

The cognitive basis of paranormal, superstitious,
magical, and supernatural beliefs: The roles of core
knowledge, intuitive and reflective thinking, and
cognitive inhibition

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Abstract

This series of studies addresses the question of why some people believe in phenomena such as horoscopes, telepathy, and omens, while others find them utterly unbelievable. The cognitive factors that explain belief in paranormal, superstitious, magical, and supernatural (PSMS) phenomena have been studied from a variety of perspectives, but consistent support for the theories and a deeper understanding of the nature of these beliefs have been missing. The present thesis argues that groundbreaking findings are unlikely as long as explanations are sought in domain-general cognitive deficits or in other domain-general factors.

In the present thesis, a review of definitions and assessment methods of PSMS beliefs found that these beliefs can best be encompassed and distinguished from other unfounded beliefs by defining them as core knowledge confusions in which the basic attributes of mental phenomena, material objects, living, and animate organisms, and the processes these engage in, are applied outside their proper domains. Four empirical studies tested predictions derived from this definition and from dual-process theories of thinking. In support of the predictions, accepting core knowledge confusion statements was related to both traditional PSMS beliefs, such as beliefs in extra-sensory perception and witches, as well as to PSMS beliefs that are not typically included in assessments, such as the belief that random events occur for a purpose. Ontologically confused conceptions of energy were discovered to be present even in upper secondary school students and they were found seemingly resistant to an instructional intervention.

In line with the notion that the basis of PSMS beliefs lies in biases in intuitive processing, the beliefs and core knowledge confusions were more common among those people who had an intuitive thinking style, and asking people to respond quickly increased their acceptance of the confusions. Given that theoretical arguments and previous findings indicate that analytical thinking restrains intuitive biases, it is surprising that previous studies have shown inconsistent findings regarding the relation of an analytical thinking style to PSMS beliefs. The present studies showed that such a relationship can indeed be found if the style is conceptualized as a striving for reflective thinking and measured accordingly. Finally, behavioral and brain imaging evidence converged to indicate that skepticism was related to stronger cognitive inhibition. By

focusing on the interplay of intuitive and reflective processes and cognitive inhibition, the present approach makes it possible to better understand individual differences in the beliefs.

Tiivistelmä

Tässä tutkimussarjassa tutkittiin, miksi jotkut ihmiset uskovat esimerkiksi astrologiaan, henkiin ja enteisiin toisten pitäessä niitä täysin epäuskottavina. Paranormaaleja, taikauskoisia, maagisia ja yliluonnollisia (PTMY-) uskomuksia selittäviä ajatteluun liittyviä tekijöitä on tutkittu useasta näkökulmasta, mutta näitä uskomuksia koskevia teorioita ei ole kyetty todentamaan, eikä uskomusten syvempää olemusta ole kyetty selittämään. Väitöskirjassa ehdotetaan, ettei läpimurto ole todennäköinen niin kauan kuin selityksiä etsitään aihepiiristä riippumattomista ajattelun heikkouksista tai muista yleisistä tekijöistä.

Ensimmäinen osatyö on katsaus PTMY-uskomusten määritelmiin ja arviointimenetelmiin. Katsauksen perusteella kaikki nämä uskomukset pystytään parhaiten kattamaan ja samalla erottamaan muista heikosti perustelluista uskomuksista määrittelemällä ne sekaannuksiksi, joissa psyykkisten ilmiöiden, aineellisten kappaleiden, elollisten ja ajattelevien olentojen sekä näitä koskevien prosessien ydinominaisuudet ulotetaan asianmukaisten kategorioidensa ulkopuolelle. Tästä määritelmästä sekä tiedon kaksoisprosessointiteorioista johdettuja hypoteeseja testattiin neljässä empiirisessä osatutkimuksessa. Tulosten mukaan sekaannusta sisältävien ydintietoväittämien hyväksyminen oli yhteydessä sekä perinteisiin paranormaaleihin uskomuksiin (kuten telepatiaan ja noitiin) että sellaisiin PTMY-uskomuksiin, jotka eivät yleensä ole sisältyneet uskomusten arviointimenetelmiin (kuten uskoon satunnaisten tapahtumien tarkoituksellisuudesta). Energiaan liittyviä ydintiedon sekaannuksia tutkittiin myös lukiolaisilla. Vaikutti siltä, ettei sekaannuksiin ole helppoa vaikuttaa opetuksen keinoin.

PTMY-uskomukset ja ydintiedon sekaannukset olivat yleisempiä niillä, joilla on intuitiivisempi ajattelutyyli. Myös vastausajan rajoittaminen lisäsi ydintietoväittämien hyväksymistä. Tulokset tukevat ajatusta, että uskomukset kumpuavat intuitiivisen ajattelun vinoumista. Koska sekä teoria että aiempi tutkimus puoltavat käsitystä, että analyyttinen ajattelu hillitsee intuitiivisia vinoumia, on yllättävää, ettei analyyttinen ajattelutyyli ole aiemmissä tutkimuksissa ollut johdonmukaisesti yhteydessä PTMY-uskomuksiin. Väitöskirjassa osoitettiin, että yhteys löytyy, jos analyyttinen tyyli käsitteellistetään pyrkimykseksi reflektiiviseen ajatteluun, ja jos sen arvioimiseen

käytetään asianmukaisia menetelmiä. Viimeinen löydös oli että sekä neuropsykologinen testi että aivokuvantamistulokset tukivat olettamusta skeptisyyden lisääntymisestä vahvan kognitiivisen inhibition myötä. Tällainen lähestymistapa, jossa tutkitaan intuitiivisten ja reflektiivisten prosessien sekä kognitiivisen inhibition välisiä suhteita, antaa aiempaa paremmat lähtökohdat ymmärtää yksilöllisiä eroja PTMY-uskomuksissa.

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Helsinki, February 2013 Annika Svedholm

List of original publications

This thesis is based on the following publications, referred to in the text by their roman numerals.

- I Lindeman, M., & Svedholm, A. M. (2012). What's in a term? Paranormal, superstitious, magical, and supernatural beliefs by any other name would mean the same. *Review of General Psychology, 16*, 241–255. doi: 10.1037/a0027158
- II Svedholm, A. M., Lindeman, M., & Lipsanen, J. (2010). Believing in the purpose of events – why does it occur, and is it supernatural? *Applied Cognitive Psychology, 24*, 252–265. doi: 10.1002/acp.1560
- III Svedholm, A. M., & Lindeman, M. (2012). Healing, mental energy in the physics classroom: Energy conceptions and trust in complementary and alternative medicine in grade 10–12 students. *Science & Education*. Advance online publication. doi: 10.1007/s11191-012-9529-6
- IV Svedholm, A. M., & Lindeman, M. (2012). The separate roles of the reflective mind and involuntary inhibitory control in gatekeeping paranormal beliefs and the underlying intuitive confusions. *British Journal of Psychology*. Advance online publication. doi: 10.1111/j.2044-8295.2012.02118.x
- V Lindeman, M., Svedholm, A. M., Riekkki, T., Rajj, T., & Hari, R. (2012). Is it just a brick wall or a sign from the universe? An fMRI study of supernatural believers and skeptics. *Social Cognitive and Affective Neuroscience*. Advance online publication. doi: 10.1093/scan/nss096

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Paper I: American Psychological Association (www.apa.org)

Papers II and IV: John Wiley and Sons (www.wiley.com)

Paper III: Springer (www.springer.com)

Paper V: Oxford University Press (www.oup.com)

Abbreviations

α	Cronbach's alfa (measure of internal consistency of a scale)
AET	Argument Evaluation Test
AGFI	Adjusted Goodness of Fit Index
ANOVA	Analysis of variance
AOT	Actively Open-Minded Thinking
β	Beta, regression coefficient
BA	Brodmann's area
χ^2	Chi squared (goodness-of-fit test statistic)
CAM	Complementary and alternative medicine
CFI	Comparative Fit Index
CSR	Cognitive Science of Religion
<i>df</i>	Degrees of freedom
η^2	Eta squared (estimate of effect size)
η_p^2	Partial eta squared (estimate of effect size)
ESP	Extra-sensory perception
<i>F</i>	ANOVA test statistic
FI	Faith in Intuition
fMRI	Functional Magnetic Resonance Imaging
GFI	Goodness of Fit Index
IFG	Inferior frontal gyrus
<i>M</i>	Sample mean
MNI	Montreal Neurological Institute
N	Number of participants
NFC	Need for Cognition
<i>p</i>	Probability of test statistic assuming null hypothesis is true
PSMS	Paranormal, superstitious, magical, and supernatural
<i>r</i>	Pearson's product-moment correlation coefficient
R^2	Proportion of variance explained
RMSEA	Root Mean Square Error of Approximation
RPBS	Revised Paranormal Beliefs Scale

ROI	Region of interest
SEM	Structural equation modeling
<i>SD</i>	Standard deviation
<i>t</i>	t-test statistic
FWE	Family-wise error

1. Introduction

Paranormal, superstitious, magical, and supernatural beliefs are psychologically puzzling phenomena. Most people read their horoscopes, but nevertheless feel the need to excuse themselves by mentioning that they do not really believe in them. Many seek alternative treatments outside of medicine for their illnesses, even though the concepts underlying these treatments, such as healing energy, are entirely foreign to science. Some people are even ready to believe that their deceased loved ones are sending them messages from the other side through a medium. Indeed, surveys on paranormal, superstitious, magical, and supernatural beliefs consistently indicate that a substantial part of the population holds these beliefs. For example, a recent Eurobarometer poll found that 37% of Europeans believe in lucky numbers (European Commission, 2010).

For psychological researchers, these beliefs have presented a conundrum for two main reasons. First, the field has not established consensus on a definition of what constitutes a belief that is paranormal, superstitious, magical, or supernatural (for short: PSMS belief). For instance, is the belief in communication through a medium a paranormal belief or a magical belief? What is the difference? What about a belief in UFOs and aliens? No clear criteria for addressing these questions have been presented in the research literature, and thus the proposed explanations have been fragmentary.

