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# Supernatural belief in 'scientific' worldviews? Investigating science-oriented Finns' explanations for origins, death and suffering

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**Abstract**

A 'scientific worldview' is commonly seen as contradictory to belief in supernatural forces, and there is little research on the supernatural beliefs of individuals who identify with science. In this article, we investigate the supernatural explanations of science-oriented individuals in domains of fundamental concern (suffering, death, and origins), and how supernatural causality is reconciled with belief in science. The open-ended responses of 387 Finns were analysed. The results show that science-oriented Finns endorsed both religion-related and more secular supernatural beliefs (such as belief in evolution as a purposeful process). Following the coexistence model, science-oriented Finns applied synthetic and target-dependent reasoning. In addition, many who invoked supernatural explanations integrated supernatural causality with science. Two forms of integrated reasoning were found: 1) supernatural agency as the ultimate cause and scientific theory as the proximate cause, and 2) a similarity-based heuristic, as seen in afterlife beliefs appealing to the law of conservation of energy.

**Keywords:** science and religion, explanatory coexistence, belief in science, supernatural, causal explanation, Finland

## Introduction

> [E]very one who is seriously involved in the pursuit of science becomes convinced that a spirit is manifest in the laws of the Universe—a spirit vastly superior to that of man, and one in the face of which we with our modest powers must feel humble.
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> — Albert Einstein (Einstein & Rosenkranz, 2013, p. 10)

In this quote, the world-famous physicist Albert Einstein aimed to answer a tricky question posed to him by a sixth-grader in 1936: Do scientists pray and, if so, what do they pray for? In his response to the child, Einstein made it clear that he did not believe in the power of prayer or 'a wish addressed to a supernatural Being' (Einstein & Rosenkranz, 2013, p. 10). Instead of believing in a personal god of any religion, Einstein found it likely that there exists a superior spirit that 'reveals itself' in the laws of nature (Einstein & Rosenkranz, 2013, p. 31). Einstein is hardly the only researcher who seems inclined to believe in a design in natural phenomena. As another example, one of the 'founding fathers' of the cognitive science of religion, Justin Barrett, has promoted the (supernatural) view that the human tendency to perceive agency in nature in itself points towards an intelligent designer (Atkinson, 2020).

Belief in supernatural phenomena in science-oriented individuals is not limited to isolated cases of prominent names. In a study on biologists and physicists in eight regions of the world, Ecklund et al. (2016, p. 4) found that a significant minority (and in Turkey, the majority) of scientists believe that 'God exists, no doubts'. Similarly, in cultures where people generally believe in the soul or an afterlife, these beliefs also seem to manifest in high rates among individuals who are likely to value science (such as medical staff and students; see Martyn et al., 2014; Walker, 2000). A handful of studies have depicted how science-oriented individuals integrate different supernatural beliefs with scientific theories (Mansour, 2011), such as the evolutionary origin of species (Evans et al., 2009).[1] Yet, research on how science-oriented individuals relate their supernatural belief to scientific accounts remains scarce. One contributing factor includes the expectation that supernatural beliefs are not part of a 'scientific worldview' (Koski, 2016, p. 11). Many scientists of religion have assumed that

[1] In a study on Egyptian science teachers' views on science and religion, Mansour (2011) reported that some described God as the creator and the ultimate cause of natural laws and processes. Consonantly, in a study of people visiting US natural history museums, Evans et al. (2009) found that some science-oriented individuals endorse theistic evolution, that is, evolution designed by God (see also Poling & Evans, 2004; Pew Research Center, 2015).

allegiance to science runs counter to belief in supernatural phenomena (Hartman et al., 2017; Williams et al., 1989; Randall & Desrosiers, 1980; Farias, 2013). In contrast to these accounts, we expect that even researchers and other individuals who identify with science hold a variety of views about the world, including supernatural beliefs and diverse interpretations of scientific theories. In the present study, we investigate the possible supernatural beliefs of science-oriented Finns and how these 'coexist' with natural explanations – including scientific ones.

### *The coexistence of scientific and supernatural explanations*

Both lay and academic accounts have suggested that as individuals learn scientific knowledge, it replaces their previous explanations for phenomena, including supernatural beliefs (Harris, 2009; Shtulman & Lombrozo, 2016; see Dawkins, 2006). However, people typically hold more than one kind of explanation in their 'repertoire' and can even explain the same event in differing ways. In developmental psychology and the cognitive science of religion, this phenomenon has been called *explanatory coexistence* (Legare et al., 2012; Shtulman & Lombrozo, 2016). Although explanatory coexistence can mean the parallel use of any different 'kinds' of explanations, such as formal and informal ones (Legare & Shtulman, 2018), work in the cognitive science of religion has focused on how the same individuals invoke both supernatural and natural causes. This kind of coexistence reasoning has been reported in a line of studies conducted in a variety of cultures (Legare & Shtulman, 2018; see also Astuti & Harris, 2008; Brent et al., 1996; Busch et al., 2017; Evans et al., 2009; Gelman & Raman, 2004; Gutiérrez et al., 2020; Harris & Giménez, 2005; Jerotijević, 2015; Legare & Gelman, 2008). Certain phenomena are expected to elicit explanatory coexistence more than others. These include themes that tap into fundamental concerns, such as death and what follows (Astuti & Harris, 2008; Harris & Giménez, 2005), illness and other suffering (Haimila, 2016; Jerotijević, 2015; Legare & Gelman, 2008), and the origins of humans and life more generally (Evans et al., 2009; Poling & Evans, 2004).

According to the coexistence model, individuals rely on both supernatural and natural explanations in several ways. An individual may lean towards one or the other depending on the context or apply both simultaneously (Legare & Shtulman, 2018; see Astuti & Harris, 2008; Preston et al., 2013; Busch et al., 2017). When individuals refer to supernatural and natural causes simultaneously, it is suggested that they apply one of the following: 1) *synthetic reasoning*, where both supernatural and natural explanations are inferred in a 'loose' manner and their relationship is not specified (e.g.

explaining illness as consuming food not fit for one's body and a lack of faith in God);[2] 2) *target-dependent reasoning*, which applies supernatural and natural causes to different aspects of a phenomenon (e.g. biological death of the body and afterlife of the persona); and 3) *integrated reasoning*, whereby supernatural and natural causes are 'well-coordinated' and formulated into a single explanation (Watson-Jones et al., 2015, p. 613; Legare et al., 2012; Legare & Shtulman, 2018). In prior work, examples of integrated reasoning have inferred supernatural processes as the ultimate cause and natural ones as the proximate mechanism. A common example of integrated reasoning is belief in God as the designer of evolution (Evans et al., 2009; Haimila, 2016; Legare et al., 2012; Legare & Shtulman, 2018; Legare & Visala, 2011; Watson-Jones et al., 2015; *cf*. also Mansour, 2011; Poling & Evans, 2004).

