agent, the EQ was administered to explore a possible positive relationship between empathy and teleological endorsement of nature. The EQ includes 22 items (e.g., "I can pick up quickly if someone says one thing but means another"), six of which were reverse-scored, to which participants responded on a 4-point Likert scale from 1 (*strongly disagree*) to 4 (*strongly agree*). In accordance with Baron-Cohen and Wheelwright (2004), normal-scored items were then recoded such that a response of strongly disagree or slightly disagree was scored 0, a response of slightly agree was scored 1, and a response of strongly agree was scored 2. Conversely, reverse-scored items were recoded such that a response of strongly agree or slightly agree was scored 0, a response of slightly disagree was scored 1, and a response of strongly disagree was scored 2. The EQ therefore had a potential range of 0 to 44, with higher scores representing a greater tendency to empathise with others. The obtained internal consistency of the EQ was excellent ($\alpha =$

.87), and very similar to what has previously been reported for this measure (α = .88) (Wakabayashi et al., 2006).

Demographics. Demographic information including age, religious affiliation, and gender, was collected from all participants. Religious affiliation was selected from one of eight options: Agnostic, Atheist, Buddhist, Christian, Hindu, Jewish, Muslim, or Other. In cases where "Other" was selected, a text box appeared on the following page so that participants could type their response.

Procedure

Assignment and exclusion. Participants were tested in groups of up to four at a time, in a session which took approximately 25 minutes to complete. After giving informed consent, assignment to conditions (un-speeded or speeded) was quasi-randomly determined for each group as a whole. As it was expected that those in the speeded condition would finish faster than those in the un-speeded condition, the assignment to condition was done at the group, rather than individual level, so as to minimise any disruption caused by participants finishing at different times.

Consistent with the criteria used by Kelemen et al. (2013), participants were excluded from analysis if they answered over 80% of control items incorrectly, or if they failed to respond to at least 75% of the teleological test items within the time limit. Although the requirement to respond to at least 75% of test-items within the time limit was stringent, it was necessary for two reasons. Firstly, it ensured that participants were treating the task as timed, and secondly, it avoided potentially unrepresentative mean scores based on a small number of observations (see Tversky & Kahneman, 1971). Due to the exclusion criterion for the speeded condition, this condition was purposely oversampled at a ratio of 1.5:1.

Instructions. After assignment to a condition, each group received standardised verbal instructions for the task. Participants were told that they would be shown a series of

"explanations for various things in the world", and their task was to "decide whether each statement was true or false by clicking the relevant button on the screen". Participants were then told to read all instructions carefully, and so as to minimise any disruption to the other participants, to turn all mobile devices off and remain seated until instructed otherwise. The experimenter remained present in the room throughout the session but was seated out of sight so as not to distract participants.

      Presentation. Participants were seated at computers; each separated from the neighbouring computers with large dividers which ensured privacy. All stimuli and measures were presented on computer screens using the Qualtrics web-based platform. After receiving verbal instructions for the task, participants opened the Qualtrics link (which had been minimised to the Windows taskbar), and upon clicking "begin", the first question that participants responded to was the initial measure of anxiety. Following this, a page of written instructions appeared which repeated the verbal instructions previously given to participants, except for the addition of the speeded/un-speeded nature of the task. The speeded instructions stated that participants would have just over three seconds to make their response, and that it was important to respond within this time limit as the next statement would automatically appear. The un-speeded instructions stated that after participants made their response, the next statement would automatically appear. The reason for presenting written instructions after the initial measure of anxiety, was to avoid the initial rating being affected by expectations of the task.

      After reading the instructions and clicking "next", the explanation judgement task commenced. All participants completed one practice block of 10 statements, the format of which was presented according to the condition of the task (un-speeded or speeded). This block, which was representative of the full task, contained three teleological test items and seven control items, and was presented in random orders to all participants. Participants

judged each statement as "true" or "false" by using the mouse to select the relevant choice on the screen. In both conditions, after the response was selected, the program automatically moved to the following explanation. However, in the event that a participant failed to respond within 3200ms in the speeded condition, the program automatically proceeded to the next explanation. Between each trial a fixation cross was displayed in the centre of the screen for 250ms so as to encourage participants to return their gaze to the position where next explanation would appear.

After completion of the practice items, the program automatically moved to the main task. Explanations were presented in blocks of ten, with each block containing three test items and seven control items. The seven control items included one true teleological, one false teleological, two true causal, and three false causal items. The three test items in each block included either one biological and two natural non-living, or two biological and one natural non-living test item. The order of items presented within each block was randomised for every participant, as was the order of blocks (only on condition that no item or block was presented more than once). Following this, participants completed the measures in a fixed order. The same measure of subjective anxiety was presented immediately following the judgement task, followed by the PNS and NFC measures. Next, the EQ, CREDs, NCS, and CRS10 measures were administered, and finally, participants were asked to provide demographic information. Upon completion of these measures, participants remained seated until the entire group had finished, at which point participants were verbally debriefed and thanked for their time.

Results

Descriptive Statistics

      Exclusion of participants. A total of 29 participants were excluded from the speeded condition for failing to respond to at least 75% of test items within the time limit, 13 were excluded from the speeded condition for responding to over 80% of control items incorrectly, and seven were excluded for failing to meet both criteria. One additional participant was excluded from the un-speeded condition for failing to provide their age. After exclusion, 88 participants remained, with 54 in the un-speeded condition and 34 in the speeded condition. Although it did not make sense to compare rates of teleological endorsement for the retained and excluded participants, as shown in Appendix J, the two groups did not differ significantly on any measure other than subjective anxiety, with the excluded participants reporting greater increases in anxiety than the retained participants.

      Exclusion and retention of variables. The central questions that this study aimed to answer involved a possible divergence in rates of implicit and explicit teleological endorsement according to the unique effect of perceived supernatural intentionality. However, several potential covariates were measured, and before addressing the central research questions, the justifications for excluding or retaining these variables must be discussed. For the sake of brevity, only statistics which are relevant to the decision to exclude or retain variables are reported.

      Religiosity. There was no significant difference in mean CRS10 scores between the un-speeded ($M = 2.82$, $SE = 0.15$) and speeded conditions ($M = 2.51$, $SE = 0.19$), $F(1,86) = 1.59$, $p = .211$, $\eta\rho^2 = .018$. Likewise, CREDs exposure did not differ significantly between the un-speeded and speeded conditions, $t(86) = 1.53$, $p = .130$, $d = 0.332$. Bivariate analyses (Table 1) revealed that CREDs exposure had moderate-to-strong statistically significant positive correlations with all CRS10 subscales but was not significantly correlated with

teleological endorsement. Importantly, of the five CRS10 subscales, the only one which was

significantly correlated with teleological endorsement was the Experience subscale, for which

a weak-to-moderate, but statistically significant positive relationship was found.

Due to the central research questions, the inclusion of the Experience (i.e., perception

of intentions) and Ideology subscales (i.e., belief in the existence) was necessary. In order to

reduce the potential for multicollinearity, the Intellect, Public Practice, and Private Practice

subscales were not retained for the main analyses. However, CREDs exposure was retained

for the main analyses, as the correlations with the Ideology and Experience subscales, while

significant and positive, were both moderate.

Gender. The distribution of gender across the two conditions of the decision-making

task did not differ significantly from chance, $X^2(1, N = 88) < 0.01$, $p = .983$. Furthermore,

females and males did not differ significantly on teleological endorsement, $t(86) = -1.09$, $p =$

.280, $d = 0.256$, or CREDs exposure, $t(86) = 0.24$, $p = .810$, $d = 0.056$. However, females

scored significantly higher than males on the CRS10 Ideology ($M_{diff} = 0.93$, $SE_{diff} = 0.30$),

$t(86) = 3.14$, $p = .002$, $d = 0.727$, and Experience subscales ($M_{diff} = 0.65$, $SE_{diff} = 0.27$), $t(86) =$

2.41, $p = .018$, $d = 0.582$. Due to the higher CRS10 scores in females than males, gender was

retained as a covariate.

Age. Ages for the final sample ranged from 17 to 45 ($M = 19.10$, $SD = 3.36$). Age

did not differ significantly between the un-speeded and speeded conditions, $t(86) = 1.47$, $p =$

.145, $d = 0.349$. However, as shown in Table 1, there were significant negative correlations

between age and endorsement of teleological test items, and between age and the CRS10

Ideology subscale. Age was therefore retained as a covariate in the main analyses.

Table 1.

Bivariate Correlations for the Un-Speeded Condition

	Religiosity							Control			Disposition		Demographics	
	Teleology	Intellect	Ideology	Public	Private	Exp	CREDs	Structure	Closure	Anxiety	Empathy	Cognition	Age	Female
Teleology	-	.041	.225	.137	.136	.348**	.194	-.248	-.027	.085	-.019	-.204	-.281*	.077
Intellect		-	.639**	.676**	.503**	.530**	.614**	-.001	.330*	.054	.161	.072	-.113	.292*
Ideology			-	.750**	.754**	.801**	.598**	-.061	.201	.044	.069	-.135	-.366**	.300*
Public				-	.768**	.596**	.789**	-.037	.254	-.118	.096	-.210	-.276*	.250
Private					-	.730**	.606**	-.039	.235	-.001	.081	-.182	-.194	.270*
Experience						-	.494**	.074	.247	.129	.046	-.106	-.227	.251
CREDs							-	-.030	.301*	.010	.067	-.088	-.107	.136
Structure								-	.504**	-.266	.077	.093	.144	-.083
Closure									-	-.135	.069	.043	-.025	.054
Anxiety										-	-.194	-.064	-.036	.030
Empathy											-	.368*	-.070	.227
Cognition												-	.297*	-.128
Age													-	-.218
Female														-

Note: Pearson's correlation coefficients in the un-speeded condition ($n = 54$) for teleological endorsement, by religiosity subscales (intellect, ideology, public practise, private practise, experience of intentional supernatural agents), credibility enhancing displays (CREDs), need for structure (structure), ambiguity intolerance (closure), subjective anxiety (anxiety), empathy quotient (empathy), and need for cognition (cognition). * $p < .05$, ** $p < .01$.

Cognitive disposition. There were no significant differences across conditions for scores on the Empathy Quotient (EQ), $t(86) = -1.54$, $p = .128$, $d = 0.336$, or Need for Cognition Scale (NCS), $t(86) = -0.36$, $p = .721$, $d = 0.079$. These two measures were also not significantly correlated with any of the CRS10 subscales, CREDs exposure, or teleological endorsement (Table 1), and so were not retained for subsequent analyses.

Compensatory control. There were no significant differences across conditions for scores on the Personal Need for Structure (PNS), $t(86) = -0.43$, $p = .670$, $d = 0.093$, Need for Closure (NFC), $t(86) = -1.27$, $p = .207$, $d = 0.282$, or Subjective Anxiety measures, $t(86) = -1.79$, $p = .078$, $d = 0.384$. No significant correlations were found between these three measures and the CRS10 Experience or Ideology subscales, or between these three measures and teleological endorsement (Table 1). As the condition of the decision-making task was not a significant predictor of scores on the PNS, NFC, or Subjective Anxiety measures, and since these three measures did not significantly predict teleological endorsement, they could not mediate the relationship between the condition of the decision-making task and teleological endorsement (see Baron & Kenny, 1986). As such, the PNS, NFC, and Subjective Anxiety measures were not retained for subsequent analyses. However, as previously mentioned, it is worth noting that participants who were excluded from analysis had significantly higher subjective anxiety scores compared to those who were retained (see Appendix J).