Second, despite decades of research on the determinants of belief, few clear and replicable patterns have emerged in the results. Research has focused on factors such as demographics, education, general and specific cognitive abilities, personality, needs, and values (reviews: Irwin, 2009; Vyse, 1997). Nonetheless, many of the findings have been inconsistent. For example, analytical thinking has been found to be positively related, negatively related, or unrelated to PSMS beliefs (references in Paper IV).

In the last years, advances in developmental psychology and dual-process theories of cognition have inspired a new approach to studying these beliefs. In this approach, the explanation for PSMS beliefs is sought in the conceptual contents of the beliefs themselves. With this, the perspective has shifted somewhat, from viewing the beliefs as a general aberration in want of an explanation, to considering them as being rooted in specific cognitive biases shared by all normally functioning human beings.

The present thesis consists of a set of papers that explore PSMS beliefs in light of this new perspective. Specifically, this thesis continues the work on formulating and testing the definition of PSMS beliefs as involving confusions of the core properties of mental phenomena, material objects, living, and animate organisms, and the processes these engage in, which was initially proposed by Lindeman and Aarnio (2007). The first paper in this thesis is a review of definitions and assessment methods in an attempt to determine whether there is reason to separate the concepts of paranormal, superstitious, magical and supernatural beliefs, or whether they can all be subsumed under this definition, and to determine how they differ from other beliefs. The four subsequent papers are empirical and test predictions derived from this definition.

The present studies investigate the beliefs in relation to dual-process theories of thinking. The observation that in people's minds, PSMS beliefs co-exist with scientific conceptions, as well as previous findings linking the beliefs to an intuitive thinking style, suggest that these beliefs originate in intuitive processing. Thus, the present thesis investigates the interplay of intuitive and analytical cognitive processes and cognitive inhibition in regulating how the beliefs are manifested. In short, the present thesis examines the two main unresolved questions concerning PSMS beliefs: What are these beliefs, and why do so many believe in them while others do not?

1.1 The cognitive basis of PSMS beliefs

1.1.1 The cognitive deficits hypothesis

Much of the cognitive research on PSMS beliefs has investigated whether belief is connected to lower reasoning capacity. Some studies have reported that general intelligence is negatively related to beliefs (Hergovich & Arendasy, 2005; Musch & Ehrenberg, 2002), but several other studies have failed to find such a connection, or the relationships have been weak (reviews: Wiseman & Watt, 2006; Vyse, 1997).

Hypotheses on more specific cognitive abilities that might explain individual differences in the beliefs have also been proposed. These hypotheses can be roughly categorized into those on critical thinking and on understanding the principles of science, those on deductive reasoning, and those on understanding probability.

The first type of cognitive deficit suggested as an explanation for paranormal beliefs is that believers fail to critically evaluate paranormal claims. However, there is little empirical evidence to support this suggestion (review: French & Wilson, 2007). For example, Roe (1999) found no differences between paranormal believers and skeptics on their ability to evaluate the validity of research reports, and Hergovich and Arendasy (2005) also failed to detect a relationship between paranormal beliefs and a composite measure of critical thinking.

Yates and Chandler (2000) investigated whether anti-scientific attitudes, rather than abilities, were related to New Age beliefs, but found no connection. However, courses teaching the principles of scientific and critical thinking, such as the role of empirical evidence for evaluating claims, do seem to lead to a decrease in paranormal beliefs (Morier & Keeports, 1994). Likewise, when Shtulman and Valcarcel (2012) asked study participants to provide explanations for their beliefs, supernatural believers referred to evidence less often than skeptics did. Crucially, believers cited less evidence even for their scientific beliefs, implying that the believers and skeptics differed generally in their epistemological sophistication.

The second type of cognitive ability factor that has been suggested to explain paranormal beliefs is the ability for deductive reasoning. This is one of the few cognitive ability factors that do differentiate paranormal believers robustly from skeptics (reviews: French & Wilson, 2007; Wiseman & Watt, 2006). For example, Wierzbicki (1985) found paranormal beliefs to be related to errors on conditional reasoning tasks. Subsequent studies have replicated this relationship and have determined that it is not limited to tasks on particular topics but emerges also on tasks that are highly abstract and content-free (Roberts & Seager, 1999) and on tasks with both anti-paranormal and pro-paranormal conclusions (Lawrence & Peters, 2004). Thus, the evidence suggests that paranormal belief is indeed related to poorer deductive reasoning, irrespective of the topic.

Finally, numerous studies have focused on the relation between paranormal beliefs and difficulties in understanding the concept of probability. The idea here is that if a person underestimates the power of chance, then ordinary coincidences will simply feel too strange to be brushed off as chance and will instead evoke feelings of paranormal meaning and purpose. For example, Blackmore and Trościanko (1985) reported that

paranormal believers underestimated the odds of winning by guessing at a coin tossing game. However, the results of later studies have been inconsistent (a recent review: Rogers, Davis, & Fisk, 2009), with the data of many studies supporting the hypothesis of probability misjudgment (Dagnall, Parker, & Munley, 2007; Roberts & Seager, 1999; Rogers et al., 2009; Rogers, Fisk, & Wiltshire, 2011) and others questioning the importance of probabilistic thinking skills for interpreting real-life events (Bressan, 2002). In short, the evidence is inconclusive on the role that probability misjudgment plays for paranormal beliefs.

1.1.2 Overactive pattern perception

Another approach to explaining PSMS beliefs has examined the tendency of believers to perceive patterns and causality. According to this approach, paranormal beliefs are caused by adopting looser criteria for judging coincidences as being meaningful. For instance, on a computer task where participants had to attempt to ascertain the rule that determined when they were rewarded, paranormal believers tested fewer hypotheses than the skeptics, but nevertheless accepted suggested rules as valid (Brugger & Graves, 1997). The authors concluded that this finding illustrates the believers' looser criteria to believe in causal connections that do not actually exist. Paranormal believers have also been found to produce more unusual associations for unrelated words (Gianotti, Mohr, Pizzagalli, Lehmann, & Brugger, 2001) and to favor false alarms over misses when searching for meaningful stimuli among noise (Krummenacher, Mohr, Haker, & Brugger, 2009; Riecki, Lindeman, Aleneff, Halme, & Nuortimo, in press). Overall, this approach seems to be well supported by evidence (reviews: French & Wilson, 2007; Wiseman & Watt, 2006).

However, at this point it is unclear whether the tendency to find meaning in noise is related specifically to paranormal beliefs. Brugger and colleagues (e.g., Brugger & Graves, 1997) suggest that loose response criteria are the cause for much delusional thought and suggest that the continuum from strict to loose response criteria might overlap with the continuum of schizotypal traits. Thus, finding meaning in noise might produce many other kinds of beliefs besides PSMS beliefs.

1.1.3 The laws of sympathetic magic

One influential theory of magical thinking (Rozin, Millman, & Nemeroff, 1986; Rozin & Nemeroff, 2002) asserts that present-day Westerners' beliefs and behavior display some of the same principles of magical thinking that the anthropologists in the late 19th and early 20th century ascribed to traditional cultures: the two laws of sympathetic magic (Frazer, 1922/1963; Tylor, 1871/1974). The first, the law of contagion, holds that things that have once been in contact continue to exert influence on each other. This influence is thought to continue if the "essence" of one thing (especially a person or an animal) has been transferred to another thing. For example, a piece of clothing worn by an evil person has become contaminated by evil. In experiments, people have been reluctant to drink water that had been in contact with a cockroach even when it had been sterilized (Rozin et al., 1986), and have behaved as if they could wash away their previous bad luck by washing their hands (Xu, Zwick, & Schwarz, 2012).

The second law, the law of similarity, entails that a representation of an object contains the "essence" of that object, and the actions taken on that representation thus affect the object itself. For example, people are less accurate at throwing darts at a picture of someone they like (Rozin et al., 1986) and they experience anxiety when destroying photographs of personally valued objects (Hood, Donnelly, Leonards, & Bloom, 2010). In short, it has been firmly established that people's beliefs and behavior adhere to these laws. Hood (2010) even considers these laws to be one of the most central building blocks of a universal tendency for supernatural thinking.

However, even the proponents of this view agree that the laws of sympathetic magic are not sufficient to explain magical thinking in its entirety. Rather, the proponents consider that these principles provide an explanation for a subset of magical thinking that does not directly involve a sense of human-like agency, but rather involves the transmission of essence or force (Nemeroff & Rozin, 2000; Rozin & Nemeroff, 2002).

1.2 Challenges for the study of PSMS beliefs

Above I have presented some of the most prominent cognitive explanations offered for PSMS beliefs. All of these approaches have made important progress in uncovering some of the cognitive factors associated with one or several types of paranormal, superstitious, magical, or supernatural beliefs. Despite decades of research, however, these approaches have yet to provide a clear answer to the question of why so many people hold these beliefs and why others do not. With some of the approaches, such as the probability misjudgment hypothesis, successive studies have yielded contradictory findings. Other findings, such as overactive pattern perception, in turn, have proven to be more robust, but it is unclear whether these findings apply to only a subset of PSMS beliefs, to all relevant beliefs, or more broadly to ill-founded beliefs and delusions that might not be of a supernatural nature at all. The present thesis argues that there are two main reasons that these approaches have not produced clearer explanations for PSMS beliefs: Conceptual vagueness and a basic problem with investigating domain-general cognitive functions.