Despite the variety of studies on the explanatory coexistence of supernatural and natural explanations (for reviews, see Legare & Shtulman, 2018; Pnevmatikos & Georgiadou, 2019), the current body of work contains some shortcomings. First, we are only aware of two studies investigating explanatory coexistence across several domains (Busch et al., 2017; Watson-Jones et al., 2015; *cf*. also Pnevmatikos & Georgiadou, 2019). Second, previous work has rarely examined *how* people integrate their supernatural belief with natural explanations (Legare & Shtulman, 2018). Generally speaking, it is expected that the integration of supernatural and natural explanations is shaped by cultural influences (Watson-Jones et al., 2015), similar to the content of supernatural beliefs more generally (Haimila, 2020; Järnefelt et al., 2018; Legare et al., 2012). Next, we will discuss the definition of 'supernatural' used in prominent works on explanatory coexistence and in this study.

### *What is 'supernatural'?*

The literature on explanatory coexistence has predominantly approached the 'supernatural' as phenomena that are 1) outside the scope of scientific enquiry or known natural laws and 2) often associated with religious or other beliefs that are culturally perceived as supernatural (Legare et al., 2012; Legare & Visala, 2011; Pnevmatikos & Georgiadou, 2019). Similar definitions have long been applied in other work on supernatural belief (see, e.g., Flanagan, 2008; Randall & Desrosiers, 1980;

[2] Another example of synthetic reasoning with respect to natural and supernatural causes might include, for example, explaining the suffering of earthquake victims as both the result of inadequate infrastructure and as nature's way of 'eliminating the weakest individuals' (Haimila, 2016, p. 19), without specifying how these explanations interact.

Watts et al., 2020).[3] However, this domain-general definition has been criticised, as it ties the content of the category 'supernatural' to 1) possibly differing views on what can be investigated with a scientific method (Lindeman & Svedholm, 2012) and to 2) what is perceived as 'supernatural' in the Western context, that is, mainly beliefs that have been traditionally conceptualised as religious, spiritual or paranormal (Haimila, 2020). A body of work indicates that some of these beliefs are also endorsed in more secular cultural contexts. For example, Bullivant et al. (2019) have reported that a majority of the population in China believes in karma, even though few Chinese individuals consider themselves religious (Haerpfer et al., 2021). In the regions of WEIRD cultures, several studies have also reported traditionally religious or spiritual beliefs among (mainly minorities of) non-religious individuals, atheists and agnostics (Banerjee & Bloom, 2014; Bullivant et al., 2019; Lindeman et al., 2019; Visuri et al., 2022; *cf.* also Pew Research Center, 2012; van Mulukom et al., 2022; Herbert & Bullock, 2020). In addition to these traditionally supernatural beliefs, we would expect that in more secular contexts, some people hold beliefs that *resemble* (supernatural) religious and spiritual views but do not apply terminology identified as such (*cf.* Banerjee & Bloom, 2014; Heywood & Bering, 2014; Järnefelt et al., 2018). For instance, the belief that we most likely live inside a simulation designed by artificial intelligence is commonly not perceived as religious, yet it bears a structural similarity to the religious belief in a reality designed by God (Haimila, 2020).

To extend the scope of the investigation to any possible beliefs that resemble traditionally supernatural beliefs in their structure yet operate with secular vocabulary, we will approach 'supernatural' with a prior definition that does not explicitly posit the supernatural in opposition with what is considered 'scientific'. More specifically, we define supernatural beliefs as ones that blend cross-culturally common core knowledge about the ontological properties of entities and processes, such as a stone (a non-living object) that knows things (a mental agent) (Lindeman & Svedholm, 2012). Defining supernatural conceptions as those that blend core knowledge draws from work in cognitive psychology (Lindeman & Aarnio, 2007; Lindeman & Svedholm, 2012) and, preceding the former, in the cognitive science of religion on religious beliefs as counterintuitive (CI; see Boyer, 1996, 2001; Pyysiäinen, 2002).[4] Although such beliefs

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[3] It should be noted that in prior work, the term 'supernatural belief' often overlaps with concepts such as belief in 'paranormal', 'extraordinary' (Drinkwater et al., 2020), 'magical' or even so-called 'superstitious' belief (Randall & Desrosiers, 1980; Stone et al., 2018). In psychology of religion, these are at times referred to as PSMS beliefs (paranormal, superstitious, magical and supernatural beliefs; see Lindeman & Aarnio, 2007; Lindeman & Svedholm, 2012; see also Herbert & Bullock, 2020). Some apply the concept of 'supernatural' belief as an umbrella term for PSMS beliefs (Schofield et al., 2018).

[4] However, Lindeman and Svedholm (2012) have noted several weaknesses in the literature on supernatural and/or religious beliefs as counterintuitive (CI). First, conceptualising supernatural

have been extensively studied from certain perspectives (e.g. the retention rates of supernatural beliefs compared to other content), fewer studies have addressed how and when people actually apply concepts that violate deep inferences about ontological categories (Purzycki & Willard, 2016), especially outside the Anglosphere (however, see Nordin & Bjälkebring, 2021; Purzycki, 2013).

### *The present research*

In the present study, we investigated whether science-oriented individuals in the Finnish context also apply supernatural explanations in their open-ended responses to domains of fundamental concern. Furthermore, we examined how these explanations are expressed and whether they are applied with scientific accounts. More precisely, we addressed the following questions:

1) Do science-oriented Finns express so-called supernatural explanations for origins, death and suffering?
2) If so, what kinds of supernatural explanations do science-oriented Finns express?
3) Are supernatural explanations integrated with science? (If so, how?)

Based on prior research, we expected that some science-oriented Finns might also apply supernatural reasoning whilst making sense of death, suffering and the origins of life. In the Nordic countries, including Finland, many perceive science and religion as conflicting (Science Barometer, 2019; Tiaynen-Qadir et al., 2021), and overall, the social surroundings of science-oriented Finns might encourage a secular vocabulary over a religious one (Haimila, 2020; Caldwell-Harris et al., 2011). Thus, we also hypothesised that the participants' supernatural accounts would mainly be secular, in the sense that they would mostly avoid expressions often associated with religiosity in

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phenomena as counterintuitive diverges from other work (including work in the cognitive science of religion) suggesting that certain forms of supernatural reasoning are intuitive, a notion that aligns with dual-process theories (e.g. Bering, 2006; Järnefelt et al., 2015). Second, it has been unclear what qualifies as counterintuitive, as studies have categorised concepts as counterintuitive using a variety of criteria. For example, a purple cow might be surprising but it does not necessarily violate cross-cultural deep inferences about animals (Lindeman & Svedholm, 2012). For similar lines of criticism in the cognitive science of religion on CI theory, see Boyer (2001); Purzycki (2013); Purzycki & Willard (2016). Thus, Lindeman and Svedholm (2012) have simply suggested to define 'paranormal, superstitious, magical and supernatural' beliefs as conceptions where distinctions between ontological categories of entities and processes (expectations that appear cross-culturally in cognitive development) are blurred, without reference to the possible (counter)intuitiveness of such beliefs.

the Finnish context and instead apply other terms, including scientific ones. To answer the research questions and address the hypotheses, we analysed science-oriented Finns' open-ended descriptions of the domains of interest using a mixed-methods approach (see also Watson-Jones et al., 2015).