Summary of exclusion and retention. Due to the central research questions, both the CRS10 Experience and Ideology subscales were retained. However, the Public Practice, Private Practice, and Intellect subscales were removed due to concerns of multicollinearity. While CREDs exposure was significantly correlated with all CRS10 subscales, it was only moderately correlated with the Ideology and Experience subscales, and so was retained. In addition, gender was retained as a covariate due higher CRS10 scores in females than males,

and age was retained as a covariate due to significant negative correlations with both teleological endorsement and Ideology scores. All other variables were excluded from subsequent analyses. The final model therefore included the condition of the decision-making task, CRS10 Experience and Ideology subscales, CREDs exposure, and participant age and gender as predictors.

Univariate distributions. A detailed discussion of the distributions of all retained variables can be found in Appendix K.   Briefly, numerical and graphical summaries suggested that the dependent variable, endorsement of teleological test-items, was normally distributed in both the un-speeded and speeded conditions. Endorsement of control items was also normally distributed in both conditions. However, the CRS10 Ideology and Experience subscales, CREDs exposure, and age were non-normally distributed in both conditions.

Manipulation Check

To check that the speeded decision-making task had a greater effect on unwarranted endorsement of teleological test items compared to incorrect endorsement of control items, a 2 (condition; un-speeded, speeded) x 3 (item-type; biological test, natural non-living test, control) mixed ANOVA was conducted. Responses to test items were coded as 1 for "true" and 0 for "false", whereas for control items, incorrect responses were coded as 1, and correct responses were coded as 0. The assumption of sphericity was met, $X^2(2) = 0.92$, $p = .080$, and as previously discussed, endorsement of teleological explanations were normally distributed within each condition, as were responses to control items.

A main effect of condition was found, due to less accurate responding in the speeded compared to un-speeded condition, $F(1,86) = 670.56$, $p < .001$, $\eta\rho^2 = .203$. The main effect of item-type was also significant, $F(2,172) = 295.92$, $p < .001$, $\eta\rho^2 = .775$. However, as

expected, both main effects were subsumed under a significant condition by item-type

interaction, $F(2,172) = 8.47$, $p < .001$, $\eta\rho^2 = .090$.

Figure 1. Endorsement of Item-Type as a Function of Condition
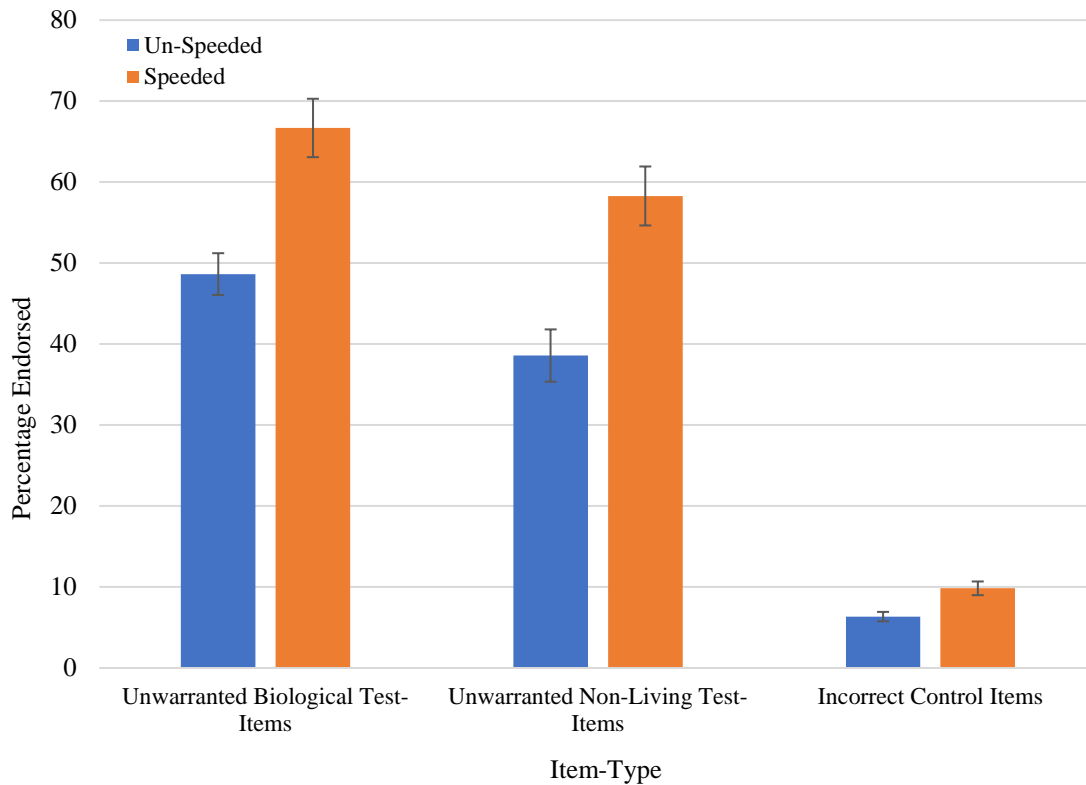
Figure 1. Unwarranted endorsement of teleological explanations of biological organisms, natural non-living objects, and incorrect endorsement of control items as a function of condition of the decision-making task. For the speeded condition, percentage endorsement is calculated as the number of items endorsed out of the number of items with valid responses. Error bars represent +/- 1 SE.

Two planned orthogonal contrasts were conducted to determine the source of this

significant interaction. Firstly, as shown in Figure 1 and Table 2, the speeded decision-

making task had a greater effect on endorsement of scientifically unwarranted teleological

explanations of nature than on incorrect endorsement of control items, $F(1,86) = 14.21$, $p <$

$.001$, $\eta\rho^2 = .142$. A second contrast showed that the difference in endorsement of

scientifically unwarranted teleological explanations of biological and natural non-living kinds

was not moderated by the condition of the task, $F(1,86) = 0.18$, $p = .673$, $\eta\rho^2 = .002$. Thus,

the speeded decision-making task had a similar effect on endorsement of biological and

natural non-living teleological explanations, and this effect was significantly greater than the

effect on incorrect endorsement of control items.

Table 2.

Mean Endorsement of Item-Type as a Function of Condition

	Item-Type		
	Unwarranted Biological	Unwarranted Natural Non-Living	Incorrect Control
Un-Speeded	48.64	38.58	6.34
	(18.97)	(23.75)	(4.28)
Speeded	66.69	58.29	9.84
	(21.03)	(21.24)	(4.94)

Note: Means are shown with standard deviations below in brackets. For the speeded condition, mean incorrect endorsement is calculated from the number of items incorrectly endorsed out of the number of items with valid responses.

Hypothesis Testing

Analysis strategy. A mixed ANCOVA was performed with condition of the

decision-making task as the between subject factor (speeded, un-speeded), item-type as the

within-subject factor (biological, natural non-living), and the CRS10 Experience subscale as

a continuous independent variable. The CRS10 Ideology subscale, CREDs exposure, age,

and gender were included as covariates. As the possible interaction between the Experience

subscale and the condition of the task was central to hypotheses three and four, this

interaction term was also included in the model. All continuous variables were mean-

centered for analysis. The dependent variable was the mean percentage of teleological

explanations endorsed. In the case of the speeded condition, this was calculated from the

number of explanations with valid responses. Responses to the test items were coded as 0 for

"false" and 1 for "true", such that higher scores represented greater teleological endorsement.

Where multiple pairwise comparisons were made, the appropriate nominal alpha-rate is

reported, against which the obtained significance is judged.

Assumptions. Based on examination of standardised residuals for each within-subject factor, there were no outliers greater than ± 3. In conjunction with non-significant Shapiro-Wilk tests, examination of histograms and Q-Q plots showed that the residuals were normally distributed within both biological item-types, $SW(88) = 0.99$, $p = .596$, and natural non-living item-types, $SW(88) = 0.98$, $p = .118$. The assumption of homogeneity of variances was met through non-significant Levene's tests for both the biological item-type, $F(1,86) = 0.27$, $p = .608$, and natural non-living item-type, $F(1,86) = 0.24$, $p = .602$. The previously discussed non-significant differences for covariates across conditions showed that the assumption of independence of the between-subject factor and covariates was met, and the assumption of homogeneity of regression slopes appeared to be met through examination of scatterplots. Finally, as there were only two within-subject factors, the assumption of sphericity was not applicable to this design.

Foundational hypotheses. The significance and effect sizes of the main-effects, interaction, and covariates from this analysis are shown in Table 3. As expected, the main effect of condition was significant. The mean percentage of test items endorsed in the speeded condition ($M = 62.08$, $SE = 3.26$) was significantly higher than the un-speeded condition ($M = 43.38$, $SE = 2.57$), providing evidence of an implicit bias for unwarranted teleological explanations of the natural world. Also, as expected, the main effect of item-type was significant, showing that unwarranted teleological explanations of biological organisms ($M = 57.45$, $SE = 2.20$) were endorsed more than those of natural non-living objects ($M = 48.19$, $SE = 2.31$).

There was an unexpected Ideology by Item-Type interaction. At the lowest levels of the Ideology subscale, the difference in endorsement of teleological explanations of natural non-living objects ($M = 59.23$, $SE = 7.48$) and biological organisms ($M = 55.97$, $SE = 7.11$) was non-significant, $F(1,80) = 0.29$, $p = .590$, $\eta\rho^2 = .004$. However, at the highest levels of

the Ideology subscale, the difference in endorsement of teleological explanations of natural

non-living objects ($M = 39.43$, $SE = 5.90$) and biological organisms ($M = 58.62$, $SE = 5.61$)

was significant, $F(1,80) = 16.35$, $p < .001$, $\eta\rho^2 = .170$, (both compared against a Bonferroni

adjusted alpha of .025). Likewise, there was an unexpected Gender by Item-Type interaction.

Although explanations of biological organisms were endorsed more than explanations of

natural non-living objects across both genders, this difference was larger in males ($M_{diff} =$

16.35, $SE_{diff} = 3.52$), $F(1,80) = 21.64$, $p < .001$, $\eta\rho^2 = .213$, than in females ($M_{diff} = 6.61$, SE_{diff}

$= 2.25$), $F(1,80) = 8.66$, $p = .004$, $\eta\rho^2 = .098$, (both compared to a Bonferroni adjusted alpha

of .025).

Table 3.

Significance and Effect Sizes for Overall ANCOVA

	df	F	p	$\eta\rho^2$
Item-type	1	21.53	< .001	.212
Condition	1	20.29	< .001	.202
Experience	1	0.37	.546	.005
Ideology	1	0.59	.444	.007
CREDs	1	1.76	.189	.021
Gender	1	0.95	.332	.012
Age	1	2.31	.132	.028
Item-type * Condition	1	0.40	.527	.005
Item-type * Experience	1	1.72	.193	.021
Item-type * Ideology	1	4.95	.029	.058
Item-type * CREDs	1	2.80	.098	.034
Item-type * Gender	1	5.25	.025	.062
Item-type * Age	1	0.13	.718	.002
Condition * Experience	1	5.12	.026	.060
Item-type * Condition * Experience	1	6.92	.010	.080
Error	80	-	-	-

Note: All continuous variables are mean-centred.