1.2.1 Conceptual vagueness and the lack of a definition

First, the most basic problem in research on paranormal, superstitious, magical, and supernatural beliefs has been that it has been unclear which beliefs are part of the same psychological phenomenon and which are not. Consequently, it is difficult to determine whether findings obtained with one specific set of paranormal beliefs (e.g., ESP, a review: Wiseman & Watt, 2006) apply to other types of paranormal beliefs (e.g. a belief in astrology). In the research literature, the terms paranormal, superstitious, magical, and supernatural have been used inconsistently. In particular, the exactly same beliefs have been filed under different constructs; belief in witches, for example, has been labeled as paranormal, supernatural, magical, and superstitious. Conversely, the same constructs have been used to refer to very different beliefs, as in the case of superstition, which has been exemplified by the fear of nonpoisonous snakes and the belief in an afterlife, among others (all references in Paper I). As the field has not had clear definitions of these terms, it has been unclear what these beliefs are, whether they differ from each other, and how they differ from other beliefs.

The main problem, however, has been that conceptual agreement has been weak in the whole field. There appears to be no consensus whatsoever on the way the concepts of paranormal, superstitious, magical, and supernatural should be defined. Consensus has been lacking for basic questions such as why belief in immortal souls should be considered to be supernatural while the belief that vitamin C prevents flu should not. Another disputable case is the belief in extraterrestrials, with some authors including it in studies of paranormal beliefs along with beliefs in phenomena such as ghosts (King, Burton, Hicks, & Drigotas, 2007), while others argue we should be careful in labeling beliefs in extraterrestrials as supernatural (Swami, Furnham, Haubner, Stieger, & Voracek, 2009).

Further, researchers disagree on the interrelationships of the beliefs. Some authors have used two, three, or all four concepts synonymously without differentiating them. Other researchers, in turn, have treated these concepts as being hierarchically related. One can find examples of research papers suggesting each of the four concepts to be superordinate to the others.

To gain clarity on these concepts, Paper I was conducted as a literature review of conceptual and operational definitions of paranormal, superstitious, magical, and supernatural beliefs. The main objective of Paper I was to address the following question: Is there reason to conceptually separate the concepts of paranormal, superstitious, magical, and supernatural beliefs, or can they instead all be covered and distinguished from other unfounded beliefs by one definition?

1.2.2 Empirical meagerness

The second challenge for the study of PSMS beliefs is that few clear empirical findings have emerged from studies adopting the traditional cognitive approaches presented above. Many of the relationships discovered have been demonstrated to be unreplicable when studied in different settings and populations, and the results have been generally inconsistent and the proportions of explained variance generally small (reviews: Irwin, 2009; Vyse, 1997). This thesis argues that as long as explanations are sought in domain-general cognitive factors, groundbreaking findings are unlikely. By definition, domain-general cognitive processes concern general forms of information processing that work in the same way irrespective of the topic at hand. For example, the studies on overactive

pattern perception have purposely used experimental tasks that are devoid of paranormal content and have argued that the tendency to see causal connections where there are none is a domain-general tendency (Brugger & Graves, 1997; Gianotti et al., 2001).

The problem with domain-general approaches, such as cognitive deficits, overactive pattern perception, and the laws of contagion and similarity, is that while these factors may increase paranormal beliefs, they may also increase poorly supported beliefs in general, paranoia, and disgust towards microbially contaminated items, which are not paranormal beliefs at all. Thus, knowing that these cognitive factors are associated with PSMS beliefs still leaves open the question of why these factors increase paranormal beliefs in some people, but take the form of non-paranormal beliefs in others. Moreover, as PSMS beliefs concern phenomena that by definition are against (gr. para), outside (lat. para) or above (lat. super) that which is natural and normal, it seems reasonable to focus on the specific content of these beliefs. In this vein, researchers on PSMS beliefs have increasingly turned to domain-specific theories. Two types of theories can be distinguished and will be presented next: the theories concerning counterintuitive representations, and theories concerning intuitive biases.

1.3 Counterintuitive representations

Since the 1990s, a new paradigm within the study of religion has increasingly attempted to explain religious beliefs and practices with reference to cognitive factors. This paradigm, the Cognitive Science of Religion (CSR), aims to explain how religious concepts are mentally represented, why they tend to be of certain types and not others, and why religions are so widespread (Atran & Norenzayan, 2005a; Barrett, 2000; Boyer, 2003).

The central insight of the CSR is that religious beliefs engage early-developing, domain-specific understanding of conceptual categories such as “person,” “object,” and “artifact” (Barrett, 2000; Boyer, 2003). Scholars have noted that religious conceptions, especially a belief in God or gods, tend to deviate from our everyday expectations on these conceptual categories on only a limited number of aspects. It has been argued that this “minimal counterintuitiveness” (Atran & Norenzayan, 2005a) is the reason that certain conceptions become successful cultural representations and easy to adopt.

Another observation is that religious concepts typically center on agency. As gods, angels, devils, prayer, spirits all involve intentional agents that break one's expectations of intentional agents, it has been suggested that the source of religious thinking is overattribution of agency (Barrett, 2000; Dein & Littlewood, 2011).

As is evident from the above, the ideas introduced in the CSR are specific to religious beliefs and the literature has not focused on PSMS beliefs in general. Even though many religious beliefs share obvious representational similarities with PSMS beliefs, it is unclear whether the results on religious beliefs are generalizable to common non-religious PSMS beliefs, such as beliefs in astrology, telepathy, and lucky numbers. Overall, beliefs per se and individual-level cognitive factors are not the focus of interest of the CSR, as it emphasizes cultural questions and group-level processes. These include the role of public religious rituals for reinforcing beliefs and for maintaining a moral reputation and social coherence (Atran & Norenzayan, 2005a; Barrett, 2000; Boyer, 2003; Gervais, Willard, Norenzayan, & Henrich, 2011).

It is also difficult to evaluate the relationship of the CSR literature to the work on the psychology of PSMS belief because the fields use the same terms in different ways. Most importantly, in the CSR, intuition refers to common sense (Atran & Norenzayan, 2005b), whereas in psychology it has a more specific meaning, which will be discussed in the following sections. Despite these difficulties in integrating findings obtained within the CSR with work on PSMS beliefs in general, the CSR has been important for focusing attention on the domain-specific representational content of supernatural beliefs. In contrast to the domain-general theories discussed earlier, by focusing on the contents of the representations, the counterintuitiveness position aims to address the central question of why people specifically adopt supernatural beliefs and not some other types of beliefs.

1.4 The present perspective: intuitive biases

The other domain-specific approach to supernatural beliefs builds directly on advances in developmental psychology and dual-process theories of thinking. This approach traces the roots of supernatural thought to domain-specific cognitive biases that are suggested to be universally present in normally developing children. Children, evidence suggests, tend to hold a dualistic view of the mind and body, in which mental processes continue after death (Bering & Bjorklund, 2004; Bloom, 2007; Harris & Giménez, 2005). Children also tend to see the world teleologically as if everything was designed for a purpose (E. M. Evans, 2000; E. M. Evans, 2008; Kelemen, 1999; Kelemen, Callanan, Casler, & Pérez-Granados, 2005; Legare, Evans, Rosengren, & Harris, 2012), and their notions of biological processes seem to involve the notion of a vital energy (Inagaki & Hatano, 2004; Morris, Taplin, & Gelman, 2000). It may be noted that similar notions were described earlier by Piaget (1929/1951), whose observations of children's thinking included, for example, that children intuitively confuse symbolic representations and material objects, overattribute animacy and consciousness to inanimate things, and see objects in the natural world as made for humans.

Thus, while the counterintuitiveness approach considers supernatural beliefs to be a violation of early-developing basic conceptions of ontological categories in the world, the intuitive biases view sees the beliefs as a reflection of these conceptions. Recently, even some scholars within the CSR have concurred that supernatural beliefs are a reflection of inborn biases (Barrett, 2012).

1.4.1 Background: dual-process theory

The intuitive biases view is closely tied to dual-process theories of thinking. In dual-process theories, a distinction is made between two types of cognitive processes: intuitive and analytical. Several variations of dual-process theories have been proposed, as well as several different terms (reviewed in J. St. B. T. Evans, 2008). For example, Epstein's cognitive-experiential self-theory distinguishes between information processing that is intuitive-experiential and analytical-rational (Denes-Raj & Epstein, 1994), while Sloman (1996) distinguished between processing that is associative and rule-based. Simply put, intuitions are thoughts and preferences that come to mind effortlessly and without conscious reflection, and that feel to be self-evidently true. In

contrast, analytical thinking is deliberate, systematic, and requires concentration (Epstein, 2010; Hodgkinson, Langan-Fox, & Sadler-Smith, 2008; Kahneman, 2003). Recently, it has been suggested that the central difference between the two types of processing is that intuitive processing (generically termed Type 1 by Stanovich, 1999) is autonomous and not dependent on working memory, while analytical thinking (Type 2) has the opposite characteristics (J. St. B. T. Evans, 2012; Stanovich & Toplak, 2012).

Two main theoretical orientations have been proposed to account for how intuitive and analytical processes interact. The first is referred to as the parallel-competitive theories, where both types of processes operate simultaneously and compete for control over thoughts and actions. This suggestion is considered by many authors to be implausible and unparsimonious due to the double resources that would be required by the two parallel processes (e.g., De Neys, 2012; J. St. B. T. Evans, 2010).

The other view, which is referred to as default-interventionist, has gained more support (J. St. B. T. Evans, 2008). According to this orientation, intuition is primary and accounts for most of human thinking, while analytical processes monitor the outputs of intuitive processing, and may intervene. Lately, even this view has been criticized as being too simple, and additional types of processes have been proposed. For example, several authors have called for a separate processing step that monitors intuitions without engaging a complete, conscious Type 2 analysis (Bonner & Newell, 2010; De Neys, 2012; J. St. B. T. Evans, 2009).

A specific type of default-interventionist theory has been proposed by Stanovich (1999, 2009a, 2009b), who argues that we should distinguish between not two but three levels of processes. In this view, Type 2 processes can be further divided into two types: the ability to constrain intuition and engage in analytic processing (the algorithmic mind) and the tendency to actually do so (the reflective mind). This corresponds to the distinction between an algorithmic and a rational processing level (J. R. Anderson, 1990). In any case, dual-process theorists agree that because of the different ways of processing information, two different conceptions of the same issue may be formed by the same individual and may then co-exist in the same mind.