## Data and methods

### *Recruitment and participants*

The first author collected the data using an online questionnaire, which was conducted on the GDPR-compliant LimeSurvey platform. The respondents were recruited via Finnish pro-research organisations. The invitation was first sent to research institutions and other research-affiliated organisations, followed by social media recruiting on Twitter, Facebook and selected discussion boards (for additional information, see Supplementary Material A). As an incentive, the respondents could participate in a raffle for an Amazon gift card (€ 60) and request a report on the results. Altogether, 683 respondents completed the questionnaire. Furthermore, 387 participants that answered the control question correctly were included in the analysis (see Supplementary Material B).[5] The participants were of multiple genders (202 women; 170 men; 15 other / I don't want to say). To protect the anonymity of the participants, age was explored using ordinal groups (18–30, 31–40, 41–50, 51–65, and over 65 years; range all groups, *Mdn* 31–40 years). The participants were highly educated (years of education $M = 19.63$, $SD = 4.59$), and half had worked in research institutions (194 participants: natural sciences, 93; humanities, 54; social sciences, 33; other, 14 participants). The participants were mainly non-religious (269 respondents), and the majority did not believe in God (268) or else felt unsure about their belief in God (66), whereas 53 stated that they believed in God (see also Haimila, 2020; Haimila & Muraja, 2021).

[5] The participants who answered all items of the control question were excluded from the sample, with the exception of some participants who stated in an open-ended comment below that they had accidentally answered the question. The instructional manipulation check resulted in a relatively high exclusion rate. One underlying factor might be the length of the questionnaire: prior to answering the structured questions (including the control question), the participants had responded to seven open-ended questions (see Procedure). Another factor possibly contributing to the exclusion rate was a technical feature of the platform, as the participants were not able to withdraw their choices from the multiple-choice question. Despite these factors, the exclusion rate is similar to that of many previous online studies (e.g. Järnefelt et al., 2018; Morren & Paas, 2020; Oppenheimer et al., 2009).

### *Procedure*

In the questionnaire, the respondents first answered open-ended questions on origins, suffering and death, followed by the Belief in Supernatural Agency and Purpose Measure, the Science-Oriented Worldview Measure (Haimila, 2020), and the Belief in Science Scale (a measure of belief in scientism; see Farias et al., 2013). In addition, the questionnaire contained an instructional manipulation check and demographic questions (see the supplementary material). In previous publications on the data, we have examined the relationship between self-reported worldview functions of science and belief in the supernatural (on structured measures, see Haimila, 2020) and supernatural and non-supernatural continuation in death beliefs (Haimila & Muraja, 2021). In the present study, we investigated the open-ended responses on suffering, death and origins. The respondents were asked seven questions pertaining to these domains (see Table 1). The questions were based on prior literature on the likely domains of the coexistence of supernatural and natural explanations and a pilot study (e.g. Legare et al., 2012; Legare & Shtulman, 2018). Concerning the domain of origins, we asked the respondents to describe their views on the origins of human consciousness, the shared ancestry of humans and chimpanzees (a question abbreviated from Evans et al., 2009), and the origins of the universe. The domain of suffering was investigated by asking the participants for their views on why 'bad things' (e.g. serious illness) happen more frequently to some people than others and why they think humans suffer.[6] The participants' possible supernatural explanations for death were explored with two questions: what do they think happens to humans after death and whether they perceive human existence as finite or infinite, and why. The questions were preceded by instructions/prompts that specified the domain of interest and encouraged the participants to reflect on different views (by stating that there might not be unanimity on the topic; e.g. 'Finns have several conceptions regarding the origins of human consciousness').

[6] The questions on suffering were based on 1) prior studies on the coexistence of supernatural and natural explanations for misfortune (and illness in particular) (see Jerotijević, 2015; Legare & Gelman, 2008); and 2) studies on the justice motive, especially on the possible tendency of humans to perceive an ultimate justice in life events (Anderson et al., 2010), which may manifest also as supernatural explanations, such as belief in karma (Raman & Winer, 2004).

Table 1: The open-ended questions investigated in this study and their instructions, presented in order of appearance.

| **Domain** | **Instructions/prompt:** | **Question:** |
|---|---|---|
| Origins | Finns have several conceptions regarding the origins of human consciousness. This question is also debated in the scientific community. | What kinds of views do you hold regarding the origins of our consciousness? (On an individual level or on a species level.) |
| | Scientists think that humans and chimpanzees shared a common ancestor as recently as 5 million years ago. | We ask you to describe how both chimpanzees and humans could arise from the same kind of ancestor. |
| Suffering | Next, we will ask you to describe your views on suffering. | Why do bad things (e.g. a serious illness) happen more to some people than others? |
| | | Why do you think there is suffering in our lives? |
| Death and thereafter | In the following questions, we will ask about your death-related views. | What do you think happens to us (humans) after death? |
| | | [An additional non-mandatory question]: Do you think the existence of an individual is temporally finite or infinite? (Could you tell us why you think this is so?) |
| Origins | Before proceeding to the science-related multiple-choice questions, we will ask you one more question on the origins of the universe.<br><br>In current [cultural] discussions, several views exist on how the universe began [to exist]. | How do you think the universe came to exist? |

For the analysis, we formulated a coding template that quantified the explanations and their terminology. More specifically, we coded whether the respondents expressed views that blend ontological core knowledge and whether the views operated with a terminology that in the Finnish context is mainly perceived as religious or spiritual (terms such as 'God' and 'reincarnation') and/or with scientific vocabulary (terms such as 'evolution') or expressions that are not commonly associated with either. Furthermore, we coded the occurrences of explanations that did not blend core knowledge, in order to track the coexistence of natural and supernatural explanations (beyond integrating supernatural reasoning with scientific terminology). Some data-

driven categories were added to capture the respondents' positions on supernatural causality in more detail. Moreover, during the coding we noticed that some respondents expressed their views more firmly, while others used hesitant wording, such as the respondent who wrote that after death 'the consciousness *may* continue' (P19). To take this into account, we coded all the main categories on a scale of 0–2, where the value '1' referred to responses that fit the criteria but applied hesitant wording and '2' for responses that did not contain hesitant wording about the view in question. In total, we conducted three rounds of coding to test and revise the template, and each of the authors analysed 10–20% of the data during this phase. The interrater reliability was good (94.9% during the third coding round). Finally, the first author coded all the responses using the established template and instructions (Campbell et al., 2013; Hruschka et al., 2004; Syed & Nelson, 2015). The categories and their definitions can be seen in Table 2. For the full coding instructions (including the criteria on what qualifies as an MCK concept), see the supplementary material.