Central hypotheses. As illustrated in Figure 2, there was a significant interaction

between the CRS10 Experience subscale and the condition of the decision-making task. As

expected, after controlling for covariates, the difference in rates of implicit and explicit teleological endorsement was moderated by the perceived experience of supernatural agents intentionally interacting with the world. Specifically, for low-Experience individuals, the difference in endorsement between the speeded ($M = 64.78$, $SE = 5.45$) and un-speeded conditions ($M = 36.01$, $SE = 5.18$) was highly significant, $F(1,80) = 22.31$, $p < .001$, $\eta\rho^2 = .218$, whereas for high-Experience individuals, the difference between the speeded ($M = 56.53$, $SE = 9.80$) and un-speeded conditions ($M = 58.52$, $SE = 9.41$) was non-significant, $F(1,80) = 0.04$, $p = .845$, $\eta\rho^2 < .001$, (both compared to a Bonferroni adjusted alpha of .025). However, while the interaction was significant, the relationship between the Experience subscale and endorsement in the un-speeded condition failed to reach significance, $B = 5.25$, $t(80) = 1.55$, $p = .125$, $\eta\rho^2 = .053$.

Figure 2. Unwarranted Teleological Endorsement for Total Test Items
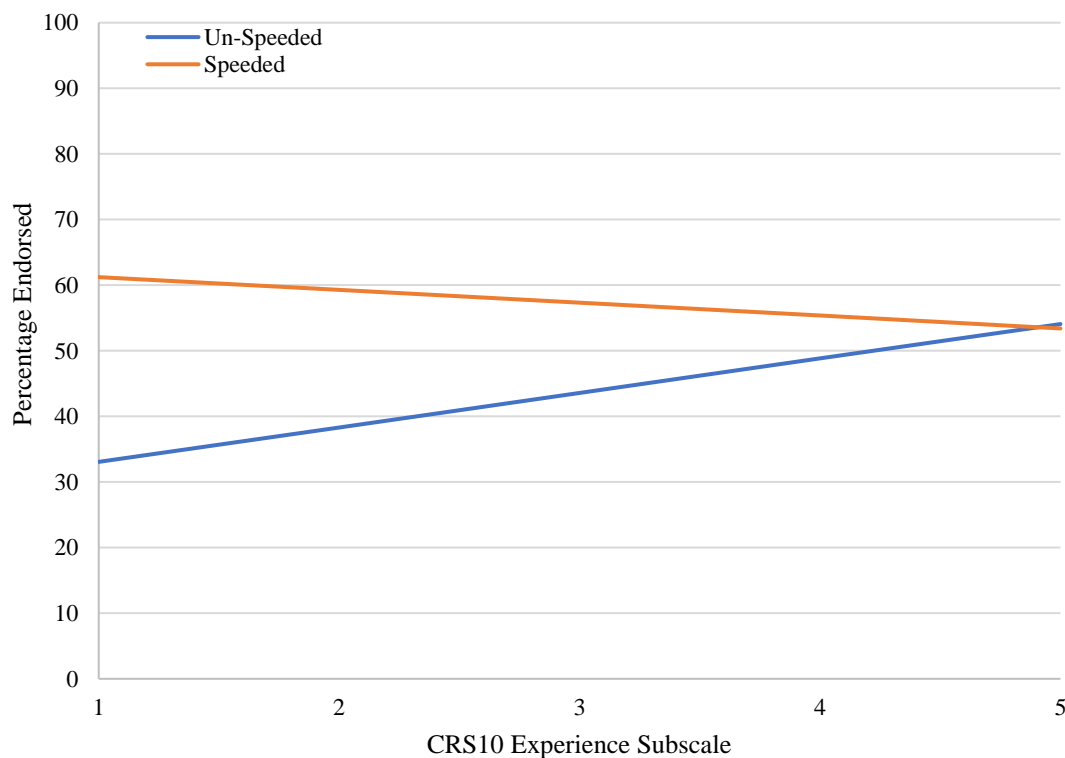

Figure 2. Percentage of scientifically unwarranted teleological test items endorsed as a function of condition of the decision-making task and perceived supernatural intentionality (CRS10 Experience subscale), controlling for CRS10 Ideology, CREDs, age, and gender. The speeded endorsement is calculated as a percentage of items endorsed from those with valid responses.

As expected, the previous two-way interaction between the CRS10 Experience subscale and the condition of the decision-making task, was itself moderated by whether the teleological explanation referred to a biological organism or natural non-living object, $F(1,80) = 6.92$, $p = .010$, $\eta\rho^2 = .080$. To examine this in more detail, endorsement of scientifically unwarranted teleological explanations of biological organisms and natural non-living objects were analysed separately. For each, an ANCOVA was conducted with the condition of the decision-making task as a between-subject factor, and the Experience subscale as a continuous independent variable. As before, these analyses included the interaction between the condition of the task and the Experience subscale, and included Ideology, CREDs, gender, and age as covariates. Finally, to aid with interpretation, all continuous predictors were mean-centered.

Teleological explanations of biological organisms. The significance and effect sizes of the main-effects, interaction, and covariates from this analysis are shown in Table 4, and parameter estimates are shown in Table 6. While controlling for all other variables in the model, endorsement of teleological explanations of biological organisms was significantly higher in the speeded ($M = 66.28$, $SE = 3.49$) compared to un-speeded condition ($M = 48.67$, $SE = 2.75$), providing evidence of an implicit bias for these explanations. However, no other predictors in the model were significant. Of particular interest, and as illustrated in Figure 3, the interaction between the condition of the decision-making task and CRS10 Experience subscale was non-significant, providing no evidence that rates of implicit and explicit teleological endorsement for biological organisms diverge in relation to the perception of supernatural agents intentionally interacting with the world.

Table 4.

Significance and Effect Sizes for ANCOVA of Biological Organisms

	df	*F*	*p*	$\eta\rho^2$
Condition	1	15.56	< .001	.163
Experience	1	<0.01	.990	<.001
Ideology	1	0.05	.825	.001
CREDs	1	0.28	.597	.004
Gender	1	0.01	.955	<.001
Age	1	1.61	.208	.020
Condition * Experience	1	1.01	.319	.012
Error	80	-	-	-

Note: All continuous variables are mean-centred.

Figure 3. Unwarranted Teleological Endorsement for Biological Organisms
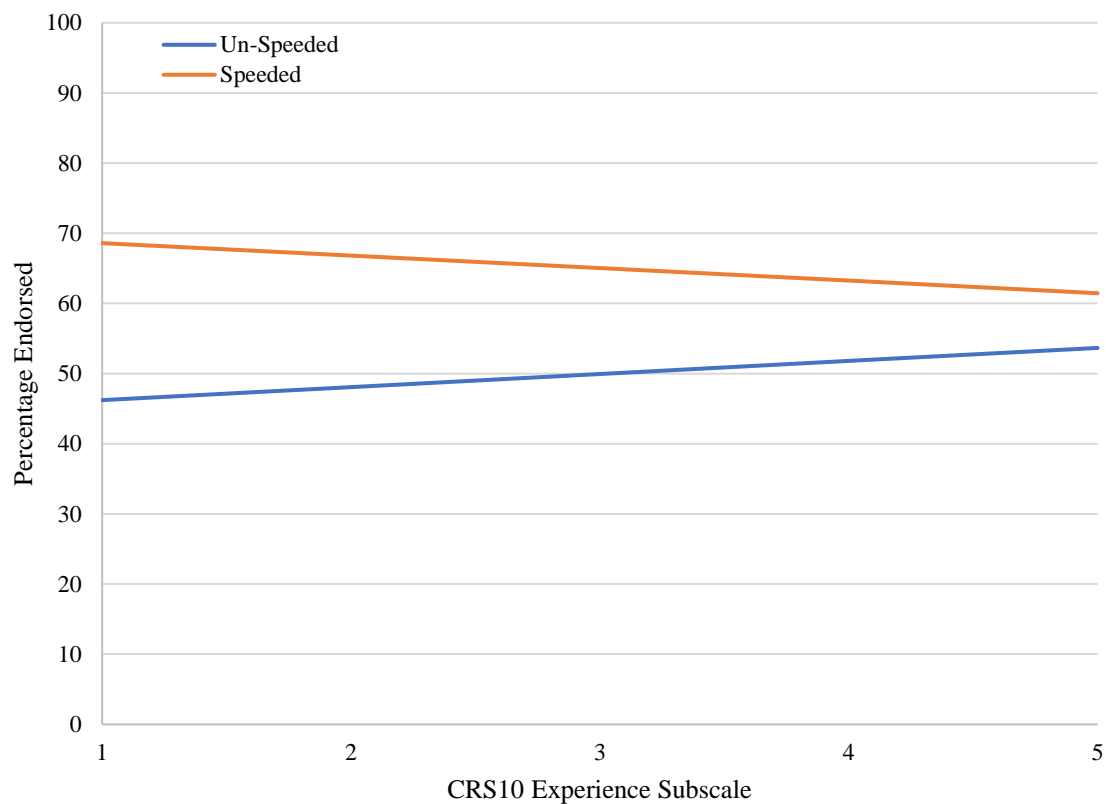
Figure 3. Percentage of scientifically unwarranted teleological test items for biological organisms endorsed as a function of condition of the decision-making task and perceived supernatural intentionality (CRS10 Experience subscale), controlling for CRS10 Ideology, CREDs, age, and gender. The speeded endorsement is calculated as a percentage of items endorsed from those with valid responses.

Teleological explanations of natural non-living objects. The significance and effect sizes of the main-effects, interaction, and covariates from this analysis are shown in Table 5, and parameter estimates are shown in Table 6. While controlling for all other variables in the model, endorsement of teleological explanations of natural non-living objects was significantly higher in the speeded ($M = 57.88$, $SE = 3.67$) compared to un-speeded condition ($M = 38.09$, $SE = 2.89$), providing evidence of an implicit bias for these explanations. No other variables in the model were significant. However, as shown in Figure 4 and Table 5, the interaction between the condition of the decision-making task and the Experience subscale was significant.

Table 5.

Significance and Effect Sizes for ANCOVA of Natural Non-Living Objects

	df	*F*	*p*	$\eta\rho^2$
Condition	1	18.13	< .001	.185
Experience	1	1.14	.289	.014
Ideology	1	2.49	.118	.030
CREDs	1	3.42	.068	.041
Gender	1	3.20	.078	.038
Age	1	2.24	.138	.027
Condition * Experience	1	9.41	.003	.105
Error	80	-	-	-

Note: All continuous variables are mean-centred.

After controlling for covariates, for low-Experience individuals the difference between the speeded ($M = 60.95$, $SE = 6.13$) and un-speeded conditions ($M = 25.80$, $SE = 5.83$) was highly significant, $F(1,80) = 26.29$, $p < .001$, $\eta\rho^2 = .247$. However, for high-Experience individuals the difference between the speeded ($M = 51.59$, $SE = 11.03$) and un-speeded conditions ($M = 63.36$, $SE = 10.59$) was non-significant, $F(1,80) = 1.08$, $p = .303$, $\eta\rho^2 = .013$, (both compared to a Bonferroni adjusted alpha of .025). Furthermore, as shown by the parameter estimates in Table 6, this interaction was being driven primarily by a

positive relationship between scores on the Experience subscale and teleological endorsement in the un-speeded, as opposed to the speeded condition. Thus, rates of implicit and explicit teleological endorsement of natural non-living objects diverged in relation to the perception that supernatural agents intentionally interact with the world. For high-Experience individuals, rates of implicit and explicit endorsement for these explanations did not differ. However, for low-Experience individuals, forced speeded responding which precluded the opportunity for inhibition, resulted in significantly higher rates of teleological endorsement for natural non-living objects, compared to un-timed responding which afforded the opportunity for inhibition.