1.4.2 Paranormal beliefs and core knowledge confusions

As dual-process theories suggest, people may hold two different conceptions of the same phenomenon. For example, transmission of illness and disease may be conceived of in both magical and biological terms (Legare & Gelman, 2008). It is also possible that the intuitive biases that children harbor and that are linked to PSMS beliefs can be found even among adults who hold these beliefs, alongside scientific knowledge that they learned later. In line with this, Lindeman and Aarnio (2007) formulated their theory of PSMS beliefs. Following their definition of PSMS beliefs as category mistakes in which the core attributes of mental, physical, and biological entities and processes are confused with each other, they predicted and found that agreement with core knowledge confusions, such as the statement “An evil thought is contaminated”, did indeed discriminate between a group of strong paranormal believers and a group of strong skeptics better than any other cognitive or emotional factor that was studied.

Further support for the idea that core knowledge confusions play a role for paranormal beliefs comes from studies using electroencephalography (EEG). EEG measurements reveal that the N400 effect elicited by statements that contain core knowledge confusions is larger in paranormal believers than in skeptics (Lindeman et al., 2008). As the N400 is known to arise from processing semantically unexpected material (Kutas & Federmeier, 2011), this result can be interpreted as indicating that in comparison to skeptics, the paranormal believers have more difficulty determining the literal truth of core knowledge sentences.

In the present thesis, the hypothesis that an acceptance of core knowledge confusion statements as being literally true is related to PSMS beliefs was further tested in Papers II, III and IV using several, larger datasets that were not restrained to extreme believers and skeptics. Paper IV tested the general hypothesis that core knowledge confusions are related to PSMS beliefs.

If the definition of PSMS beliefs as core knowledge confusions holds true, it should cover all forms of PSMS beliefs, including those that have not previously been included in popular assessment measures. One such belief is that random but important life events occur for a purpose. This belief is very common, strong and found cross-culturally (Deridder, Hendriks, Zani, Pepitone, & Saffiotti, 1999; Lupfer, Tolliver, & Jackson, 1996) but it has not been included in the measures that have been used to

assess PSMS beliefs (for recent reviews of assessment methods, see Irwin, 2009 and the online supplementary table to Paper I, <http://dx.doi.org/10.1037/a0027158.supp>). Most authors, however, seem to agree that seeing purpose in random events is a form of supernatural belief (e.g., E. M. Evans & Wellman, 2006; Gjersoe & Hood, 2006; Zusne & Jones, 1989). Bering (2002, 2006), in turn, has argued that attributing purpose to random events is an evolved bias that is present in all humans in one form or another. Similarly, Guthrie (1993) has suggested that the tendency to see justice in events is a manifestation of an evolved predisposition to overattribute agency to the workings of the world. The focus of Paper II was to investigate the relationship of beliefs in the purpose of events to beliefs traditionally included in the PSMS beliefs literature, and to determine whether they are universal or can be explained by individual differences in the same core knowledge confusions as other PSMS beliefs.

1.4.3 Core knowledge confusions involving energy and force

Leslie (1994) has suggested that the core knowledge of the physical domain includes a basic notion of force or energy, which in physical interactions is transferred from one object to another. While energy and force are two different concepts in science, lay people often consider them to be one and the same (Chabalengula, Sanders, & Mumba, 2012). Several authors have also made the observation that beliefs about magical causation often refer to spiritual energies and forces (Nemeroff & Rozin, 2000; Zusne & Jones, 1989). However, as Lindeman and Saher (2007) observe, the esoteric use of the word “energy” is very different from how the concept is used in science. The idea of spiritual energy is more reminiscent of the concept of vitalistic energy that young children hold (Inagaki & Hatano, 2004; Morris et al., 2000). In support of this contention, Lindeman and Saher (2007) concluded that alongside scientifically correct conceptions, strong paranormal believers exhibited vitalistic energy conceptions. For instance, when asked to explain biological processes, such as why a wound heals, the paranormal believers referred to energy. They also accepted statements that described energy as having attributes of living organisms and mental phenomena, such as healing, being living or being spiritual. Thus, conceptions in which energy and force are described with the attributes from other ontological categories can be considered to be core knowledge confusions.

Scholars interested in esoteric or vitalistic conceptions of energy are not, however, the only researchers to have studied people's notions of energy. As energy is a central concept in physics, people's understanding of it is the natural focus of extensive research on science learning (e.g., Saglam-Arslan, 2010). Of interest to the present thesis, the literature on physics education research reveals that students tend to think of energy as some type of generic fuel, which is especially used by humans (Driver, Squires, Rushworth, & Wood-Robinson, 1994; Nordine, Krajcik, & Fortus, 2011; Trumper, 1993). Studies in physics education research have not, however, tended to directly investigate whether people conceive of energy as having properties from the ontological categories of living and animate phenomena.

With the aim of integrating these two lines of research, Paper III investigated whether students in upper secondary school (ages 15-18) would hold conceptions of energy as living and animate. The idea was that this group of participants would be relatively non-selected with respect to PSMS beliefs. Conducting the study among students also enabled us to analyze the relationship of these conceptions to the students' scientifically valid energy conceptions. In line with dual-process theory and the previous studies that indicate that early, ontologically incorrect conceptions continue to influence people's responses long after they have consciously been replaced with scientific views (McCloskey, Caramazza, & Green, 1980; Shtulman & Valcarcel, 2012), ontologically confused conceptions were expected to co-exist in the students' minds with conceptions that were more in line with scientifically accepted views.

References to esoteric energies are also intrinsic to many forms of complementary and alternative medicine (CAM). For example, crystal healing is based on the idea of creating a healing energy field around the patient and unblocking the patient's energy. Therefore, Paper III also investigated whether conceptions of energy as being psychological and biological are related to a trust in CAM.

1.4.4 Conceptual change

To understand the nature of people's ontologically confused intuitive conceptions, an important question concerns their stability. In light of the co-existence findings discussed above, ontological misconceptions seem resistant to change. On the other hand, researchers in science education have argued that lay notions are not as clear,

robust and discrete as scientific conceptions are, but are rather fragmented, flexible and open to change and development – after all, this is the basis for learning (Amin, 2009; diSessa, Gillespie, & Esterly, 2004; Gupta, Hammer, & Redish, 2010; Hammer & Elby, 2003).

Thus, the second aim of Paper III was to investigate whether the students' conceptions would change during the physics courses from which the study participants were recruited. Inspired by studies on teaching science topics that are ontologically challenging (Slotta & Chi, 2006; Wiser & Amin, 2001), a lesson that directly targeted ontological differences between common conceptions and scientific views (hereafter referred to as the Targeted Lesson) was especially designed for this study. Attending this lesson was expected to lead to larger decreases in ontologically confused conceptions than attending the regular curriculum without this additional intervention.

1.4.5 Intuitive thinking

As PSMS beliefs seem resistant to critical argumentation, many researchers have been interested in determining whether these beliefs are linked to a preference for intuitive information processing. As support for this idea, researchers have gathered that in both intuitive thinking and paranormal belief, personal experiences are taken as valid even when they contradict scientific knowledge (Epstein, 2010; King et al., 2007; Sadler-Smith, 2011). Some of the most direct evidence on the role of intuitive thinking in producing supernatural belief comes from a study that experimentally manipulated thinking to be more intuitive. A writing task requesting participants to reminisce about a time when trusting their intuition led to good outcomes temporarily increased their assessments of their belief in God (Shenhav, Rand, & Greene, 2012). In the present thesis, intuitive thinking was approached both by using self-report measures of the participants' characteristic thinking style, and by using an experimental manipulation (speeded responding) that favors intuitive conceptions.

Several studies have linked the self-reported tendency to rely on intuition to a variety of PSMS beliefs (Epstein, Pacini, Denes-Raj, & Heier, 1996; Genovese, 2005; King et al., 2007; King & Hicks, 2009; Sadler-Smith, 2011; Wolfradt, Oubaid, Straube, Bischoff, & Mischo, 1999). In one of the largest surveys on this topic to date, with more than 3 000 respondents, Lindeman and Aarnio (2006) found that faith in intuition

predicted PSMS beliefs better than a range of emotional factors, such as emotional instability and the desire for control. Further, the intuitive style turned out to mediate the regularly found differences in belief by gender and educational level. In other words, women held more PSMS beliefs than men partly because they were more intuitive than men, and people with lower educational attainments held more beliefs partly because they were more intuitive than people at higher educational levels (Lindeman & Aarnio, 2006).

In line with the above findings, the present thesis investigated the relationship of an intuitive thinking style both to core knowledge confusions and paranormal beliefs (Paper IV), and to ontologically confused energy conceptions (Paper III). An intuitive style was expected to positively predict all of these variables.

The second way in which intuitive thinking was approached in this thesis was by investigating whether the acceptance of core knowledge confusions increases when response time is limited. This hypothesis was based on the assumption that core knowledge confusions are based on intuitive processing, which is usually inhibited and censored by analytical processes. The expectation was that the short time allotted for responding would simply not allow analytical processing and thus, the responses would reveal more intuitive conceptions. This hypothesis is in line with previous findings showing that speeded conditions increase teleological attributions (Kelemen & Rosset, 2009) and reduce analytic reasoning processes (J. St. B. T. Evans & Curtis-Holmes, 2005). Similarly, limiting executive resources by burdening them with a secondary task has been shown to increase heuristic responses at the expense of logical responses (De Neys, 2006). In the present thesis, core knowledge confusions were chosen as the dependent variable because we assumed they form the basis of PSMS beliefs. Thus, Study 1 of Paper IV tested the hypothesis that an acceptance of core knowledge confusions increases under conditions that favor intuitive processing, that is, under time pressure.