Table 2. The coding template[7]

| Category | Code | Definition | Examples: |
|---|---|---|---|
| The main categories<br><br>Scale 0–2 | Non-MCK | The respondent expresses a view that does not mix core knowledge (that is separate from any possible MCK conceptions in the response). | 'The universe originated from the Big Bang.' (2)<br>'When a human dies, the mind flames out and the body decomposes.' (2)<br>'Suffering is due to chance and genes. I also believe in some kind of karma.' (2)<br>(Note: The last is also categorised as MCK religious or spiritual.) |
| | MCK incl. religious or spiritual terminology | A conception that mixes core knowledge contains a term that is commonly associated with religiosity or spirituality in the Finnish context. | 'One cannot help but think that in other dimensions, we might discover what we conceive of as God.' (1)<br>'Evolution is a part of God's plan.' (2)<br>'Humans have a soul.' (2)<br>'Karma can kick one hard.' (2) |
| | MCK incl. science terminology | A conception that mixes core knowledge and contains a term associated with scientific research in the Finnish context. | 'God could have created the Big Bang.' (1)<br>'The purpose of evolution is to develop humanity.' (2) |
| | MCK other | A conception that mixes core knowledge and only uses expressions that are not primarily associated with religion/spirituality or science. | 'Of course, it could be that our essence survives death in some form.' (1)<br>'Consciousness is everywhere.' (2)<br>'It comes to mind that some being could have made the universe.' (1) |
| Additional categories<br><br>Scale 0–1 | MCK conflicted | The respondent expresses experiencing conflict about a conception that mixes core knowledge. (In addition, MCK categories can be coded.) | 'The thought of an afterlife feels comforting, but I can't bring myself to believe in it.' (1)<br>'It comes to mind that some being could have created the universe. But I do not consider this likely.' (1) |
| | MCK mere rejection | A conception that mixes core knowledge merely to reject it (MCK categories are not coded). | 'At least there is no purpose to suffering. Things just happen.' (1) |
| | MCK ambiguous | It is difficult to decipher whether the conception fills the criteria of the MCK categories (or whether it is used e.g. as a metaphor). | |

[7] In addition to the categories listed here, we originally included a category for views that discussed species as an intentional individual ('MCK evolution species as an individual'). However, we decided to exclude this category since it was only relevant in the domain of origins, and such views could also be coded to other MCK categories (namely, to MCK conceptions that contain scientific terminology).

*Note.* 'MCK' refers to 'mixing core knowledge'. In the main categories, we used a scale of 0–2 (0 = does not fit the criteria, 1 = fits the criteria but applies hesitant wording, and 2 = fits the criteria). The examples listed here are from the coding instructions and were based on the pilot study data and the authors' observations while developing the template.

It should be noted that there were some limitations to the method: First, we decided to categorise some expressions as supernatural based on terminology alone *if* respondents did not specify how they perceive the concept (whether their interpretation of the term mixes core knowledge). The concepts that we decided to categorise in this manner included belief in 'God', a 'soul', 'karma' and 'the afterlife'.[8] Second, since the questions on origins, death and suffering were not formulated similarly, this might affect the findings on comparisons across domains, and this should be kept in mind when interpreting the results.[9]

## Results

### *Preliminary analysis*

Endorsement of supernatural explanations in the open-ended responses was weakly associated with some demographic variables. There was a weak negative correlation between years of education and supernatural explanations ($r_s$ = –.16, $p$ = .002), and gender was also associated with the endorsement of supernatural causality (Kruskal-Wallis $H(2)$ = 6.575, $p$ = .037).[10] Formulating supernatural explanations in one's own words in the open-ended responses was not related to age or work affiliation to research. We also examined the relationship between the extent of supernatural explanations in the open-ended responses and a structured scale on supernatural belief

[8] Although we expected that concepts such as 'God' would activate certain schematic content, people's conceptions of God might still differ (Purzycki & Willard, 2016). Hence, it is plausible that someone might have referred, for example, to belief in God in an unconventional manner, a belief that would still be classified as supernatural if the respondent did not elaborate on their view. However, it did not seem meaningful to exclude mentions of e.g. God from the supernatural explanations. Consequently, this was a trade-off we decided to accept for the purpose of analysing the open-ended data.

[9] Although use of the same wording for questions on each domain would have been demanding to implement in a meaningful manner, this notion is still important, since in the current study only the domain of suffering contained a 'why' question. Some authors have noted that people might be more prone to apply supernatural reasoning in their reflections on *why* things happen (e.g. why bad things happen) compared to *how* they happen (Bering, 2011; *cf.* also Kelemen, 2003).

[10] Those who responded 'Other/I do not want to say' formulated supernatural explanations less than other gender groups, albeit the differences between groups not being significant in pairwise post hoc tests.

(Belief in Supernatural Agency and Purpose Measure) and belief in science (Science-Oriented Worldview Measure and Belief in Science Scale, see Farias et al., 2013; Haimila, 2020). There was a strong positive relationship between expressing supernatural causality in one's own words and the score of the supernatural belief scale ($r_s = .563$, $p < .001$). Belief in science was at least somewhat negatively associated with supernatural belief in the open-ended responses (moderate relationship with the Belief in Science Scale ($r_s = -.384$, $p < .001$) and weak relationship with the Science-Oriented Worldview Measure ($r_s = -.215$, $p < .001$)).

### *Science-oriented natural and supernatural beliefs about origins, death and suffering*

In their accounts on origins, death and suffering, the science-oriented respondents mainly relied on non-supernatural (non-MCK) explanations. A non-supernatural explanation of some kind was mentioned by an overwhelming majority (98.9%), whereas approximately one in three (36.3%) invoked supernatural (MCK) causality in at least one of their responses (see Table 3). More conservatively speaking, around one in four (27.6%) referred to supernatural processes without any hesitation, for instance by stating that the universe 'was created' (P2077) instead of wondering if it 'could have been created' by God (P1572).

Table 3: Frequencies of different explanations across domains (percentage of cases)

| | Across all responses | Responses on origins | Responses on suffering | Responses on death |
|---|---|---|---|---|
| Non-MCK | 98.9 (98.7) | 96.9 (95.1) | 95.9 (95.6) | 92.9 (91.6) |
| MCK | 36.3 (27.6) | 16.0 (12.1) | 23.8 (20.4) | 21.8 (14.2) |
| MCK religious/ spiritual | 20.3 (14.5) | 10.9 (8.3) | 8.3 (7.0) | 17.9 (12.6) |
| MCK science | 13.7 (10.3) | 8.0 (6.2) | 4.1 (3.6) | 3.2 (1.8) |
| MCK other | 21.3 (16.1) | 4.4 (3.4) | 14.0 (12.1) | 6.3 (2.9) |
| MCK conflicted | 12.6 | 3.1 | 2.1 | 8.2 |

*Note*. Without clauses: percentages of respondents who applied supernatural explanations (values 1–2 on the scale 0–2). In clauses: percentages of respondents who applied assured wordings (value 2). N = 387, except in the variables with all the domains or death ($n = 380$), as seven respondents did not answer Q6, a non-mandatory death-related question.