Figure 4. Unwarranted Teleological Endorsement for Natural Non-Living Objects

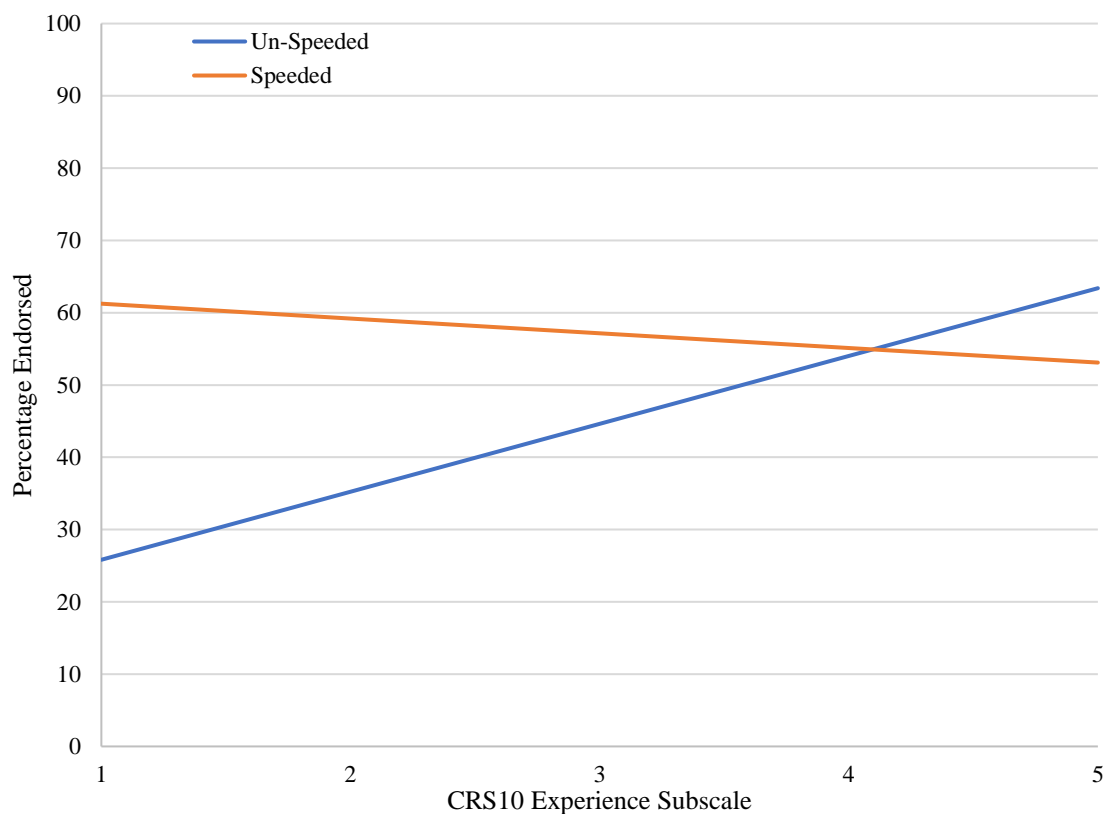*Figure 4*. Percentage of scientifically unwarranted teleological test items for natural non-living objects endorsed as a function of condition of the decision-making task and perceived supernatural intentionality (CRS10 Experience subscale), controlling for CRS10 Ideology, CREDs, age, and gender. The speeded endorsement is calculated as a percentage of items endorsed from those with valid responses.

Table 6.

Parameter Estimates for Teleological Endorsement

	Biological Kinds		Natural Non-Living Kinds	
	B	Unique R^2	*B*	Unique R^2
Intercept	48.79	-	31.36	-
Condition (Speeded)	17.72**	.074	20.13**	.184
Age	-0.87	.016	-1.07	.019
Gender	-0.29	<.001	9.46	.027
CREDs	0.77	.003	2.84	.029
Ideology	0.66	<.001	-4.95	.021
Experience	1.86	.003	9.39*	.051
Condition * Intention	-3.65	.010	-11.73**	.078

Note: All continuous variables are mean-centred. The un-speeded condition is used as the reference group.
* $p < .05$, ** $p < .01$.

Performance on Control Items

In order to explore possible alternative interpretations of these results, performance on control items are discussed below. For the following analyses, responses to control items were coded as 0 for correct and 1 for incorrect, such that higher scores represented greater inaccuracy. As these analyses were not central to the hypotheses, for the sake of brevity, only relevant effects are discussed.

General inaccuracy. An alternative interpretation of the preceding results could be that perhaps accuracy in general differed according to the perception of supernatural intentionality. A 2 (control item-type; true, false) x 2 (condition; un-speeded, speeded) mixed ANCOVA was conducted which included the CRS10 Experience subscale as a continuous predictor, and the CRS10 Ideology subscale, CREDs exposure, and participant age and gender as covariates, while also allowing for the interaction between the decision-making task and the Experience subscale.

The main effect of the decision-making task was significant, $F(1,80) = 13.00$, $p =$ .001, $\eta\rho^2 = .140$, with greater inaccuracy in the speeded ($M = 9.78$, $SE = 0.75$) compared to un-speeded condition ($M = 6.32$, $SE = 0.59$). The Experience subscale was not a significant predictor of control item inaccuracy, $F(1,80) = 1.10$, $p = .297$, $\eta\rho^2 = .014$, and the Experience subscale did not significantly moderate the effect of the decision-making task, $F(1,80) = 1.61$, $p = .209$, $\eta\rho^2 = .020$. If a general inaccuracy in responding for high-Experience individuals was the reason for the pattern of endorsement for teleological test-items, then a significant result would be expected for one or both of these effects.

True-bias and false-bias. Another possibility was that high-Experience individuals may be biased towards judging explanations as true. If this were the case, then these individuals should be less accurate on false control items (i.e., those which warrant a response of "false") compared to low-Experience individuals. Conversely, low-Experience individuals may be biased towards judging explanations as false. If this were the case, then these individuals should be less accurate on true control items (i.e., those which warrant a response of "true") compared to high-Experience individuals. However, no support was found for either of these possibilities.

There was no evidence of an interaction between control item-type (true, false) and the Experience subscale on inaccuracy of responses, $F(1,80) = 1.54$, $p = .218$, $\eta\rho^2 = .019$. There was also no evidence for a three-way interaction between control item-type, condition of the decision-making task, and the Experience subscale, $F(1,80) = 1.97$, $p = .164$, $\eta\rho^2 =$ .024. Thus, there was no evidence of a "true-bias" or "false-bias" for individuals at the high- and low-ends of the Experience subscale, respectively, and this did not differ across conditions of the decision-making task.

Teleological controls. A final possibility was that the interaction between the decision-making task and Experience subscale on rates of scientifically unwarranted

teleological endorsement had nothing to do with notions of intentionality in nature. Conceivably, this interaction could be due to a bias for teleological explanations in high-Experience individuals, regardless of the explanation's plausibility. To explore this, endorsement rates of false teleological control items were examined (e.g., Houses have doorbells in order to make dogs bark), while using the same predictors from the preceding analyses.

The main effect of the decision-making task was significant, $F(1,80) = 8.71$, $p = .004$, $\eta\rho^2 = .098$, with higher endorsement in the speeded ($M = 13.37$, $SE = 1.83$) compared to un-speeded condition ($M = 6.41$, $SE = 1.44$). Averaged across conditions, the Experience subscale did not significantly predict endorsement of false teleological control items, $F(1,80) = 0.39$, $p = .533$, $\eta\rho^2 = .005$. There was also no significant interaction between the Experience subscale and the decision-making task on endorsement of these items, $F(1,80) < 0.01$, $p = .954$, $\eta\rho^2 < .001$. Thus, while the Experience subscale moderated the effect of the decision-making task on endorsement of scientifically unwarranted teleological explanations of natural non-living objects (Figure 4), it did not moderate the effect of the decision-making task on endorsement of false teleological control items.

Discussion

Teleological explanations of nature seem to imply the intentions of an agent for which physical evidence does not exist. Previous research has implicated religious belief as a predictor of scientifically unwarranted teleological endorsement. Specifically, belief in "God" and "Nature is a powerful being" have both been shown to positively predict endorsement of teleological explanations of nature (Kelemen et al., 2013). However, whether God or Nature, belief in either of these agents arguably involves many facets. The current study had three principle aims. Firstly, to determine whether, consistent with the theory of intention-based teleology (Kelemen, 1999a), the perceived experience of supernatural agents intentionally interacting with the world predicts explicit endorsement of teleological explanations of nature, over and above other aspects of belief in supernatural agents. Secondly, to reconcile the findings of a positive relationship between supernatural agent beliefs and teleological endorsement, with findings of an enduring teleological bias (Casler & Kelemen, 2008; Kelemen & Rosset, 2009). Thirdly, this study aimed to determine whether the relationship between rates of implicit and explicit teleological endorsement and belief in supernatural agents, depends upon what in the natural world is being explained.

Review of Results

Co-existence of conflicting beliefs. Consistent with the argument that teleological and non-teleological beliefs can co-exist in the one mind (e.g., Kelemen & Rosset, 2009), it was hypothesised that teleological explanations of the natural world would be endorsed at a higher rate when participants were not given a chance to inhibit their responses, compared to when they were given a chance to inhibit their responses. This prediction was supported by a significant main effect of the condition of the decision-making task. Specifically, when participants were instructed to make their response within 3200ms of the explanation being

presented, a significantly higher proportion of teleological test items with valid responses were endorsed compared to the un-speeded condition.

Biological and natural non-living kinds. As teleological reasoning is thought to be based in an understanding of intentionality (Kelemen, 1999a, pp. 286–291), and as only biological organisms are capable of having intentions, it was hypothesised that teleological explanations of biological organisms would be endorsed at higher rates than those of natural non-living objects. The main effect of item-type supported this prediction, showing that consistent with Kelemen and Rosset (2009, study 1), teleological explanations were viewed as more acceptable when they referred to biological organisms compared to natural non-living objects.

Co-existence is moderated by supernatural intentionality. It was hypothesised that after controlling for other aspects of "belief", the difference between rates of implicit and explicit teleological endorsement of nature would be moderated by the perception of supernatural agents intentionally interacting with the world. Specifically, that explicit teleological endorsement would be positively related to perceived supernatural intentionality, and that the difference between implicit and explicit teleological endorsement would be larger for individuals who rejected notions of supernatural intentionality, compared to those who accepted notions of supernatural intentionality.