1.4.6 Analytical and reflective thinking

In addition to intuitive thinking, researchers have been interested in the role of analytical thinking in explaining individual differences in PSMS beliefs. The assumption has generally been that the predilection to analyze questions carefully and

consciously should lead to a lower endorsement of paranormal claims. Research findings have, however, been less consistent on this point than for intuitive thinking. The self-reported tendency to rely on analytical thinking has sporadically shown slight negative associations (Lindeman & Aarnio, 2006) or positive associations (Wolfradt et al., 1999) with various PSMS beliefs, but in most studies, no associations were established (Epstein et al., 1996; Genovese, 2005; King et al., 2007; Sadler-Smith, 2011; Yates & Chandler, 2000). However, to support the role of analytical thinking for supernatural beliefs, experimental manipulations that increase participants' analytical thinking (for example, by showing them a photo of Rodin's statue *The Thinker*), have been found to lead people to assess their religiosity as lower (Gervais & Norenzayan, 2012). Why, then, has this relationship not been found in studies of thinking style?

One possible reason for this lack of findings is methodological. Most of the above studies operationalized the analytical thinking style as a need for cognition (NFC), which refers to engagement in and enjoyment of thinking (Cacioppo, Petty, Feinstein, & Jarvis, 1996; Cacioppo, Petty, & Kao, 1984). As it is possible that the NFC conflates actual Type 2 thinking with mere ruminations on intuitions, the present thesis turned to other possible means of measuring preferences for analytical or rational thinking.

One such measure is the Actively Open-Minded Thinking (AOT) self-assessment scale (Sá, West, & Stanovich, 1999; Stanovich & West, 1997). This scale has been designed to assess intellectual aims and epistemic values, such as the willingness to perspective-switch, decontextualize, and to consider alternative opinions and evidence. Evidence suggests this scale succeeds in its aims, as it has been negatively linked to the ability to justify one's views using evidence (Sá, Kelley, Ho, & Stanovich, 2005) and positively to the ability to overcome belief bias on reasoning tasks (Macpherson & Stanovich, 2007). Actively open-minded thinking has also been found to be related to lower superstition in a mature student sample (Sá et al., 2005) and among 10-11-year-olds (Kokis, Macpherson, Toplak, West, & Stanovich, 2002).

Another measure intended to measure Type 2 thinking is the Argument Evaluation Test (AET; Stanovich & West, 1997). This test was designed to measure one's ability to evaluate objective argument quality independently of one's own beliefs, and it has been found negatively related to superstitious thinking (Stanovich & West, 1997) and positively to performance on reasoning tasks, even when controlling for intelligence

(Stanovich & West, 1998). Thus, several findings converge in favor of the argument that these measures capture the essential features of Type 2 thought better than the NFC.

Based on the above considerations, the present thesis included both the NFC, and AOT and AET among the potential predictors of core knowledge confusions and paranormal beliefs (Paper IV) and students' ontologically confused energy conceptions (Paper III). AOT and AET were expected to be better predictors of beliefs than NFC. Further, it should be noted that neither AOT and AET nor NFC were expected to be the opposite of the intuitive style, but to complement it and possibly explain an additional independent portion of the variation in the beliefs.

1.4.7 Cognitive inhibition

The last factor whose relationship to PSMS beliefs the present thesis studied was cognitive inhibition. Cognitive inhibition generally refers to those executive functions, a.k.a. forms of cognitive control, that involve suppressing, restraining, stopping or overriding a mental process. Inhibition is central for everyday functioning, as normal cognition involves a constant need to choose between competing sensory inputs and to adjust behavior to changing circumstances (M. C. Anderson & Levy, 2007). For example, cognitive inhibition involves suppressing unwanted or irrelevant thoughts, withholding inappropriate responses, and controlling one's attention in relation to one's goals. Within these processes, researchers often distinguish between those that correspond to different processing levels: perceptual, working memory, and response output (Friedman & Miyake, 2004; Nigg, 2000; Redick, Heitz, & Engle, 2007). Cognitive inhibition is considered to be resource-dependent and to display considerable individual variation (Gorfein & MacLeod, 2007).

The relationship between cognitive inhibition and the other factors that are studied in this thesis is not entirely clear. The default-interventionist dual-process theories use the term inhibition and posit that intuitive responses are inhibited by analytic processes (J. St. B. T. Evans, 2008, 2010). However, studies on dual-process theory seldom cite research on inhibition and currently these research areas are not fully integrated. In addition, studies on cognitive inhibition typically employ experimental tasks on which it is relatively easy to designate stimuli as targets to be processed and distractors to avoid. Therefore, these tasks involve basic cognitive processes such as arithmetic, visual

selective attention, and recall of list items, but seldom reasoning or beliefs (e.g., M. C. Anderson & Levy, 2007).

One of the few dual-process theorists who have attempted to integrate the concept of cognitive inhibition with dual-process theory is Stanovich (2009a, 2009b). To Stanovich, a crucial prerequisite for carrying out analytic processes is an inhibiting of default intuitive responses, but this does not alone translate to rational thought or behavior. This framework gives clearly separable roles for cognitive inhibition and for reflective processes in the reasoning system. Consequently, it also presents criteria to determine which component of the reasoning system each assessment method measures. Stanovich argues that for a task to measure reflective tendencies, it must leave open the choice of a solution, as in the AOT and AET discussed in Section 1.4.6. In contrast, traditional means of measuring inhibition provide participants with clearly defined instructions. Thus, Stanovich argues that these methods reveal nothing about whether the person will choose to reason rationally, but that they can instead be used to measure the algorithmic capacity that is needed to inhibit the default intuitive processes.

In the present thesis, it was expected that effective cognitive inhibition would be related to skepticism, or in other words, that weak cognitive inhibition would be related to PSMS beliefs and to core knowledge confusions. Previous findings also support this hypothesis. First, group comparisons of strong supernatural believers and skeptics have demonstrated that the believers perform more poorly on the Wisconsin Card Sorting Test, including the subscale of perseverative errors, which is considered to measure inhibition problems (Lindeman, Riekkki, & Hood, 2011). Second, the intuitive teleological and animistic biases that are considered by many to be one of the roots of PSMS beliefs have been shown to be more common among people with Alzheimer's disease, in which inhibitory control deteriorates (Lombrozo, Kelemen, & Zaitchik, 2007; Zaitchik & Solomon, 2008). Third, decreased cognitive inhibition and PSMS beliefs share many correlates that are not directly related to these beliefs, such as creativity, feelings of threat, and intuitive thinking (references in Paper V).

The concept of cognitive inhibition was approached in this thesis in two ways. First, Study 1 of Paper IV investigated the relationship of PSMS beliefs and core knowledge confusions to individual performance differences on a Stroop test. Various versions of Stroop tests are popular in research as well as in the clinical neuropsychological

assessment of executive functions. In the color-word Stroop test, participants are presented with the names of colors printed in different color fonts, and requested to name the font color while disregarding the verbal content. On congruent trials, the word and the font color match, while on incongruent trials they are incompatible (for example, the word “green” is printed in blue). People tend to take longer to respond and to make more errors on the incongruent than on the congruent stimuli. This decrease in color-naming speed is called the Stroop interference effect (MacLeod, 1991, 2005; Strauss, Sherman, & Spreen, 2006).

The specific functions underlying the Stroop interference effect are suggested to primarily reflect the perceptual and response stages of processing (Friedman & Miyake, 2004; Nigg, 2000; Redick, Heitz, & Engle, 2007). Furthermore, it has been suggested that the resolution between competing processes in working memory (processing of the word’s font color versus its verbal content) also contribute to the Stroop effect (Kane & Engle, 2003). Thus, the Stroop test was selected in the present thesis to act as a general measure of cognitive inhibition. In line with previous findings linking teleological and animistic biases to weaker inhibition as measured by a Stroop test (Kelemen & Rosset, 2009), we expected the magnitude of the Stroop interference effect to be related to accepting more core knowledge confusions.

The second way in which cognitive inhibition was approached in the present thesis was through functional magnetic resonance imaging (fMRI). Paper V used fMRI to investigate whether people who hold PSMS beliefs differ from skeptics in terms of their brain activations when viewing stimuli that invite supernatural interpretations. The focus of interest was an area in the right inferior frontal gyrus (right IFG), as both imaging and lesion studies have linked activation in this area to tasks that require cognitive inhibition (a review: Aron, Robbins, & Poldrack, 2004). Damage to the right IFG impairs performance on tasks that require quick switching between two tasks, or tasks that require response inhibition, such as go/no-go tasks, in which one should routinely press a button but be able to refrain from pushing the button when a no-go signal is presented. Imaging studies indicate that in healthy subjects, this same area is active during those tasks.

Furthermore, right IFG activation has recently even been implicated in the context of higher cognition. On syllogistic reasoning tasks, right IFG activation is related to

performance on trials on which beliefs and logic are in conflict and on which responding correctly is considered to require the inhibition of beliefs (De Neys, Vartanian, & Goel, 2008; Goel & Dolan, 2003; Tsujii, Masuda, Akiyama, & Watanabe, 2010; Tsujii & Watanabe, 2010). Furthermore, disrupting right IFG function through repetitive transcranial magnetic stimulation (rTMS) enhances belief bias on these tasks, which can be taken to indicate impaired inhibition of belief-based responses (Tsujii, Sakatani, Masuda, Akiyama, & Watanabe, 2011). Based on these results, we expected that the hypothesized weaker cognitive inhibition of the paranormal believers would show as weaker right IFG activation as compared to skeptics, when viewing material that invites supernatural thoughts.

2. Aims of the study

This thesis addressed six overarching research questions (a–f below). Table 1 indicates which of these were addressed by each paper, and the types of data that were used.

More detailed hypotheses are found in the original papers.