As reliance on natural explanations was a common denominator among most respondents, very few merely applied supernatural explanations (1.1%; see Table 4). Instead, those who invoked supernatural causality also inferred natural causes, at least in some domains/part of their responses. Next, we examine the kinds of supernatural reasoning that science-oriented Finns expressed in the data and how these were related to reliance on natural causes.

### *Vocabulary of supernatural beliefs and the modes of coexistence*

Supernatural explanations were expressed in different ways. More specifically, respondents applied *traditionally religious or spiritual* explanations (20.3%), while some also formulated supernatural beliefs that applied *scientific terminology* (13.7%) or expressed supernatural causality with *(other) secular terms* (21.3%). These ways of expressing supernatural causality were not necessarily distinct, as many applied more than one of these frameworks in their responses (see Table 4). In the sections below, we first examine how the traditionally religious and 'other' explanations were applied. Following these descriptions, we discuss explanations that integrated scientific terminology with supernatural reasoning, including with traditional religious and spiritual accounts.

Table 4: Frequencies of response patterns (percentage of cases)

| | Across all responses | Responses on origins | Responses on suffering | Responses on death |
|---|---|---|---|---|
| Non-MCK only | 63.7 | 83.4 | 76.1 | 77.1 |
| MCK only | 1.1 | 2.6 | 4.2 | 6.1 |
| Non-MCK & MCK | 35.3 | 13.4 | 19.7 | 15.8 |
| Non-MCK & MCK rel. | 19.2 | 8.2 | 5.3 | 12.1 |
| Non-MCK & MCK scie. | 13.7 | 7.9 | 4.2 | 2.9 |
| Non-MCK & MCK other | 20.8 | 3.7 | 12.1 | 5.0 |
| > 1 MCK type | 15.3 | 6.6 | 2.6 | 5.3 |
| MCK scie. & rel. | 8.4 | 5.3 | 0.8 | 2.6 |
| MCK oth. & rel. | 9.7 | 1.3 | 1.3 | 2.6 |
| MCK scie. & other | 5.0 | 1.6 | 0.5 | 0.5 |
| MCK & Confl. | 7.6 | 1.3 | 1.8 | 1.6 |

*Note*. N = 380. Here, we have included all the respondents who applied supernatural and natural explanations (values 1–2 on a scale of 0–2).

### *Religious and spiritual explanations: understanding death and origins*

Respondents most often applied traditionally religious and spiritual accounts to explain death and what follows (17.9% of the respondents) and/or the domain of origins (10.9%). Some, albeit very few, merely endorsed supernatural religious causes without discussing natural explanations (see Table 3). These responses were somewhat more frequent in the domain of death – some merely discussed death and what follows with religious and/or spiritual terms, such as 'God', 'soul' or 'Heaven'. As one respondent stated, after death '[l]ife continues. Since God has created the human, the human remains' (P2705).

However, as most respondents applied *at least* natural explanations in all domains, religious explanations mainly coexisted with natural causes. Many engaged in target-dependent reasoning. This was evident especially in the domain of death, where biological explanations were applied to the *body* and supernatural (religious) ones to the *persona* (see also Legare & Shtulman, 2018). One respondent inferred supernatural continuity to the consciousness and natural decay of the body in the following manner:

> In death, our bodily functions cease to exist, and our body becomes earth's dust and ashes. Our mind, soul and consciousness exist in God's plans even before our birth. […] The existence of the soul [literally: soul-like existence], mind and consciousness after our death is infinite in time. (P1723)

Some of the religious explanations for origins also operated in a target-dependent manner. Such accounts separated matter (bodily functions) from the persona (spirit or soul), hereby attributing the origins of human consciousness to supernatural causes. These accounts were often accompanied by the notion that scientific explanations are insufficient when it comes to making sense of conscious experience. As one respondent wrote:

> With biological explanations, there's the problem that they do not explain the origins of experience in any satisfactory way, the Chinese room. […] Biology can explain functions but not experience/consciousness. The spiritual account provides a more satisfactory explanation for consciousness arising. […] My own beliefs: […] consciousness (depending on the definition), to the extent that a computer programme could be conscious, arises physically and biologically. The

> experience arises in a divine manner [*ylimaallisesti*]. I like to think that we live in a simulation that was created for some purpose. (P1624)[11]

In line with prior findings, some respondents hesitated to apply an evolutionary theory of origins to human consciousness (Elsdon-Baker et al., 2017) due to the perceived uniqueness of humans, or the human soul (see also Blancke et al., 2012). Thus, although the respondents generally believed in the theory of evolution, some also specified that as human beings are a unique creation of God, 'the core of humanity, the soul, was formed by some supernatural means' (P105).

In addition to the target-dependent accounts, respondents also integrated religious views with scientific content, especially in the domain of origins (see Table 4). They did so by discussing 'God' or a 'higher power' as the ultimate explanation for origins and the natural process serving as the proximate cause (see also Evans et al., 2009). Thus, the integrated accounts applied the same natural explanations as most other respondents (i.e. the Big Bang for the origin of the universe and evolution for the origin of humans), but such accounts posited God or a higher power as the underlying catalyst, or, at minimum, as an influence that resulted in reality in its present form. For instance, when asked how humans and chimpanzees can have a common ancestry, one respondent replied: 'because both species have diverged into their own [species]. Due to natural selection, but also through divine intervention' (P2128).[12]

In addition to the domains of death and origins, some respondents applied religious or spiritual explanations to make sense of suffering. In this domain, respondents less frequently mentioned 'God', but also discussed the effects of 'karma' as the cause of misfortune. They mainly referred to the concept of karma in longer discussions or lists of causes, often mentioning it last.[13] The respondents usually did not specify how karma was related to the other, natural causes, and thus engaged in synthetic reasoning. Some even mentioned that it would be very difficult to explain the underlying mechanism of karma or how it functions in relation to other (natural)

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[11] Similar lines of reasoning were also present in the respondents' conflicted accounts. As one respondent wrote: 'Rationally, I believe that consciousness has evolutionary origins that have led to the development of the brain. Consciousness, thus, is formed in a fully materialistic manner, as a result of the brain's functions. Still, instinctually, I am prone to think that humans have some kind of soul that is distinct from the body, and that it contains an understanding of the individual self – and in that way, probably of consciousness. Even if it would be possible to replicate a human with such accuracy that we could rebuild all the connections and the memories in the brain, it still would not be me […]' (P676).

[12] Others did not integrate evolution and religious design to the same extent but still supposed that evolution at least 'partly' operates 'under the guidance of a higher power' (P252).