The evidence provided only partial support for this hypothesis. After controlling for age, gender, CREDs exposure, and the CRS10 Ideology subscale, there was a significant interaction between the CRS10 Experience subscale and the condition of the decision-making task. However, despite the significant interaction, the relationship between the Experience subscale and teleological endorsement failed to reach significance in the un-speeded condition. Evidently, while the slopes for the Experience subscale in the two conditions of the decision-making task were significantly different from each other, they were not

significantly different to zero. However, as predicted, after controlling for age, gender, CREDs exposure, and the Ideology subscale, at the lowest level of the Experience subscale there was a significant increase in teleological endorsement from the un-speeded to the speeded condition, whereas at the highest level of the Experience subscale, no significant difference between the un-speeded and speeded conditions was observed. These results suggest that for individuals who reject notions of supernatural agents intentionally interacting with the world, explicitly held teleological beliefs conflict with their underlying tendency to view the natural world in terms of function. However, for individuals who endorse such notions of supernatural intentionality, there is no evidence to suggest that their explicitly held teleological beliefs conflict with their underlying bias for functional explanations of the world.

Post-hoc analyses helped to rule out some alternative explanations for these results. Firstly, inaccuracy of control items did not differ according to scores on the CRS10 Experience subscale, suggesting that individuals who accepted notions of supernatural intentionality were not less accurate in general than those who rejected notions of supernatural intentionality. Secondly, there was no evidence of a bias to incorrectly judge control items as either true or false depending on scores on the Experience subscale. High-Experience individuals were not significantly more likely to incorrectly judge control items as "true" compared to low-Experience individuals. Likewise, low-Experience individuals were not significantly more likely to incorrectly judge control items as "false" compared to high-Experience individuals. Finally, high-Experience individuals did not differ significantly from low-Experience individuals in their endorsement of false teleological control items, suggesting that the relationship between perceived supernatural intentionality and scientifically unwarranted teleological endorsement of the natural world was not simply due to a tendency to endorse teleological explanations regardless of plausibility. In showing that

the previous results were not due to a general inaccuracy or specific response biases which vary according to the perception of supernatural intentionality, these post-hoc analyses provide strong support for the argument that all individuals implicitly view the natural world in terms of intentions, and that explicit beliefs about purpose in nature diverge from implicit beliefs in individuals who reject notions of supernatural intentionality.

Moderation of the moderation of co-existence. If, as it has been argued, teleological explanations necessarily imply the intentions of an agent, then differences in the divergence of implicit and explicit endorsement and the relationship with perceived supernatural intentionality would be expected, depending on whether the target of the teleological explanation is capable of having intentions. As natural non-living objects are never capable of having intentions, whereas some biological organisms are, it was hypothesised that the relationship between implicit and explicit teleological endorsement and perceived supernatural intentionality, would itself be moderated by whether the teleological explanation referred to a biological organism or natural non-living object. Specifically, the moderating effect of perceived supernatural intentionality was predicted to be stronger for teleological explanations of natural non-living objects compared to biological organisms.

This hypothesis was supported by a significant three-way interaction between the CRS10 Experience subscale, the condition of the decision-making task, and the type of teleological explanation. As predicted, the previous two-way interaction between the condition of the decision-making task and the Experience subscale was being driven mostly by teleological explanations of natural non-living objects as opposed to explanations of biological organisms. For teleological explanations of biological organisms, the interaction between the condition of the task and the Experience subscale was non-significant, whereas for teleological explanations of natural non-living objects, the interaction between the condition of the task and the Experience subscale was highly significant. For the latter, there

was a significant positive relationship between perceived supernatural intentionality and endorsement in the un-speeded condition, showing that explicit endorsement of these explanations was positively related to the perception of supernatural intentionality over and above belief in the existence of supernatural agents. Furthermore, at the lowest level of the Experience subscale there was a significant increase in endorsement from the un-speeded to the speeded condition, suggesting a divergence of implicit and explicit teleological endorsement. This contrasts with the highest level of the Experience subscale, where no significant difference was observed between endorsement in the un-speeded and speeded conditions. Thus, implicit and explicit endorsement of teleological explanations of natural non-living objects diverge according to an individual's perceived experience of supernatural agents intentionally interacting with the world, yet there is no evidence to suggest the same pattern of divergence for teleological explanations of biological organisms.

Implications and Future Research

   Co-existence. The significant increase in teleological endorsement from the un-speeded to the speeded condition, clearly supports the argument of an enduring teleological bias which may co-exist with conflicting beliefs (Casler & Kelemen, 2008; Kelemen & Rosset, 2009; Kelemen et al., 2013). The co-existence of two seemingly contradictory beliefs fits well with the Logical Intuition dual-process model (De Neys, 2012). According to this model, multiple automatic responses to stimuli are generated in parallel, and whether or not these conflict with one another is what determines whether effortful thought is subsequently engaged (De Neys, 2012; also see Pennycook et al., 2015). Understood this way, when placed under time pressure and given no opportunity to engage in effortful thought, the response of the participant should reflect an "unfiltered" intuition.

   The results of this study help to rule out two possible alternatives to the co-existence perspective. Firstly, a significant interaction between the condition of the decision-making

task (speeded, un-speeded) and item type (natural non-living test, biological test, control), showed that the effect of the speeded condition was significantly greater for endorsement of teleological test items than for incorrectly answered control items. Therefore, the higher endorsement of teleological test items in the speeded compared to un-speeded condition, could not be due to a general inaccuracy caused by speeded responding.

A second alternative explanation is that according to compensatory control theory, people need to perceive their lives as orderly and non-random. When this perception is threatened through reduced personal control, they may increase their belief in an available external source of control such as God (Kay, Gaucher, McGregor, & Nash, 2010; Kay, Moscovitch, et al., 2010; Landau et al., 2015). It is conceivable that a speeded decision-making task could threaten perceived personal control, as participants cannot control the rate at which explanations are presented. Given that teleological explanations of the natural world are quasi-religious (Kelemen, 2004), it could therefore be argued that increased endorsement in the speeded compared to un-speeded condition, may be due not to an underlying bias for teleological explanations, but instead to teleological explanations serving as a source of compensatory control. However, no support was found for this alternative explanation. There were no significant differences between conditions of the decision-making task for scores on the Personal Need for Structure (PNS), Need for Closure (NFC), or Subjective Anxiety measures, which would have been expected if the speeded condition caused a threat to personal control.

There was also no significant relationship between endorsement of teleological test-items and scores on the PNS, NFC, or Subjective Anxiety measures, suggesting that dispositional differences in coping with uncertainty were unrelated to teleological endorsement. However, as noted earlier, absence of evidence is not evidence of absence, and it is worth noting that only the CRS10 Intellect subscale showed a significant positive

relationship with the NFC measure. It is possible then, that the null-findings for teleology

functioning as a source of compensatory control are simply due to this particular sample. It is

also worth reiterating that participants who were excluded from analysis had significantly

higher subjective anxiety scores compared to those who were retained, and this may have

resulted in a restriction of range for anxiety scores which contributed to the null results. An

approach which may yield answers in future research, is to use alternative methods to induce

a threat to personal control. These include tasks where participants are asked to recall

situations in which they lacked control, and to generate reasons why the future is

uncontrollable (e.g., Kay, Gaucher, et al., 2010). However, while the possibility of teleology

functioning as a source of compensatory control cannot be ruled out, the available evidence

favours the interpretation of a co-existence of teleological and non-teleological beliefs.

Given the evidence in favour of the co-existence perspective, somewhat surprisingly,

the extent to which individuals reported to enjoy engaging in effortful analytic thought, as

measured by the Need for Cognition Scale (NCS), was not significantly correlated with

endorsement of teleological test-items. However, also in contrast to previous research

linking religious disbelief to analytic cognitive style (e.g., Pennycook et al., 2014, 2012), in

the present study no significant relationship was found between scores on the NCS and any of

the CRS10 subscales. A possible reason for this discrepancy could be the use of a self-report

measure of cognitive disposition in the current study, rather than performance-based

measures such as Base Rate Conflict tasks and the Cognitive Reflections Test (CRT) used in

previous research. Although the NCS purports to measure the tendency to engage in and

enjoy thinking (Cacioppo & Petty, 1982), previously reported correlations between scores on

the NCS and performance-based measures of analytic disposition such as the CRT, are

positive, but weak (Frederick, 2005). Future research should investigate the possible

negative relationship between scientifically unwarranted teleological endorsement and

analytic disposition, by employing performance-based measures such as the CRT. Evidence

of a negative relationship between performance on these tasks and unwarranted teleological

endorsement, would provide further support for the co-existence perspective.

     Intentionality. These results help to qualify previous findings of a positive

relationship between belief in supernatural agents and endorsement of teleological

explanations of the natural world (e.g., Banerjee & Bloom, 2014; Kelemen et al., 2013).

Consistent with the theory of an intention-based teleology (Kelemen, 1999a), an aspect of

belief in supernatural agents which uniquely predicts teleological endorsement, is the belief

that these agents are *agents who intentionally interact with the world*. This highlights the

possibility that the findings by Kelemen and colleagues of belief in "Nature as a powerful

being" as a stronger predictor of scientifically unwarranted teleological endorsement than a

belief in "God" (Kelemen et al., 2013), may be due, in part, to the wording of the questions.

Although belief in the former implies that agency and intentions are intrinsic to the natural

world, it also implies that Nature is a being capable of causing change. A belief in the latter,

on the other hand, likely implies that agency and intentions are extrinsic to the natural world,

but makes no implications regarding the capabilities of God to cause change (i.e., a powerful

being). Therefore, the strength of a belief in "Nature as a powerful being" in predicting

scientifically unwarranted teleological endorsement, may have less to do with viewing the

natural world as *intrinsically* agentic, and more to do with the fact that this item emphasises

the intentional aspect of an agent, whereas a belief in "God" does not.

     The current results also help to reconcile the positive relationship between belief in

supernatural agents and teleological endorsement (Banerjee & Bloom, 2014; Kelemen et al.,

2013), with findings of an enduring teleological bias (Casler & Kelemen, 2008; Kelemen &

Rosset, 2009). The finding that explicit teleological endorsement diverges from implicit

endorsement depending upon the perception of supernatural intentionality, is consistent with

both the argument of an enduring intentionality heuristic (Rosset, 2007, 2008), and the

Logical Intuition dual-process model more broadly (De Neys, 2012). Central to the idea of

an intentionality heuristic is that everything is first perceived as intentional, and that this must

be overridden in order to judge something as non-intentional (Rosset, 2007). Applied to the

natural world, it is easy to see how a failure to inhibit the intentionality heuristic could lead to

quasi-religious notions of function and purpose. For example, if this heuristic response was

not inhibited when explaining a cloud raining, intentions would either be attributed to the

cloud itself, or to an agent that intended the cloud to rain. Understood this way, the

difference in explicit teleological endorsement between individuals at the lower- and upper-

ends of the Experience subscale, depends not on whether they perceive intentions in the

natural world, but whether they inhibit this response in favour of another. The suggestion

that "non-religious" individuals may implicitly hold quasi-religious beliefs is not new, and is

consistent with notions of implicit theism within the CSR literature (e.g., Hitzeman &

Wastell, 2017; McCauley, 2011; Shariff & Norenzayan, 2007). Put simply, non-religious

individuals may purposely inhibit the response of "intentional" when explaining the natural

world, whereas religious individuals give the source of the perceived intentions a name.