Overarching research questions and expectations:

a) Is there reason to conceptually separate the concepts of paranormal, superstitious, magical, and supernatural beliefs, or can they instead all be covered and distinguished from other unfounded beliefs by one definition? (Paper I)

b) Are confusions of the core properties of mental phenomena, material objects, living, and animate organisms, and the processes these engage in, related to PSMS beliefs? Following the definition of PSMS beliefs as involving these confusions, we expected people's acceptance of statements including these confusions to be positively associated with their PSMS beliefs (Papers II, IV), including beliefs in the purpose of events (Paper II).

c) Do conceptions of energy as being psychological and biological, a type of core knowledge confusion, exist along scientific conceptions among students, do they decrease with instruction, and are they related to trust in complementary and alternative medicine? The answer to these questions was expected to be yes. (Paper III)

d) Are intuitive and reflective thinking styles related to PSMS beliefs and to core knowledge confusions? We expected to replicate the previously established positive relationship between intuitive thinking and PSMS beliefs, and to extend it to core knowledge confusions. In addition, we expected a reflective thinking style to be negatively related to the beliefs and to the confusions, providing it is assessed using appropriate measures designed to capture Type 2 thinking. (Papers III, IV)

e) What is the effect of time pressure on the acceptance of core knowledge confusions? Time pressure was expected to increase the acceptance of these confusions. (Paper IV)

f) Is cognitive inhibition related to core knowledge confusions and to PSMS beliefs? We expected to find that individual differences in cognitive inhibition as measured by a Stroop test predict core knowledge confusions (Paper IV) and that PSMS beliefs predict

weaker activation of the right IFG when people are viewing stimuli that may be interpreted as involving supernatural content (Paper V).

Table 1. Overview of studies.

Paper	Research questions	Participants	Data type
I	a		Literature review
II	b	Study 1: 505 supernatural believers and skeptics who were students at universities, representing a wide variety of disciplines Study 2: 2 145 Finnish volunteers	Study 1: Online self-report Study 2: Online self-report
III	c, d	102 upper secondary school students (ages 15-18)	Self-report and follow-up 3 weeks after regular curriculum or instructional intervention
IV	b, d, e, f	Study 1: 50 Finnish volunteers, of whom 62% had completed a bachelor's or higher university degree Study 2: 458 Finnish volunteers, majority = students or working	Study 1: Self-report, speeded condition and performance measures Study 2: Online self-report
V	f	Pilot study: 119 Finnish volunteers Main study: 23 supernatural believers and skeptics	Pilot study: Online self-report Main study: Self-report and fMRI

3. Methods

3.1 Participants and procedures

A total of 3 402 Finnish people (70% female) participated in the studies. The participants represented a wide range of ages (14–73) and occupations, including upper secondary school students, university students, people working full-time, participants recruited from a representative pool of Finnish adults, skeptics and paranormal believers, and volunteers from the general public recruited through public online discussion forums. Out of the participants, 3 227 filled in anonymous online self-report questionnaires, and 175 participated in studies with experimental designs. Details for each study are presented below.

Paper II, Study 1: 505 Finnish volunteers, 368 females and 137 males, participated in the study. Ninety-four per cent of the present sample were full-time students at universities and they represented a wide variety of disciplines, including the humanities as well as the technical, natural, medical, social and behavioral sciences. The mean age of the participants was 24, ranging from 16 to 48. They were recruited among the participants in an earlier study on superstition on the grounds that their score on a measure of paranormal beliefs was either in the highest or lowest 10th percentile of their gender. The potential participants were contacted by electronic mail and they were referred to an online questionnaire.

Paper II, Study 2: 2 145 Finnish volunteers participated in the study, 1 462 females and 683 males, with a mean age of 27.2 years, ranging from 14 to 73. The participants were recruited via electronic student mailing lists and five Internet discussion forums. The recruitment message stated the study concerned beliefs, worldview and cognition, and provided a link to the online questionnaire.

Paper III: The participants were 102 grade 10–12 students from three upper secondary schools in Helsinki, Finland, mean age 16 years (range 15–18), 48 females. The study was conducted in the classroom during school hours as part of the physics courses that the students were attending. Six groups participated, representing three consecutive course levels (Physics 1, 2 and 3). One group from each course level attended the Targeted Lesson and the other did not.

The study had a pretest–posttest design. At pretest, after obtaining the students’ consent, they completed a questionnaire booklet that included measures of conceptions of energy, trust in CAM, cognitive styles, and demographic variables. The students were told the study concerned what upper secondary school students think about energy. In the groups that attended the Targeted Lesson, the rest of the 75-minute session was used for a targeted lesson on ontological categories described below. In the other groups, the rest of the session was used on the normal course curriculum. At posttest, three to four weeks after pretest and towards the end of the courses, the students completed measures of conceptions of energy and trust in CAM. The number of students who completed the second questionnaire was 93.

The duration of the targeted lesson was approximately 30 minutes and it was taught by the author of this thesis. The main objective of this lesson was to increase the awareness that descriptions of energy as biological and animate are incompatible with descriptions of energy as a physical process. The students were asked to discuss assigned questions concerning CAM and the basic attributes of lifeless objects, living things, animate beings, objects and processes and energy. The lesson ended by concluding that when energy is described as it is described in CAM, its ontological properties are mixed up.

Paper IV, Study 1: The participants were 50 Finnish volunteers recruited from student mailing lists, by snowball sampling and by inviting participants of a previous study who had expressed an interest in further studies. The mean age was 34 (range 19–62), and 74% were female. Nineteen (38%) were university students, 21 (42%) were working full time, and 5 (10%) were otherwise occupied. Thirty-one (62%) had completed a bachelor’s or higher university degree.

Paper IV, Study 2: The participants were 458 volunteers who completed an online survey, recruited through messages on student mailing lists and popular, public Finnish online discussion forums for paranormal topics and general discussion. Three hundred and fifty-three (77.1%) were female, 91 (19.9%) male, and 14 persons (3.1%) did not disclose their gender. The mean age was 27 ($SD = 7.9$, range 18–65) and the majority were students (76.6%) or working at the time of the survey (17.2%).

Paper V, Pilot study: 119 volunteers (99 female, 20 male; mean age 27 years, range 19–48) were recruited through student mailing lists and referred to an online questionnaire.

Paper V, Main study: Twenty-three volunteers, none of whom had participated in the pilot study, were recruited from a participant pool constituting a representative sample of 15- to 56-year-old Finnish people. To recruit supernatural believers and skeptics, the subjects who were at the extreme ends (highest and lowest 10%) of the distribution of supernatural belief in a previous study (Lindeman, 2011) were contacted. Out of the 23 participants, 12 were supernatural believers (6 female, 6 male; mean age 38 years, range 23–53) and 11 were skeptics (6 female, 5 male; mean age 34 years, range 21–49). Additional inclusion criteria were lack of psychiatric or neurological disorders and fulfillment of the fMRI safety requirements. The study had prior approval from the ethics committee at the Hospital District of Helsinki and Uusimaa, and all subjects signed a written informed consent form.

3.2 Measures

Paranormal beliefs (Studies II, IV, V) were measured using items from Tobacyk's (2004) Revised Paranormal Belief Scale (RPBS), which is a slightly revised version of the Paranormal Belief Scale (Tobacyk & Milford, 1983). This scale includes items such as, "Some people have an unexplained ability to predict the future," "Psychokinesis, the movement of objects through psychic powers, does exist," and "Black magic really exists," which are rated on a 5-point scale (1 = completely disagree, 5 = completely agree). Papers II and V used Tobacyk's (2004) original 26-item version. In Paper IV, three items concerning the possibility of extraterrestrial life, mind reading, and witches were omitted from the analysis as several participants reported giving them high ratings despite interpreting them in a non-paranormal way. In Study 2 of Paper IV, the scale was completed by adding 3 items on ghosts and spiritual beings and 3 items on lucky amulets from Lindeman and Aarnio (2006).

In Study 2 of Paper IV, the 7 original subscales of the RPBS (Extraordinary life forms, PSI, Superstition, Precognition, Spiritualism, Traditional religious beliefs, Witchcraft) as well as a new subscale, Amulets, were calculated separately. The

reliability (all reliabilities are Cronbach's α) of the scale ranged from .92 to .95, and the reliabilities of the subscales ranged from .82 to .95.

Beliefs in the purpose of events (Paper II) were assessed by requesting participants to read short descriptions of random events, to imagine themselves in the situations described, and to then indicate on a 5-point scale whether they thought the event had a purpose. Study 1 of Paper II included 18 items from Lindeman and Aarnio (2007) that described co-occurrences with positive, negative or neutral outcomes for the participant. An example item is: "Your flight is delayed because of fog, and at the airport you meet the person whom you will get engaged to a year later. Did the fog have a purpose?" Study 2 included 15 items that described a broader range of events. In addition to co-occurrences that had outcomes for the participant, items were also included that described singular events (e.g. "You unexpectedly got promoted at work. The promotion had a purpose") and events that had outcomes for other people (e.g. "A lethal, contagious disease spread to Finland. The disease spread for a purpose"). In Study 1, the participants could interpret the word "purpose" as they wanted, and in Study 2, they were explicitly instructed to rate the events as having a purpose if they thought they were intentionally caused by an invisible agent or force. The reliability of the scale was .98 in Study 1 and .97 in Study 2.

Core knowledge confusions of the attributes of physical, biological and psychological phenomena (Papers II and IV) were assessed by items from Lindeman and colleagues (2008), Lindeman and Aarnio (2007), Lindeman and Saher (2007), as well as by new items. The items were statements attributing (1) qualities of matter, such as volume, to mental phenomena (example items: "An unstable human mind is disintegrating," "The mind falls apart when ill"), (2) the biological qualities of life and contagion to mental phenomena or to natural, lifeless entities (example items: "An evil thought is contaminated" and "Stars live in the sky"), and (3) mental properties, such as perceptions, emotions, beliefs, desires and intentions, to natural, lifeless entities, such as stones and planets, to plants and trees, to human-made artifacts, and to force (example items: "When summer is warm, flowers want to bloom," "Planets know things," "A home knows its inhabitants," and "Force can sense a human being").