[13] One respondent explained why some people suffer more than others as follows: 'Chance. Genetics. Karma. The baggage of the previous generations and of prior lives' (P2005).

causes. For instance, one participant discussed why some people suffer more than others in the following manner:

> At the individual level, for instance, due to chance, attitude and an attentive bias, […] a person who has baby fever will see strollers and kids everywhere, a banker sees expectations of profit and opportunities to invest, and a pessimist waiting for disasters will find them […]. Additionally, on a more general level, I also believe in the effect of things such as soul paths and karma, but this text and the respondent's skills are not sufficient to analyse them. (P1254)

The presence of a belief in karma is interesting, as it indicates that some science-oriented Finns also apply moral explanations for suffering – and, more particularly, ones that entail supernatural punishment as ultimate justice (Maes, 1998; Bullivant et al., 2019; *cf*. Jerotijević, 2015). However, the participants more frequently explained suffering with reference to other supernatural accounts – ones that did not entail traditionally religious or spiritual terminology.

### *'Other' explanations: an emphasis on folk accounts of suffering*

Many supernatural explanations that did not contain traditionally religious terminology still relied on similar lines of reasoning as those described in the previous section. For instance, while discussing the shared ancestry of humans and chimpanzees, some referred to a more general 'designer' instead of God (P2705; P2173). However, supernatural causality that did not refer to religious content was mainly applied to make sense of *suffering*. In these accounts, supernatural reasoning did not necessarily entail (direct) agency or design but rather an inherent purpose or underlying mechanism of balance. For the most part, the perceived purpose of suffering was to enable or increase humans' appreciation of that which is good. As one respondent wrote, suffering exists '[t]o make us value life during better times […]' (P2559). In these accounts, respondents viewed suffering as beneficial, or at least necessary, as it enables *non-suffering* or happiness and 'balances the entirety' (P2069).[14]

[14] As another respondent wrote: 'Suffering is associated with the circulation of life. For example, illnesses decrease the amount [of humans] and help maintain a balance in the world. Suffering is also a part of life and its qualia; to attain something good there must be another side. […]' (P998). Another respondent also explained suffering by it reducing 'overpopulation', as '[…] there are way too many of us. The purpose of life is not pleasure but the logical order of things, and I gather that the human population is not meant to be this high […]' (P201).

Supernatural accounts with less specific ('other') terminology also coexisted with natural explanations. Respondents mainly engaged in target-dependent reasoning, in which supernatural and natural explanations were applied to different kinds of suffering. For instance, some described one's own suffering as purposeful but preferred to explain the afflictions of others by referring to natural, such as societal, causes. As an example, one respondent wrote that '[t]o some extent the purpose of suffering is to teach us something about ourselves. On the larger scale, like in the case of famine, pandemics, slavery, etc., suffering is often caused by the unequal and inhumane world order' (P2614).

Overall, what these 'other' supernatural explanations of suffering have in common is that, through a perceived purpose, they engage in *benefit-finding* (see also Banerjee & Bloom, 2014). It should be noted that respondents also applied somewhat similar lines of reasoning to natural explanations for suffering (for example, misfortune can enable personal growth). However, the difference between the natural and the supernatural explanations (from our perspective) was that the latter expressed a perceived benefit and/or purpose as the *cause* of suffering, and hence engaged in (supernatural) teleo-functional reasoning (Kelemen, 2003; see also Heywood & Bering, 2014).

In addition to the aforementioned 'other' explanations, some also discussed whether the purpose of suffering might be its benefit as a warning signal. As one respondent wrote:

> Essentially, suffering is nature's way to get humans or another animal to avoid things that are dangerous and decrease their odds to reproduce. The purpose of it [suffering] is hence to advance survival. (P2635)

Although this response (and other similar responses) did not explicitly mention the biological nature of this function, a similar line of reasoning was evident in responses that integrated scientific theories, such as the theory of evolution, with supernatural agency and purpose. Next, we describe the integrated reasoning of the science-oriented respondents.

### *Integrating science and the supernatural*

Science-oriented Finns mainly integrated supernatural belief with scientific theories in the domain of origins. As mentioned above, they often did so by referring to supernatural agency or design as the ultimate cause, while applying scientific knowledge to describe the proximate (physical/biological) mechanism. In the case of the origin of the universe, some deemed supernatural causality to be necessary, since

'the universe cannot come out of nothing, but it has to have a creator' (P1404). Some further specified why they perceive creation or design as a necessary element for the origins of the universe:

> [...] even the Big Bang requires the influence of something greater, [something] more planned. Thus, behind the world's beginning there must be an intelligent designer, who has seen all the colours, the beauty, the diversity and the combinations of basic chemical elements. I cannot comprehend how everything could be mere coincidence. (P1723)

In other words, many struggled to grasp how the perceived order of the universe could have been formed by chance or how the universe could have emerged 'out of nothing' – a somewhat frequent interpretation of the Big Bang theory among the respondents who integrated scientific origins with religious belief.[15] Still, integrated reasoning did not necessarily entail religious agency. Instead, some added agency, design or purpose to natural processes with *mere* scientific terms. Such accounts mainly perceived some part of the evolutionary process as goal-directed. One form of reasoning involved describing individual-like intentionality in species. For example, one respondent posited that consciousness might also exist at the species level, as 'species aim to prosper (i.e. reproduce and develop) in competition over lebensraum, but also in collaboration with other species, for the ecosystem to thrive' (P648).[16]

However, the respondents also applied integrated reasoning in other ways. Another means of integrating a supernatural explanation with a scientific one was to indicate *similarity* between a scientific theory and supernatural account. More specifically, some science-oriented Finns applied this kind of reasoning to vindicate the continuity of the soul or (some aspects of) consciousness after death. In practice, they did so by referring to thermodynamics – and, more precisely, the law of conservation of energy. For example, one respondent stated a belief in

> [...] some kind of reincarnation or 'realignment', since it's the only theory that sustains all existence but still follows the laws of entropy. Particles disintegrate and realign into different (possibly smaller, more chaotic, etc.) entities. Our consciousness is electromagnetic energy. According to the first law of thermodynamics, all energy remains, it cannot disappear but only changes its form. (P356)

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[15] It should be mentioned that the same experience (how something can come out of 'nothing') also puzzled many of those who merely relied on natural causes to explain origins.

[16] In addition to this Gaia-like belief in balance/flourishing in the ecosystem as the purpose of evolution, some mentioned that evolution aims to fill all the ecological niches or 'possibilities in nature' (P2152) or seeks to 'try' different combinations and mutations 'to preserve life' (P2171).

In a somewhat similar manner, some referred to quantum mechanics (and the possible future knowledge that it might eventually produce) to justify their beliefs or more hesitant supernatural reasoning about death and what follows.[17]

### *Are there secular forms of supernatural reasoning (among science-oriented Finns)?*

To further investigate whether the supernatural explanations expressed using different kinds of terminology could be conceptualised as religious or secular, we examined whether supernatural accounts in the open-ended responses (operationalised as blending core knowledge) were related to religious belief (operationalised as God belief). For the analysis, we calculated a supernatural belief score for each participant across all domains,[18] for each domain and for each term category. Furthermore, as we were interested in the coexistence of supernatural and non-supernatural explanations, we also formulated similar sum variables for the category of non-supernatural causes.