    Given the relationship between perceived supernatural intentionality and endorsement

of teleological explanations of natural non-living objects, it is surprising that in contrast to

Banerjee and Bloom (2014, study 2), the extent to which individuals reported thinking about

the mental states of others, as measured by the Empathy Quotient (EQ), showed no

significant correlation with rates of teleological endorsement. However, in the current study

the relationship between scores on the EQ and each of the CRS10 subscales were also non-

significant. Given that prior research has found a positive relationship between EQ scores

and belief in a personal god (Norenzayan et al., 2012), this was unexpected. However, the

current study is not the first to obtain null-results when investigating the link between

understanding the mental states of others and belief in gods (e.g., Maij et al., 2017; Reddish et al., 2016; Vonk & Pitzen, 2017). Closer inspection of the items used in previous research to measure a belief in gods, offers insight into a possible reason for this discrepancy. Whereas Norenzayan et al. (2012) measured belief in God using items which emphasised a personal relationship with God (e.g., "When I am in trouble, I find myself wanting to ask God for help"), others have used items which do not emphasise this relationship. For example, Maij et al. (2017) measured religiosity using items which emphasised behavioural aspects of belief (e.g., "How often do you pray?"). It is possible then, that the extent to which individuals think about the mental states of others is predictive of their perceived personal relationship with supernatural agents, yet is not predictive of other aspects of belief, such as the perception that supernatural agents intentionally interact with the world.

Source of perceived intentions. The results showing the unique effect of perceived supernatural intentionality in predicting explicit endorsement of teleological explanations of natural non-living objects, provides strong support for the intention-based theory of teleology outlined by Kelemen (1999a, pp. 286–291). Although there was no evidence that perceived supernatural intentionality moderates the difference between implicit and explicit teleological endorsement for biological organisms, this does not mean that the biological world is not subject to explanation through the lens of an intentionality heuristic. Rather, the very reason why a stronger interaction between the condition of the task and perceived supernatural intentionality was predicted for natural non-living objects than biological organisms, was because some biological organisms are capable of having intentions of their own, whereas natural non-living objects are not. Therefore, it is possible that the reason why perceived supernatural intentionality was not positively related to rates of explicit endorsement of teleological explanations of biological organisms, is that a suitable candidate for the source of the perceived intentions is the biological organism itself.

However, despite the prediction of a dissociation in endorsement between explanations of natural non-living objects and biological organisms being supported by the results, this does not necessarily mean that the perception of supernatural intentionality is unrelated to endorsement of teleological explanations of biological organisms. As both questions in the CRS10 Experience subscale mention "God or something divine", this emphasises a supernatural agent which, due to this study being conducted in a predominantly Christian culture (Australian Bureau of Statistics, 2017), would likely be viewed as extrinsic to the physical world by most participants. If biological organisms are understood as having intentions of their own, then the current lack of moderation may be due to an incongruence between a supernatural agent conceptualised as being removed from nature, serving as the source of perceived intentions for biological organisms.

The possibility of a sensitivity to the source of perceived intentions as an explanation for the current results is, admittedly, speculative. Data from this study offer no way of testing this hypothesis, and unfortunately, the results from Kelemen et al. (2013) showing belief in "Nature as a powerful being" as a predictor of teleological endorsement, were not reported separately for explanations of biological organisms and natural non-living objects. However, if congruence between the source of perceived intentions and the location of the proposed supernatural agent is important, then a dissociation might be expected in future research. Specifically, the "intentional agent" aspect of a belief in Nature (as a being) should positively predict explicit endorsement of teleological explanations of biological organisms, and this should be stronger than the effect of this belief in predicting explicit endorsement of teleological explanations of natural non-living objects. Conversely, and in-line with the current results, the "intentional agent" aspect of a belief in God should positively predict explicit endorsement of teleological explanations of natural non-living objects, and this should be stronger than the effect of this belief in predicting explicit endorsement of

teleological explanations of biological organisms. Although speculative, the idea of a sensitivity to the source of perceived intentions is worthy of investigation, and would help to further clarify the relationship between teleology and religious belief.

  Life events. In addition to further exploring the relationship between perceiving the intentions of supernatural agents and endorsement of teleological explanations of the natural world, an avenue for future research would be to investigate whether a similar relationship exists with teleological beliefs about life events. Bering (2002) argues that whereas the tendency to see the intentions underlying behaviour is the result of the Theory of Mind system, the tendency to see meaning in life events is the result of a cognitive system known as Existential Theory of Mind. Bering's position differs slightly to that of Kelemen (1999a). Whereas Kelemen argues that the tendency to promiscuously endorse teleological explanations of whole biological organisms and natural non-living objects is the result of an over-generalisation of thinking in intentional terms, Bering argues that the tendency to see meaning in life events is not a by-product of ordinary cognitive processes, but an adaptation in itself.

  Regardless of whether this is an adaptation or by-product, seeing meaning in life events necessarily implies the intentions of an agent (Bering, 2002), and as such, it is no surprise that belief in the existence of God has been shown to positively predict the tendency to interpret life events in terms of an intended purpose (Banerjee & Bloom, 2014; Heywood & Bering, 2014). Therefore, similar questions which drove the current research also apply to teleological explanations of life events; specifically, whether there is a dissociation of implicit and explicit teleological beliefs, and whether this dissociation is moderated by the perception of supernatural intentionality over-and-above other aspects of belief in supernatural agents. With regards to whether there is a dissociation, there is reason to suspect that implicit and explicit teleological beliefs about life events would co-exist, as even ardent

atheists see meaning in life events (Banerjee & Bloom, 2014; Heywood & Bering, 2014). From a theoretical perspective, it certainly seems plausible that this dissociation would be moderated by the perception of supernatural intentionality, as intentions are central to the theories of both Kelemen (1999a) and Bering (2002). In order to better understand how the dissociation of implicit and explicit beliefs about life's purpose are moderated by the perception of disembodied intentions, a useful approach for future research would be to employ a speeded decision-making task which precludes the opportunity to successfully inhibit intuitions.

Strengths and Limitations

Although the results of this study have generated additional questions, they have also contributed to the current understanding of teleology in several ways. This is the first study to isolate the effect of perceived intentions from general "belief" in supernatural agents. From a theoretical perspective, this aspect of belief in supernatural agents would be expected to be absolutely central to teleology, as PT theory rests on the claim that teleology is based in an understanding of intentions (Kelemen, 1999a, pp. 286–291). This study has also helped to reconcile two major themes in teleology research: the co-existence of teleological and non-teleological beliefs, and the positive relationship between teleology and belief in supernatural agents. In reconciling these two themes, this study helps to qualify previous findings from both lines of research. Specifically, teleological beliefs do seem to co-exist with potentially conflicting non-teleological beliefs, but the perception of supernatural intentionality moderates the difference between the two. Furthermore, by controlling for CREDs exposure in addition to religious belief, these results speak to the naturalness with which teleological explanations of nature occur.

Despite these strengths, there are certain limitations which should be noted. Firstly, the use of first-year psychology undergraduates limits the generalisability of these results.

This sample was not only homogenous with respect to age and level of education, but due to their common enrolment in a first-year psychology course, likely shared many interests and traits which were not controlled for in this study. However, while this sample was internally homogenous, thereby potentially limiting the generalisability of these results, as the majority of teleology research in adults has been conducted within North America (e.g., Banerjee & Bloom, 2014; Kelemen & Rosset, 2009; Kelemen et al., 2013), the use of Australian undergraduates provides further evidence that a teleological bias arises independently of one's immediate culture.

An additional limitation of the current study was the level of exclusion from the speeded condition. It was necessary to exclude participants who did not make enough valid responses on teleological test-items for two reasons. Firstly, as extreme scores are more likely to occur within small samples (Kahneman, 2011; Tversky & Kahneman, 1971), calculating the mean endorsement for participants who only made valid responses to a small number of test-items, would likely yield misleading results. Secondly, participants who did not have enough valid responses to test-items in the speeded condition were unlikely to have treated the task as speeded. As this study aimed to examine how the difference between implicit and explicit teleological endorsement was moderated by the perception of supernatural intentionality, it was crucial to ensure that participants in the speeded condition were treating the task as such. A possible solution to the high exclusion rate would be to slightly increase the time-limit in the speeded condition. This would allow the retention of more participants in the speeded condition, which would thereby increase statistical power.

Finally, it worth mentioning that although the current results are consistent with both the theory of intention-based teleology (Kelemen, 1999a) and prior empirical work (Banerjee & Bloom, 2014; Kelemen et al., 2013), the finding of perceived supernatural intentionality moderating the difference between implicit and explicit teleological beliefs is novel, and has

yet to be demonstrated in samples other than this one. Given the fact that these results are novel and add to the understanding of teleology in important ways, replication in more heterogeneous samples should be a priority for future research.

Conclusion

The tendency to explain the natural world in terms of function is innate and persistent. Children are drawn to such explanations from a young age (Kelemen, 1999b, 1999c), and in the absence of formal education (Casler & Kelemen, 2008), or when under time-pressure to respond (Kelemen & Rosset, 2009; Kelemen et al., 2013), adults display child-like teleological tendencies. This tendency to explain the natural world in terms of function is thought to result from an understanding and over-generalisation of intentionality (Kelemen, 1999a). All teleological explanations, whether describing a human-made artefact, biological organism, or natural non-living object, imply the intentions of an agent. Due to the implication of agency when explaining the natural world in teleological terms, these explanations constitute a quasi-religious belief (Kelemen, 2004), so unsurprisingly, a positive relationship between scientifically unwarranted teleological endorsement and belief in supernatural agents has been observed (Kelemen et al., 2013).

This study has added to the current knowledge in the field by addressing three primary questions. Firstly, what is it about "belief" in supernatural agents that is predictive of teleological endorsement? Secondly, how can the co-existence of teleological and non-teleological explanations of nature be reconciled with the positive relationship with belief in supernatural agents? Finally, does the relationship between implicit and explicit endorsement and perceived supernatural intentionality depend upon what in the natural world is being explained? In answering these questions, this study suggests that although "non-religious" individuals may inhibit notions of supernatural intentionality, this does little to alter their underlying intuitions which give rise to teleological beliefs about nature. Given the

naturalness with which teleological explanations occur, it seems that the tendency to view

nature as the result of an agent's prior intention is very much a normal feature of adult

cognition.