The participants were asked to rate whether they thought the statements could be literally true. Examples were given of literally true statements and fully metaphorical

statements to guide the participants in responding. Responses were given on a 5-point scale (Study 1 of Paper II) or a dichotomous scale (Study 2 of Paper II, and Paper IV). In Study 1 of Paper II, 3 subscales with 6-16 items each were calculated separately, and in Study 2 of Paper II, 6 subscales with 5 items each. The reliabilities of the subscales ranged from .63 to .94, and the reliability of an 11-item overall scale (Study 2 of Paper IV) was .88.

In Study 1 of Paper IV, participants rated items in speeded and unspeeded conditions. In the speeded condition, 5 items were briefly presented on a computer screen one at a time, and participants were instructed to respond as quickly as possible. In the unspeeded condition, participants responded to another 5 items using a pen and paper and the response times were not limited.

In all studies, the core knowledge questionnaires included filler items (literally true statements, metaphorical statements, and strange but possible statements) for comparison and to disguise the purpose of the questionnaire.

Ontologically confused conceptions of energy (Study 1 of Paper II, and Paper III) were assessed by the following method. In Paper II Study 1, the items concentrated on ideas of energy as biological and mental, for example, as being capable of healing, living, purifying, dying, growing, withering, desiring, believing or being good, bad or poisonous (e.g. “Energy can grow”). These conceptions were assessed using 20 items from Lindeman and Saher (2007) rated on a 5-point scale (1 = does not apply at all, 5 = applies very well). The reliability of this scale was .94. In Study 2 of Paper II, corresponding items used the word “force” instead of “energy.” These items are described as part of the core knowledge confusions above.

In Paper III, conceptions of energy were assessed using 64 items of the form “energy can ____,” selected so as to include attributes of a wider range of ontological categories. Three subscales were formed, describing energy as a mental property, e.g., “Energy can be sensed as an experience,” in biological terms, e.g., “Energy can breathe,” and with attributes of animate beings, e.g., “Energy can want things.” As the reliabilities of these subscales were weak (range = .56-.78), a composite Ontologically Confused Conceptions score was also calculated, which showed better reliability ($\alpha = .86$). In addition, conceptions of energy as a material substance were assessed by 9 items ($\alpha = .61$), such as “Energy can be of a certain color,” and scientifically valid conceptions

were assessed by 11 items ($\alpha = .44$), such as “Energy can manifest as electric current.” Participants rated each statement on a dichotomous scale by circling the statements they thought could be literally true.

Trust in Complementary and Alternative Medicine (Paper III) was assessed using a list of 13 complementary and alternative treatments that are commercially available in Finland: homeopathy, psychic healing, EFT (Emotional Freedom Techniques), anthroposophical medicine that is based on the teachings of Rudolf Steiner, aromatherapy, Feng Shui, treatment of blockages in the body’s energy channels or meridians such as Shiatsu, treatments employing life force and spiritual energy such as Reiki, treatments based on the four elements of the body (earth, water, fire and air), such as Ayurveda, the use of yoga, relaxation techniques and meditation in the treatment of illnesses, Horstmann therapy, distance healing such as the laying on of hands or healing from a longer distance, and spiritual healing and energywork. These items were rated on a 6-point scale (Do you believe that the following treatments are effective in treating illnesses? 0 = I have never heard of this treatment or I can’t say, 1 = I don’t believe it at all, 5 = I believe it completely). The internal consistency of the scale was $\alpha = .92$. A composite score for trust in CAM was calculated for those who had reported an opinion on at least 5 treatments (95% of participants) by averaging the scores of items that had been given ratings between 1 and 5.

Faith in intuition (Papers III and IV) was assessed using the FI scale of the Rational-Experiential Inventory of Epstein and colleagues. In Paper III, the 5-item version (Epstein et al., 1996) was used and in Paper IV, the 20 item-version was used (Pacini & Epstein, 1999). The items were rated on a 5-point scale (1 = fully disagree, 5 = fully agree). In Study 2 of Paper IV, the items were divided into subscales of Experiential Engagement, measuring the tendency to rely on intuitive judgments and enjoy making them (example item: “I often go by my instincts when deciding on a course of action”), and Experiential Ability, measuring the experience of one’s intuitive judgments being reliable (example item: “I hardly ever go wrong when I listen to my deepest gut feelings to find an answer”). The reliability of the overall FI scale and the subscales ranged from .60 to .90.

Need for cognition (Papers III and IV) was assessed using various versions of the NFC scale. In Paper III, the 5-item version of Epstein and colleagues (Epstein et al.,

1996) was used. In Study 1 of Paper IV, the 18-item scale of Cacioppo and colleagues (1984) was used. Finally, Study 2 of Paper IV used 20 items from Pacini and Epstein (1999) that were divided into subscales on Rational Engagement, measuring reliance on analytical thinking and enjoyment of it (example item: “I enjoy solving problems that require hard thinking”), and Rational Ability, measuring trust in one’s ability to think rationally (example item: “I usually have clear, explainable reasons for my decisions”). All the items were rated on a 5-point scale (1 = fully disagree, 5 = fully agree). The reliabilities of the overall NFC scale and the subscales ranged from .75 to .91.

Actively Open-Minded Thinking (Papers III and IV) was assessed using the AOT scale (Sá et al., 1999; Stanovich & West, 1997). The scale consists of 41 statements, such as, “I tend to classify people as either for me or against me” (reverse coded) and “Difficulties can usually be overcome by thinking about the problem, rather than through waiting for good fortune.” The items were rated on a 6-point scale (1 = disagree strongly, 6 = agree strongly). The reliability of the scale ranged from .81 to .84.

The Argument Evaluation Test (Study 1 of Paper IV) was used to assess the ability to evaluate the quality of arguments independently of one’s own opinion, considered to be a measure of a tendency for reflective thinking. The test (Stanovich & West, 1997) proceeded in two parts. First, participants rated 23 statements on a 4-point scale (1 = strongly disagree, 4 = strongly agree). The items mostly concerned societal topics, for example, “Women should stay home and take care of the children while they are young”. Later, after having completed several other tasks, participants read short dialogues about the same topics and evaluated the quality of the last argument in the dialogues on a 4-point scale (A = very weak, D = very strong). Some of the items were slightly modified to be more relevant for Finnish participants. In analyzing the AET, the participants’ ratings of argument quality were regressed simultaneously on their own opinions and on the ratings of a panel who were experts on judging argument quality, representing an objective standard. Fifty separate regression analyses were run, one for each participant. The beta coefficients of these regression equations served as the participants’ AET scores.

Individual differences in the strength of cognitive inhibition (Study 1 of Paper IV) were assessed using a computerized color-word Stroop test. In the word reading condition (*W*), the names of 4 colors were displayed on a screen in black and the

participants were instructed to press a color-coded key depending on the word on the screen. In the color naming condition (*C*), the text 'XXXX' was shown in different colors and participants were instructed to press the corresponding key. In the color-word condition (*CW*), the names of the 4 colors were shown written in different colors and the participants were instructed to press the key that corresponded to the color of the font. Reaction times for correct trials were calculated and the Stroop interference score was calculated using Golden's (1978) formula: $CW - ((W \times C)/(W + C))$.

Brain activations associated with supernatural thinking (Paper V) were assessed using a task that inquired about supernatural signs. The participants first read short stories (one to two sentences long) describing critical life situations, imagined themselves in the situations described, and then saw a picture paired with each story. An example item is: "You have been unemployed and have now finally gotten a job interview. You are unsure about how it went and are anxiously awaiting the decision," followed by a picture of a business suit. In the Pilot study, the participants viewed 24 story-picture pairs on a webpage and rated, on a 5-point scale, the extent to which they would think that each picture contained a sign or a message regarding how the situation was going to turn out.

In the Main study 30 story–picture pairs, which were developed and selected on the basis of the pilot study and balanced with respect to emotional valence, were presented to participants on a small screen 20 cm from the participant's face while they were undergoing fMRI. The blood oxygenation level dependent (BOLD) signal was recorded. This method provides a measure of how the blood flow in each part of the brain changes over time, indicating increases or decreases in brain activity in each area. The participants were shown each story for 7 seconds, then a picture for 5 seconds, followed by an 8-second pause showing a blank screen. Thus, the experiment used a block design with relatively short blocks, comparing activations between the story, picture and rest conditions.

Five different activation effects in the fMRI signal were analyzed: (1) The overall effect on the whole brain of viewing the pictures as compared to the rest phases, (2) overall activation differences between skeptics and supernatural believers, (3) differences between skeptics and believers in an area in the right IFG that was chosen a priori as a region of interest (ROI), (4) differences between skeptics and believers in an

a priori ROI in the left IFG, and (5) whether the strength of activation of the right IFG ROI while the participants were viewing the pictures was related to their self-reported sign seeing.

A self-report variable for seeing signs was also obtained. After leaving the fMRI scanner, the participants rated, on a 5-point scale, the same stories and pictures that they had viewed during the scan, on the extent to which they would think that each picture contained a sign or a message about how the situation was going to turn out.

4. Results

4.1 Definitions

The review of relevant literature from the last two decades on paranormal, superstitious, magical, and supernatural beliefs showed that seven main types of conceptual definitions have been used. The first five defined the beliefs in terms of domain-general characteristics: Most authors considered magical, superstitious, paranormal, or supernatural beliefs to be (1) false beliefs, and many defined this falsity as meaning (2) scientific impossibility. Three classes of definitions were variations on the theme of associative biases, defining the beliefs as building on (3) covariation bias, (4) the laws of sympathetic magic, and (5) irrational acts. The last two definitions appealed to domain-specific representations, and could be divided into (6) counterintuitive and (7) intuitive beliefs.