According to our analysis, supernatural belief and religious belief were positively associated with large effect size (Kruskal-Wallis $H(2) = 125.71$, $p = .000$, $\eta 2 = .32$). The mean ranks indicated that theists (320.95) scored higher in supernatural reasoning than the undecided (219.47) and atheists (162.62). The relationship between God belief and supernatural reasoning was by far the strongest in the domain of death ($H(2) = 185.20$, $p = .000$, $\eta 2 = .49$). However, belief in God was also positively associated with a supernatural explanations with a fairly large effect size in the domain of origins ($H(2) = 118.76$, $p = .000$, $\eta 2 = .30$) and in the domain of suffering ($H(2) = 73.49$, $p = .000$, $\eta 2 = .19$).

Moreover, there was a positive relationship between belief in God and supernatural explanations *regardless* of the terminology that was applied. Somewhat unexpectedly, operating with religious vocabulary was associated with belief in God with a very large effect size ($H(2) = 173.96$, $p = .000$, $\eta 2 = .46$). However, God belief was also positively associated with supernatural explanations operating within a science-related terminology ($H(2) = 31.66$, $p = .000$, $\eta 2 = .08$) or other terminology: ($H(2) = 27.14$, $p = .000$, $\eta 2 = .07$), albeit with a considerably smaller (medium to small)

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[17] One respondent described their thoughts on what happens after death as follows: 'I do not know. When our body dies, our brains flame out and our consciousness with it. On the other hand, I'm thinking that in a similar way as physical things are only interactions in quantum fields (or how did it go), so too could consciousness also survive after all, somewhere deeper, or merge into a larger consciousness' (P1313).

[18] Sum of the supernatural belief score on a scale of 0–14 (on a scale of 0–2 for each question).

effect size. Furthermore, there was a strong negative relationship between God belief and the extent to which the respondent relied on non-supernatural causes ($H(2) = 94.64$, $p = .000$, $\eta 2 = .25$).

## Discussion

### *An overview of the findings*

Overall, most science-oriented Finns relied on natural causes in their reflections on human origins, suffering and death (see also Gelman & Raman, 2004; *cf.* Watson-Jones et al., 2015). However, a minority (approximately one in three) also inferred supernatural causation in their reflections on domains of fundamental concern, when 'supernatural' was operationalised as violations of cross-cultural expectations regarding the ontological properties of entities (Lindeman & Svedholm, 2012). Supernatural explanations were expressed in several ways. The respondents applied traditional religious or spiritual explanations (e.g. by referring to 'God' or 'karma'), but they also engaged in supernatural reasoning that operated with more secular language (e.g. suffering as a lesson). The studied domains differed in the kinds of supernatural explanations that they elicited. Supernatural explanations for death and what follows mainly relied on a religious framework (see also Pnevmatikos & Georgiadou, 2019), and they often evoked target-dependent reasoning, such as biological explanations for the body and supernatural causation for the persona (Legare & Shtulman, 2018; see Harris & Giménez, 2005). On the other hand, supernatural causes for suffering for the most part did not elicit religious explanations but instead evoked other kinds of teleo-functional reasoning. The participants most frequently integrated supernatural causality with science in their reflections on origins, moulding scientific content into science-oriented supernatural explanations (such as belief in God as the cause of the Big Bang; *cf.* also Hefner, 1997).

Contrary to our expectations, science-oriented Finns did not mainly rely on a secular supernatural. Instead, religious and other 'traditional' supernatural explanations were used somewhat equally frequently. Supernatural reasoning was intertwined with religiosity regardless of the cultural backdrop of the terms applied. In other words, the supernatural explanations that referred to science-related or other secular vocabulary were (to some extent) also associated with religious belief. Moreover, of those who at some point inferred supernatural causality in their responses, the majority at least invoked traditionally religious explanations. The results may refer to one of two possibilities: either supernatural reasoning is more likely among those who also hold other supernatural beliefs, or non-religious science-

oriented individuals are attuned to recognise reasoning that might be considered supernatural (*cf*. Pyysiäinen et al., 2003) and, as this might conflict with their identities, suppress supernatural lines of reasoning in their reflected responses. In either case, our findings provide some support for the suggestion that individuals who endorse one kind of supernatural belief (e.g. belief in God) are more likely to also hold other supernatural beliefs (e.g. purpose in evolution) (Lindeman et al., 2015; Orenstein, 2002; Svedholm et al., 2010; *cf*. also Pennycook et al., 2012; Wilson, 2018). However, it should be added that the effect sizes show that non-believers (in God) also engaged in supernatural reasoning, especially in their views on why there is suffering. The findings could indicate that science-oriented non-believers have less of a need to invoke supernatural explanations for death and origins compared to human suffering (on non-religious sense-making strategies for death, see Haimila & Muraja, 2021). Still, the results could also relate to the way in which the questions were formulated – something that we will address in the limitations of this study.

One interesting detail in our results concerns *how* respondents integrated supernatural reasoning with science. The responses of science-oriented Finns mainly integrated science with supernatural belief by referring to the supernatural as the ultimate cause and natural causality as the proximate cause – for instance, by referring to God as the designer of evolutionary origins. This causal strategy has also been noted in prior work on explanatory coexistence (Evans et al., 2009; Legare et al., 2012; Legare & Shtulman, 2018; Watson-Jones et al., 2015). However, some respondents integrated supernatural explanations with science by relying on *similarity-based* reasoning, that is, by noting features they deem similar in scientific and supernatural content (on the similarity heuristic, see Goulding & Friedman, 2021; *cf*. also Hammer & Lewis, 2010). In practice, those participants detailed how the law of conservation of energy might entail continuity of the soul, as 'energy' does not disappear in either perspective. Hence, there appeared to be two distinct strategies for integrating science and supernatural accounts: 1) integration by locating supernatural and natural causes to distinct (proximate and ultimate) levels of causation and 2) similarity-based integration.

### *Limitations and future directions*

There were some limitations in our methodology that should be noted, some of which can inform future research. For one, the questions on origins, death and suffering were not formulated similarly, and this might interfere with the comparisons of supernatural explanations across domains (see also Watson-Jones et al., 2015). Although the use of the same wording for questions pertaining to each domain would

have been demanding to implement in a meaningful manner, this notion is important since in the current study only the domain of suffering contained a 'why' question, which some have suggested might function as a catalyst for supernatural belief (see Bering, 2011).[19] Thus, future studies could refine the research design by balancing the 'why' questions across domains, if the domains are to be compared.