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Appendix A. Explanation Judgment Task Stimuli

Test items

1. Bats hunt mosquitoes in order to control over-population.

2. Bees frequent flowers in order to aid pollination.

3. Birds transfer seeds in order to help plants germinate.

4. Mites live on skin in order to eliminate dead skin cells.

5. Trees produce oxygen so that animals can breathe.

6. Ferns grow at ground level in order to conserve humidity.

7. Microbes convert nitrogen in order to enrich the soil.

8. Moss forms around rocks in order to stop soil erosion.

9. Water exists so that life can survive on Earth.

10. Earthworms tunnel underground in order to aerate the soil.

11. The fittest animals survive so that species can grow stronger.

12. Finches diversified in order to survive.

13. Germs mutate in order to become drug resistant.

14. Lemurs have adapted in order to avoid extinction.

15. Parasites multiply in order to infect a host.

16. Molecules fuse in order to create matter.

17. Particles collide in order to produce chemical reactions.

18. Rain falls in order to allow plants to grow.

19. Sand dunes form in order to stop waves eroding vegetation.

20. The sun makes light so that plants can photosynthesize.

21. The Earth rotates around the sun so that it can receive light.

22. Glaciers compact snow in order to conserve volume.

23. The Earth has an ozone layer in order to protect it from UV light.

24. Hurricanes circulate seawater in order to gather energy.

25. Lightning releases electricity in order to travel.

26. Mountains fold inwards in order to maintain mass.

27. Oceans dissolve rocks in order to retain ocean minerals.

28. Earthquakes happen because tectonic plates must realign. *

29. Volcanoes erupt in order to release underground pressure. *

30. Geysers blow in order to discharge underground heat. *

Control items

True Teleological

1. Alarm clocks beep in order to wake people up.

2. Bicycles have handlebars so that people can steer them.

3. People wear contact lenses in order to see more clearly.

4. Doctors prescribe antibiotics in order to treat infections.

5. Children wear mittens in the winter in order to keep their hands warm.

6. People buy microwaves in order to heat their food.

7. Pencils exist so that people can write with them.

8. Women put on perfume in order to smell pleasant.

9. Schools exist in order to help people learn new things.

10. Traffic lights change color in order to control traffic.

False Teleological

1. Houses have doorbells in order to make dogs bark.

2. Window blinds have slats so that they can capture dust.

3. People chew food in order to strengthen their jaw muscles.

4. People put coins into meters in order to get rid of spare change.

5. Cows have udders in order to allow farmers to milk them.

6. Hair becomes grey so that people can look older.

7. Musicians have two hands in order to play instruments.

8. Kittens have soft fur so that people will want to pet them.

9. Lamps shine brightly so that they can produce heat.

10. Mice run away from cats in order to get exercise.

True Causal

1. A lightbulb shines because electricity passes through its filaments.

2. Butter is greasy because it contains a great deal of fat.

3. Clothes cling in the dryer because tumbling together produces static.

4. Conception occurs because sperm and egg cells fuse together.

5. Candles melt because the wax becomes very hot.

6. Fireworks explode because gunpowder ignites when a fuse is lit.

7. Objects fall downwards because they are affected by gravity.

8. Icicles melt because the temperature increases.

9. Butcher knives slice through meat because they have sharp edges.

10. Lily pads float on the water because they have a large surface area.

11. Lollipops are sweet because sugar is a main ingredient.

12. Lizards shed their skins because they outgrow them.

13. Magnets stick together because their poles attract.

14. Otters are water resistant because their fur has natural oils.

15. Redwood trees stay firmly planted because they have strong roots.

16. Suction cups stick because they create a pressure vacuum.

17. Mushrooms grow in the forest because the soil has the right nutrients.

18. Soda fizzes because carbon dioxide gas is released.

19. Tadpoles become frogs because they undergo metamorphosis.

20. Teeth decay because the enamels are dissolved.

False Causal

1. Billboards are brightly coloured because they are large.

2. Soda cans are cylindrical because they are made of aluminium.

3. Chocolate is brown because it contains a significant amount of sugar.

4. Chipmunks hibernate in the winter because they eat nuts.

5. Cleaning fluids are corrosive because they have pungent odours.

6. Coyotes howl because they live in the hot desert.

7. Peppermint gum is chewy because it freshens peoples' breath.

8. Keys open locked doors because they are made of metal.

9. Male lions have large manes because they are carnivores.

10. Cows make mooing noises because they graze on grass.

11. The moon shines brightly because it has many craters.

12. Pebbles have rounded edges because they are little.

13. Mobile phones receive text messages because they are portable.

14. Polar bears are white because they swim in icy ocean water.

15. Potatoes contain starch because they grow in the ground.

16. Deserts are flat because they are covered with sand.

17. Pruning shears have sharp blades because they have handles.

18. Rivers have rapids because a lot of fish swim in them.

19. Rocks are heavy because they are made of inorganic material.

20. Roses have delicate petals because they have prickly thorns.

21. Raspberries are bright red because they grow on bushes.

22. Sea lions have a thick layer of blubber because they feed on fish.

23. Snakes make hissing noises because they move by slithering on the ground.

24. Snowflakes are white because they are symmetrical.

25. Soup is hot because it is primarily liquid.

26. Spiders spin intricate webs because they have eight legs.

27. Saturn is a planet because it has rings surrounding it.

28. Toads make croaking noises because they catch flies with their tongues.

29. Paper towels are absorbent because they are thin.

30. Oceans have waves because they contain a lot of saltwater.

Note: The final three teleological test-items marked by an asterisk (*) were presented to participants but were excluded from analysis.

Items adapted from: Kelemen, D., Rottman, J., & Seston, R. (2013). Professional physical scientists display tenacious teleological tendencies: Purpose-based reasoning as a cognitive default. *Journal of Experimental Psychology, 142*, 1074-1083. doi: 10.1037/a0030399.

Appendix B. Centrality of Religiosity Scale (CRS)

Instructions: Please answer the following questions based on your gut feelings. There are no right or wrong answers. Do not spend more than about 10 – 15 seconds on each one.

1. How often do you think about religious issues?
   - Never
   - Rarely
   - Occasionally
   - Often
   - Very often

2. To what extent do you believe that God or something divine exists?
   - Not at all
   - Not very much
   - Moderately
   - Quite a bit
   - Very much so

3. How often do you take part in religious services?
   - Never
   - Less often
   - A few times a year
   - One to three times a month
   - Once a week
   - More than once a week

4. How often do you pray?
   - Never
   - Less often
   - A few times a year
   - One to three times a month
   - Once a week
   - More than once a week
   - Once a day

- Several times a day

5. How often do you experience situations in which you have the feeling that God or something divine intervenes in your life?

- Never
- Rarely
- Occasionally
- Often
- Very often

6. How interested are you in learning more about religious topics?

- Not at all
- Not very much
- Moderately
- Quite a bit
- Very much so

7. To what extent do you believe in an afterlife – e.g., immortality of the soul, resurrection of the dead or reincarnation?

- Not at all
- Not very much
- Moderately
- Quite a bit
- Very much so

8. How important is it to take part in religious services?

- Not at all
- Not very much
- Moderately
- Quite a bit
- Very much so

9. How important is personal prayer for you?

- Not at all
- Not very much
- Moderately
- Quite a bit

- Very much so

10. How often do you experience situations in which you have the feeling that God or something divine wants to communicate or reveal something to you?

- Never

- Rarely

- Occasionally

- Often

- Very often

11. How often do you keep yourself informed about religious questions through radio, television, internet, newspapers, or books?

- Never

- Less often

- A few times a year

- One to three times a month

- Once a week

- More than once a week

12. In your opinion, how probable is it that a higher power really exists?

- Not at all

- Not very much

- Moderately

- Quite a bit

- Very much so

13. How important is it for you to be connected to a religious community?

- Not at all

- Not very much

- Moderately

- Quite a bit

- Very much so

14. How often do you pray spontaneously when inspired by daily situations?

- Never

- Less often

- A few times a year

- One to three times a month

- Once a week

- More than once a week

- Once a day

- Several times a day

15. How often do you experience situations in which you have the feeling that God or something divine is present?

- Never

- Rarely

- Occasionally

- Often

- Very often

Note: The full CRS15 is presented here. However, the CRS10 which included only the first ten of these items was used for analysis.

Scoring: Items with five response choices are scored from 1 (never) to 5 (very often), or from 1 (not at all) to 5 (very much so). Items with six response choices are scored from 1 (never) to 5 (more than once a week & once a week). Items with eight response choices are scored as 1 (never), 2 (a few times a year & less often), 3 (once a week & one to three times a month), 4 (more than once a week), and 5 (once a day & several times a day).

Appendix C. Credibility Enhancing Displays (CREDs) Scale

Instructions: The following questions ask about experiences during your upbringing that relate to religion. Specifically, the questions ask about your perceptions of your primary caregiver or caregivers (i.e., parents or guardians). Please answer each of the following according to your overall impression of your caregiver(s) on the following scale:

1	2	3	4	5	6	7
To no extent at all						To an extreme extent

1   To what extent did your caregiver(s) attend religious services or meetings?

2   To what extent did your caregiver(s) engage in religious volunteer or charity work?

3   Overall, to what extent did your caregiver(s) act as good religious role models?

4   Overall, to what extent did your caregiver(s) make personal sacrifices to religion?

5   To what extent did your caregiver(s) act fairly to others because their religion taught them so?

6   To what extent did your caregiver(s) live a religiously pure life?

7   To what extent did your caregiver(s) avoid harming others because their religion taught them so?

Scoring: Total score is the average of all items.

Publication of scale: Lanman, J., & Buhrmester, M. (2016). Religious actions speak louder than words: Exposure to credibility-enhancing displays predicts theism. *Religion, Brain & Behaviour, 7*, 1-14. doi: 10.1080/2153599X.2015.1117011.

Appendix D. Need for Closure Scale (NFC) – Ambiguity Intolerance Subscale

Instructions: Read each of the following statements and decide how much you agree with each according to your beliefs and experiences. Please respond according to the following scale:

1. Strongly disagree
2. Moderately disagree
3. Slightly disagree
4. Slightly agree
5. Moderately agree
6. Strongly agree

Questions:

1. I don't like situations that are uncertain.
2. I feel uncomfortable when I don't understand the reason why an event occurred in my life.
3. When I am confused about an important issue, I feel very upset.
4. In most social conflicts, I can easily see which side is right and which is wrong.
5. I like to know what people are thinking all the time.
6. I dislike it when a person's statement could mean many different things.
7. It's annoying to listen to someone who cannot seem to make up his or her mind.
8. I feel uncomfortable when someone's meaning or intention is unclear to me.
9. I'd rather know bad news than stay in a state of uncertainty.

Source: Kruglanski, A., Atash, M., De Grada, E., Mannetti, L., & Pierro, A. (2013). Need for closure scale (NFC). *Measurement Instrument Database for the Social Science*. Retrieved from: www.midss.ie

Appendix E. Personal Need for Structure (PNS) Scale

Instructions: Read each of the following statements and decide how much you agree with each according to your attitudes, beliefs, and experiences. It is important that you realise that there are no "right" or "wrong" answers to these questions. Please respond according to the following 6-point scale:

1. Strongly disagree
2. Moderately disagree
3. Slightly disagree
4. Slightly agree
5. Moderately agree
6. Strongly agree

1. It upsets me to go into a situation without knowing what I can expect from it.
2. I'm not bothered by things that interrupt my daily routine.
3. I enjoy having a clear and structured mode of life.
4. I like to have a place for everything and everything in its place.
5. I enjoy being spontaneous.
6. I find that a well-ordered life with regular hours makes my life tedious.
7. I don't like situation that are uncertain.
8. I hate to change my plans at the last minute.
9. I hate to be with people who are unpredictable.
10. I find that a consistent routine enables me to enjoy life more.
11. I enjoy the exhilaration of being in unpredictable situations.
12. I become uncomfortable when the rules in a situation are not clear.

Neuberg, S. & Newsom J. (1993). Personal need for structure: Individual differences in the desire for simple structure. *Journal of Personality and Social Psychology, 65*, 113-131.

Appendix F. Subjective Anxiety

Instructions: How anxious do you feel right now?

0………………………………………………………………………………………..100

Note: This was presented both pre and post. Participants used a sliding scale to indicate their level of anxiety.

Appendix G. Need for Cognition Scale – Short (NCS) Scale

Instructions: Please answer the following questions using the options provided. There are no correct or incorrect answers.

Response options:

-4: Very strongly disagree

-3: Strongly disagree

-2: Moderately disagree

-1: Slightly disagree

0: Neither agree or disagree

1: Slightly agree

2: Moderately agree

3: Strongly agree

4: Very strongly agree

Questions:

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.*
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.*
5. I try to anticipate and avoid situations where there is a likely chance that I will have to think in depth about something.*
6. I find satisfaction in deliberating hard and for long hours.
7. I only think as hard as I have to.*
8. I prefer to think about small, daily projects to long-term ones.*
9. I like tasks that require little thought once I've learned them.*
10. The idea of relying on thought to make my way to the top appeals to me.
11. I really enjoy a task that involves coming up with new solutions to problems.
12. Learning new ways to think doesn't excite me very much.*
13. I prefer my life to be filled with puzzles that I must solve.

14. The notion of thinking abstractly is appealing to me.

15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.

16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.*

17. It's enough for me that something gets the job done; I don't care how or why it works.*

18. I usually end up deliberating about issues even when they do not affect me personally.

Note: * = reverse-scored item.

Scoring: Total score is the average of all items after reverse-coding the relevant items.

Publication of scale: Cacioppo, J., Petty, R., & Kao, C. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment, 48*, 306-307. doi: 0.1207/s15327752jpa4803_13.

Appendix H. The Empathy Quotient – Short Form (EQ)

Instructions: Please answer the following questions using the response options provided. There are no right or wrong answers to these questions, and you should not overthink them too much.

Response options:

      Strongly agree

      Slightly agree

      Slightly disagree

      Strongly disagree

Questions:

1. I can easily tell if someone else wants to enter a conversation.
2. I really enjoy taking care for other people.
3. I find it hard to know what to do in a social situation.*
4. I often find it difficult to judge if something is rude or polite.*
5. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.*
6. I can pick up quickly if someone says one thing but means another.
7. It is hard for me to see why some things upset people so much.*
8. I find it easy to put myself in somebody else's shoes.
9. I am good at predicting how someone will feel.
10. I am quick to spot when someone in a group is feeling awkward or uncomfortable.
11. I can't always see why someone should have felt offended by a remark.*
12. I don't tend to find social situations confusing.
13. Other people tell me I am good at understanding how they are feeling and what they are thinking.
14. I can easily tell if someone else is interested or bored with what I am saying.
15. Friends usually talk to me about their problems as they say that I am very understanding.
16. I can sense if I am intruding, even if the other person doesn't tell me.
17. Other people can often say that I am insensitive, though I don't always see why.*

18. I can tune into how someone else feels rapidly and intuitively.

19. I can easily work out what another person might want to talk about.

20. I can tell if someone is masking their true emotion.

21. I am good at predicting what someone will do.

22. I tend to get emotionally involved with a friend's problems.

Note: * = reverse scored item.

Scoring: For normal-scored items, a response of strongly agree was scored 2, slightly agree was scored 1, and responses of slightly disagree or strongly disagree were scored 0. For reverse-scored items, a response of strongly disagree was scored 2, slightly disagree was scored 1, and responses of slightly agree or strongly agree were scored 0. Total score was obtained by summing all item scores.

Publication of scale: Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., Goldenfeld, N., Delaney, J., Fine, D., Smith, R., & Weil, L. (2006). Development of short forms of the Empathy Quotient (EQ-Short) and the Systemizing Quotient (SQ-Short). *Personality and Individual Differences, 41*, 929-940. doi: 10.1016/j.paid.2006.03.017.

Appendix I. Demographic Questions

Instructions: Please answer the following questions.

1. What is your age in years? _____

2. Which of the following choices best describe your religious views?

    a. Agnostic

    b. Atheist

    c. Buddhist

    d. Christian

    e. Hindu

    f. Jewish

    g. Muslim

    h. Other

    i. If "Other", what? _____

3. What is your gender?

    a. Male

    b. Female

    c. Other

Appendix J. Comparison of Retained and Excluded Participants

Table 7.

Comparison of Mean Scores on Predictor Variables for Retained and Excluded Participants

	Retained ($n = 88$)	Excluded ($n = 50$)	t	p	d
CRS10	-	-	-	-	-
Ideology	3.27 (1.33)	3.38 (1.31)	0.46	.649	0.083
Experience	2.31 (1.19)	2.66 (1.35)	1.60	.113	0.275
Intellect	2.94 (1.09)	2.96 (1.22)	0.08	.934	0.017
Private	2.53 (1.43)	2.54 (1.55)	0.02	.982	0.007
Public	2.44 (1.41)	2.41 (1.47)	-0.13	.896	0.021
CREDs	3.27 (1.78)	3.14 (1.86)	-0.41	.682	0.071
Age	19.10 (3.37)	19.96 (4.48)	1.25	.214	0.217
EQ	25.89 (7.16)	25.49 (8.54)	-0.26	.799	0.051
NCS	9.33 (15.70)	6.26 (20.10)	-1.00	.321	0.170
PNS	46.14 (6.82)	47.01 (8.38)	0.70	.483	0.113
NFC	39.40 (5.96)	40.36 (6.51)	0.88	.380	0.154
Anxiety *	5.45 (15.10)	15.24 (20.00)	3.01	.004	0.552
-	-	-	X^2	p	OR
Gender	62 (70.45 %)	36 (72.00 %)	0.04	.847	0.928

Note: Mean scores are shown with standard deviations in brackets. For gender, the number of females are shown. CRS10 = centrality of religiosity Scale, CREDs = Credibility enhancing displays, EQ = empathy quotient, NCS = need for cognition scale, PNS = personal need for structure, NFC = need for closure (ambiguity intolerance subscale). * Equality of variances not met, so comparison is based on df = 81.08.

Appendix K. Univariate Descriptives

The distributions for all variables were examined separately for the un-speeded and speeded conditions. For endorsement of teleological explanations, responses of "true" were coded 1 and responses of "false" were coded 0, such that higher scores represented greater endorsement. The endorsement percentage was then calculated from the number of test-items with a valid response. In the un-speeded condition, total teleological endorsement appeared to be normally distributed, $SW(54) = 0.97$, $p = .158$, as did endorsement of biological explanations, $SW(54) = 0.97$, $p = .187$. Endorsement of natural non-living explanations returned a significant Shapiro-Wilk result, $SW(54) = 0.94$, $p = .010$, suggesting a slight departure from the normality. However, examination of histograms and Q-Q plots suggested that this distribution was approximately normal. Likewise, the numerical summary in Table 8 shows that this distribution was not skewed and was mesokurtic. Examination of the distributions in the speeded condition showed that total teleological endorsement, $SW(34)$ $= 0.94$, $p = .084$, endorsement of biological explanations, $SW(34) = 0.96$, $p = .207$, and endorsement of natural non-living explanations, $SW(34) = 0.97$, $p = .373$, were all normally distributed. This was confirmed through examination of histograms and Q-Q plots, and the numerical summary provided in Table 8.

When examining the distribution of responses to control items, incorrect responses were coded 1 and correct responses were coded 0, such that higher scores represented greater inaccuracy. Responses were normally distributed in both the un-speeded, $SW(54) = 0.97$, $p = .125$, and speeded condition, $SW(34) = 0.98$, $p = .723$, and examination of the numerical summary confirmed these results.

Table 8.

Univariate Descriptive Statistics for Variables Included in Main Analyses

	Mean	Std. Dev	Skewness	Kurtosis
Un-Speeded Condition	-	-	-	-
Endorsement of Explanations	-	-	-	-
Total Teleological	44.17	19.26	0.53	-1.36
Biological Organisms	48.64	18.97	0.28	-1.15
Natural Non-Living Objects	38.58	23.75	1.15	-1.21
Incorrectly Answered Control	6.34	4.28	1.31	-0.19
Religiosity	-	-	-	-
Ideology	3.33	1.34	-1.22	-1.52
Experience	2.37	1.13	0.97	-1.35
CREDs	3.50	1.73	0.26	-2.12
Demographics	-	-	-	-
Age	19.52	4.08	15.22	45.77
Speeded Condition	-	-	-	-
Endorsement of Explanations	-	-	-	-
Total	63.11	19.19	-1.49	-0.58
Biological Organisms	66.69	21.03	-0.84	-0.59
Natural Non-Living Objects	58.29	21.24	-0.31	-1.01
Incorrectly Answered Control	9.84	4.94	-0.03	-0.73
Religiosity	-	-	-	-
Ideology	3.18	1.34	-0.55	-1.44
Experience	2.21	1.30	1.62	-1.32
CREDs	2.91	1.82	1.62	-1.11
Demographics	-	-	-	-
Age	18.44	1.56	6.78	11.43

Note: Skewness and kurtosis reported above are calculated by the statistic divided by the standard error.

In the un-speeded condition, the CRS10 Ideology subscale was non-normally distributed, $SW(54) = 0.91$, $p < .001$, as was the Experience subscale, $SW(54) = 0.91$, $p = .001$, and CREDs exposure, $SW(54) = 0.93$, $p = .004$. Although the numerical summary (Table 8) did not reveal issues with skewness or kurtosis, examination of Q-Q plots and histograms for each variable confirmed the significant Shapiro-Wilk results. The CRS10 Ideology subscale appeared slightly negatively skewed, whereas the Experience subscale and CREDs exposure were slightly positively skewed. Distributions were similarly non-normal

in the speeded condition for the CRS10 Ideology subscale, $SW(34) = 0.92$, $p = .020$, Experience subscale, $SW(34) = 0.83$, $p < .001$, and CREDs exposure, $SW(34) = 0.88$, $p = .002$. Although the Ideology subscale appeared approximately normal, the histograms for the Experience subscale and CREDs exposure were both positively skewed, despite the numerical summary suggesting otherwise (Table 8).

Finally, as would be expected in an undergraduate sample, the age of participants was strongly positively skewed and leptokurtic in both the un-speeded $SW(54) = 0.45$, $p < .001$, and speeded conditions, $SW(34) = 0.63$, $p < .001$.

Appendix L. Ethics Approval

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(Research)

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28 February 2018

Dear Associate Professor Wastell

Reference No: 5201800087

Title: *The effect of awe on endorsement of teleological explanations in religious believers and non-believers*

Thank you for submitting the above application for ethical and scientific review. Your application was considered by the Macquarie University Human Research Ethics Committee (HREC (Medical Sciences)).

I am pleased to advise that ethical and scientific approval has been granted for this project to be conducted at:

Macquarie University

This research meets the requirements set out in the *National Statement on Ethical Conduct in Human Research* (2007 – Updated May 2015) (the *National Statement*).

Standard Conditions of Approval:

1. Approval is contingent on continuing compliance with the requirements of the *National Statement,* which is available at the following website:

http://www.nhmrc.gov.au/book/national-statement-ethical-conduct-human-research

2. This approval is valid for five (5) years, subject to the submission of annual reports. Please submit your reports on the anniversary of the approval for this protocol.

3. Proposed changes to the protocol and associated documents must be submitted to the Committee for approval before implementation.

It is the responsibility of the Chief investigator to retain a copy of all documentation related to this project and to forward a copy of this approval letter to all personnel listed on the project.

Should you have any queries regarding your project, please contact the Ethics Secretariat on 9850 4194 or by email ethics.secretariat@mq.edu.au

The HREC (Medical Sciences) Terms of Reference and Standard Operating Procedures are available from the Research Office website at:

https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics

The HREC (Medical Sciences) wishes you every success in your

research. Yours sincerely

Professor Tony Eyers
Chair, Macquarie University Human Research Ethics Committee (Medical Sciences)

This HREC is constituted and operates in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research* (2007) and the *CPMP/ICH Note for Guidance on Good Clinical Practice*.