On a further note, we wish to remark that it was at times challenging to differentiate between the 'types' of explanatory coexistence (Watson-Jones et al., 2015, p. 617) and, more specifically, instances that could be perceived as target-dependent and/or integrated reasoning. Previously, some have suggested that target-dependent reasoning equals inferring natural and supernatural causes to distinct aspects of a phenomenon (Watson-Jones et al., 2015), while others have stated that an explanation does not constitute target-dependent reasoning unless it is also specified 'how the two forms of explanation fit together'. Thus, for instance, Legare et al. (2012, p. 783) and Legare and Shtulman (2018, p. 18) do not qualify 'biological decay and spiritual metamorphosis' as a target-dependent explanation of what happens after death. In our analysis, we decided to follow the operationalisation by Watson-Jones et al. (2015). Thus, we referred to the decay of the body and the continuity of the spirit as target-dependent reasoning, even if the interaction of these phenomena was not explicitly specified. In fact, if the interaction *was* further specified, the response might qualify as 'well-coordinated' – a criterion for integrated reasoning used by Watson-Jones et al. (2015, p. 613). To ease the difference between these 'three different ways' of explanatory coexistence, we hope that future work would further discuss and specify the characteristics of target-dependent and integrated reasoning (if they are to be applied as concepts in future research, as in the present study and some prior ones; see Watson-Jones et al., 2015; see also Haimila, 2016; Legare & Visala, 2011, p. 171).[20] This would enable consistent application of the concepts across studies and, accordingly, more meaningful comparisons of findings.

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[19] However, it should be noted that 1) to our knowledge, this claim still needs to be investigated, and 2) although the 'why' questions might evoke a reliance on supernatural causality more easily than the 'how' questions, we would suspect that people are more prone to ask 'why' within certain domains, such as suffering (Bering, 2011) and other events perceived as high impact (Heywood & Bering, 2014).

[20] While scholars have not suggested that the different types of coexistence (synthetic, target-dependent and integrated reasoning) are mutually exclusive lines of reasoning, it should be explicitly noted that in our data, some simultaneously applied target-dependent and integrated reasoning. For instance, the belief that there is supernatural design in the evolution of humans, in particular when it comes to the emergence of human consciousness, can be seen as both an integrated account (supernatural design in evolution) and target-dependent reasoning (supernatural design in human consciousness in particular, similar to other target-dependent accounts that differentiate between the mind and the body; see Legare & Shtulman, 2018).

Lastly, as the definition and operationalisation of the supernatural in our study are conceptually close to the idea of supernatural beliefs as minimally counterintuitive (MCI), we wish to note that some of the criticism directed at the MCI literature also applies to the present study. More specifically, Purzycki and Willard (2016) have suggested that anthropomorphism (e.g. adding human-like intentionality to non-intentional entities, such as plants) comes so easily to humans that it might not be meaningful to regard it as a violation of deep inferences, that is, it might not be 'supernatural' according to our definition either (contra Lindeman & Svedholm, 2012). Moreover, the same could be argued for some other ways of reasoning traditionally associated with supernatural belief that have been operationalised as supernatural by Lindeman and Svedholm (2012) and the present study. For example, cross-cultural findings suggest that humans may be prone to perceive design in nature (Järnefelt et al., 2015, 2018). It seems relevant, then, to ask what actually constitutes a violation of core knowledge and whether belief in design in nature qualifies as such a 'violation'. Should investigations of supernatural reasoning exclude, for instance, anthropomorphic beliefs and belief in design in nature? On a further note, scientific content can also run counter to intuitive expectations (Evans et al., 2009; McCauley, 2011; Shtulman, 2015; Spelke & Kinzler, 2007). A field that offers ample examples is quantum mechanics. For instance, findings on the 'superpositions' of particles have often been popularised with the notion that particles can be in two places at once (this is done even by scientists; see Hossenfelder, 2022). This (popularised) scientific account not only aligns with some supernatural beliefs but also fits the criteria of supernatural reasoning, since people generally expect physical objects to exist in a singular location (Boyer, 2001).[21] Intriguingly, a strict application of supernatural as core knowledge violations might then lead to a concept of 'supernatural' that excludes some traditionally supernatural beliefs (such as design in nature) and includes certain accounts that align with science. It might be tempting to disregard such a concept as non-functional – what use could we have for this kind of definition of 'supernatural'?[22] We would argue, at the least, that the aforementioned remarks on 'supernatural' indicate directions for future research. First, *if* supernatural beliefs are operationalised as in the present study (see also Lindeman et al., 2012), it should be acknowledged that the conception of supernatural likely comprises two kinds of beliefs: ones that are attention-grabbing and violate core knowledge (e.g. a person walking through a wall of concrete) and ones that are more likely to be expected and may not violate core knowledge (e.g. design in the symmetry of a snowflake; see Järnefelt, 2013). Second,

[21] Another example of scientific content derived from quantum mechanics that violates deep inferences is the many-worlds theory (Crease, 2019).
[22] We wish to thank Dr Aku Visala for challenging us with this thought-provoking question.

the overlap with scientific knowledge and inference violations can indicate that certain scientific accounts might more likely elicit integrated reasoning than others, due to the 'strange' content of the scientific findings (at least how they are currently popularised by some scientists).[23] In other words, we would argue that the overlap between the concept of 'supernatural' and some scientific accounts might inform research on how people reason about science and should thus not be overlooked. This overlap could provide future approaches to further understand, for instance, the appeal of quantum physics in religious and non-religious spirituality (see Lewis, 2007).

## Conclusion

In psychology of religion, some have deemed it unlikely that individuals who believe in science would endorse supernatural beliefs (see, e.g. Farias, 2013; Randall & Desrosiers, 1980). The present research found that in a Nordic sample of Finns, a minority of science-oriented individuals also believed in supernatural phenomena. Many who believed in the supernatural integrated their belief with scientific theories. The most common strategy of integration was to describe supernatural agency as an ultimate cause and scientific mechanisms as the proximate cause. However, some also integrated scientific and supernatural explanations by referring to their perceived similarity. The results bolster the suggestion that supernatural and natural explanations coexist across cultural settings (Legare et al., 2012; Legare & Shtulman, 2018). Furthermore, the findings provide new insight into how people integrate their belief in the supernatural and science (Legare & Shtulman, 2018) and add to the body of work on how supernatural explanations, when operationalised as so-called 'inference violations', are applied (Purzycki & Willard, 2016, p. 235). In the limitations, we noted some unresolved questions about what exactly qualifies as a violation of ontological core knowledge and, therefore, a supernatural or so-called PSMS belief. As 'supernatural' beliefs have also been approached as PSMS beliefs in other recent studies (e.g. Herbert & Bullock, 2020; Lindeman et al., 2019), future work could further clarify the concept of ontological core knowledge and its violations, in order to

[23] However, it is important to note that even if any scientific account fit the criteria of 'supernatural' as inference violations, it does not follow that the account would be *unscientific* – or that supernatural reasoning would generally be aligned with science. When 'supernatural' is defined from a cognitive perspective, and thus detached from what is currently in accord with science, the concept of 'supernatural' merely becomes a tool to extract how people reason about different entities and processes. In other words, it is not applicable to discussions about what lies beyond the domain of naturalistic enquiry but instead helps to reveal how people reason about phenomena.

decipher the extent to which beliefs conceptualised as 'supernatural' actually fit their definition.

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