The review revealed no solid reasons to separate the four concepts. First, operationalizations of paranormal, superstitious, magical, or supernatural beliefs were not systematically different from each other, as most of the beliefs were variously labeled using at least three of the concepts. Some small trends were nonetheless detected, such as a tendency to label luck-related beliefs as superstitions. However, these trends reflected the etymological histories of the concepts more than their theoretical underpinnings.

Second, the domain-general definitions were found to be either too narrow to cover all relevant beliefs, or too broad to differentiate PSMS beliefs from other unfounded beliefs. For example, defining the beliefs as irrational acts excludes beliefs that allow the individual to be passive, such as beliefs in omens, astrology, and telepathy. Considering the beliefs to be the result of a covariation bias, in turn, does not encompass beliefs in single phenomena such as devils or an afterlife, and the laws of sympathetic magic are confined only to a subset of magical beliefs. Domain-specific definitions fared better in distinguishing PSMS beliefs from other unfounded beliefs, but still covering, we argued, all relevant beliefs.

Out of the domain-specific definitions, the definition of supernatural beliefs as counterintuitive was found to be difficult to integrate with other work in developmental and cognitive psychology because of the different use of the term intuitive. Another

difficulty was that it is unclear whether the definition even covers beliefs, such as belief in a flying cow which, at face value, should not be defined as religious or supernatural.

4.2 Core knowledge confusions

The two studies in Paper II investigated the ability of core knowledge confusions to predict belief in the purpose of events and other PSMS beliefs. Both studies showed the same basic results. First, beliefs in the purpose of events were strongly related to the paranormal beliefs measured by the Revised Paranormal Beliefs Scale (Study 1: $r = .62$, $p < .001$, Study 2: $r = .70$, $p < .001$). Second, the results of multi-group structural equation modeling (SEM) revealed that in both datasets, a model in which core knowledge confusions were used to predict both types of beliefs had a good fit to the data (fit indexes for Study 1: $\chi^2 = 53.17$, $df = 24$, $p < .01$, GFI = .97, AGFI = .95, CFI = .98, RMSEA = .04, and Study 2: $\chi^2 = 518.88$, $df = 55$, $p < .001$, GFI = .97, AGFI = .95, CFI = .82, RMSEA = .06).

In these models, a latent factor, which was named General Core Knowledge Confusion, accounted for a substantial portion of the variation in all core knowledge confusion scales (51–70% in Study 1, 29–59% in Study 2). This latent factor predicted much of the variation in latent factor General Paranormal Belief (33% and 49%). The General Paranormal Belief factor accounted for a majority of the variation in beliefs in the purpose of events (67% and 61%) and in paranormal beliefs (63% and 86%). In Study 1, the core knowledge confusions related to energy were the confusions with the strongest associations to the belief variables. In the SEM, these had a strong independent relation to the General paranormal belief factor over and beyond their loading on the General core knowledge confusion factor. In Study 2, when items used the word “force” instead of “energy,” and they were phrased similarly to all other confusion items, this independent relationship disappeared. Thus, the results from both studies in Paper II supported the hypotheses that beliefs in the purpose of events and the paranormal beliefs included in the RPBS overlap strongly, and that core knowledge confusions predict both types of beliefs.

The two studies in Paper IV replicated the result that paranormal beliefs were positively related to core knowledge confusions. In Study 1, this relationship was weaker ($r = .32$) than in other studies, possibly due to the small number of items used to

assess the confusions. In Study 2, the relationship was at the expected level ($r = .50$), which was likely due to the improvements that were made to the ontological confusions measure.

4.3 Core knowledge confusions involving energy among upper secondary school students

On average, the upper secondary school students studied for Paper III accepted that 7.83 out of a possible 41 ontologically confused statements on energy could be literally true. The most common type of confusion that the students accepted was a description of energy as a mental property. Indeed, approximately a third of the students considered energy something that can literally be good, mental, spiritual, and sensed as an experience. It was also relatively common for students to accept ideas that described energy with properties of a living thing that can grow, heal, poison, and wither. Less common conceptions concerned likening energy to an animate being that can see, hear, know, want and have subjective experiences.

The pattern of accepting statements indicated that the ontologically confused conceptions seemed to co-exist with scientifically valid energy conceptions in the students' minds. The majority of students (78%) correctly checked at least nine out of the eleven scientifically valid statements, and none of the confusions correlated with the scientifically valid conceptions, suggesting that a student could hold confused conceptions independently of scientific conceptions.

Moreover, the data showed that the ontologically confused conceptions decreased during the physics courses. The students accepted fewer items describing energy with attributes of living things, animate beings and as a mental property at the end of their physics courses than they did at the beginning (repeated-measures ANOVA on the composite score of ontologically confused conceptions: $F(1,90) = 22.77, p < .001, \eta_p^2 = .24$). Their endorsement of scientifically valid descriptions, in contrast, did not change. No differences were found between the group that had attended the Targeted Lesson and those who had not, indicating that the Targeted Lesson did not have the expected effect on the students' conceptions. Furthermore, no differences were detected between the course levels in the pretest energy conceptions.

Lastly, the ontologically confused conceptions of energy were related to trust in CAM. A more detailed inspection of the correlations reveals that this relationship was driven by the conceptions of energy as a mental property ($r = .45, p < .001$ at pretest, and $r = .32, p < .05$ at posttest). Conceptions of energy as a living thing or an animate being were, in turn, not significantly associated with trust in CAM.

4.4 Intuitive, analytical, and reflective thinking

The two studies in Paper IV demonstrated that paranormal beliefs were positively correlated with an intuitive thinking style and negatively with reflective thinking. In Study 1 of Paper IV, a stepwise regression analysis showed that paranormal beliefs were best predicted by the FI scale ($\beta = .37, p < .01$), and out of the analytical and reflective style measures (AOT, AET, NFC), only AOT significantly augmented the predictive power ($\beta = -.43, p = .001, R^2 \text{ change} = .18$).

In Study 2 of Paper IV, analyses were run for both the overall FI and NFC scales and for the “ability” and “engagement” subscales suggested by Pacini and Epstein (1999). When FI and NFC were divided into these subscales, both of the engagement subscales were more strongly related to paranormal beliefs than their ability counterparts. Nevertheless, AOT was again superior to NFC in predicting paranormal beliefs. When using the overall scales, FI emerged as the best predictor of paranormal beliefs ($\beta = .46, p < .001$), and AOT added to the predictive power ($\beta = -.34, p < .001, R^2 \text{ change} = .11$) but NFC did not. When using the ability and engagement subscales, experiential engagement emerged as the best predictor ($\beta = .46, p < .001$), augmented by AOT ($\beta = -.34, p < .001, R^2 \text{ change} = .12$), but by neither of the NFC subscales. If core knowledge confusions were added to the independent variables, they surpassed all the thinking style variables in predicting paranormal beliefs ($\beta = .50, p < .001$). Study 2 of Paper IV also examined whether the relationships with the thinking styles were the same for all types of paranormal beliefs. The general pattern was predominately the same for all paranormal belief subscales.

The correlations between the core knowledge confusions and thinking styles were also obtained. In Study 1 of Paper IV, these relationships were nonsignificant, possibly due to the small number of items. In Study 2, the relationships were similar to those for

paranormal beliefs, but weaker (r 's having a magnitude of .21–.46 for paranormal beliefs, and .14–.34 for core knowledge confusions).

Among the younger students who were studied in Paper III, the relationships of their ontologically confused energy conceptions with the thinking style variables were weaker than might have been expected, but the trends were evident in the expected directions. In short, ontological confusions seemed to be negatively related to a disposition for actively open-minded thinking, and positively related to trust in intuition. However, these results need to be interpreted with caution because none of them met the confidence level which, due to the large number of correlations, was Bonferroni-adjusted to .0006.

The effect of encouraging intuitive responding by constraining the time allowed for responding was examined in Study 1 of Paper IV. The results were as expected. The number of ontological confusions accepted as literally true was significantly higher in the speeded than the unspeeded condition ($F(1,49) = 50.29, p < .001, \eta_p^2 = .51$). Erroneous responses on the filler statements also increased somewhat in the speeded condition, but inspection of the effect sizes (η_p^2), which were clearly smaller for the fillers (.09 and .07 for the two types of fillers), indicated that the increase in ontological confusions was not an artifact of a general disruption of reading or motor control, but a genuine effect of the speeded condition.

4.5 Cognitive inhibition

Study 1 of Paper IV examined the role of individual performance differences in cognitive inhibition. The results showed that paranormal beliefs were not significantly related to Stroop scores. In contrast and as expected, the core knowledge confusions correlated positively with the scores on the Stroop test (higher scores indicating poorer inhibition). In the speeded condition, this relationship was amplified (from $r = .30$ in the unspeeded condition to $r = .51$ in the speeded condition). A stepwise regression analysis predicting core knowledge confusions in the speeded condition showed that after accounting for Stroop scores ($\beta = .51, p < .001$), none of the thinking style measures (FI, NFC, AOT, AET) significantly added to the predictive power.

In Paper V, prior to the fMRI study measuring the brain activations related to supernatural thinking, a pilot study was conducted to ensure the validity of the stimuli.

The results of the Pilot study confirmed the prediction that seeing signs in story-picture pairs is indeed a form of supernatural thinking, with the two variables correlating strongly positively ($r = 0.50$, $p < .001$). The Main study then replicated this relationship between supernatural beliefs and seeing signs. The supernatural believers group reported seeing signs in the pictures approximately twice as often as the skeptics group did ($M = 3.49$ and $M = 1.79$, respectively; one-way ANOVA: $F(1,21) = 25.92$, $p < .001$, $\eta^2 = .56$).

The results of the fMRI analyses (Paper V, Main study) were as follows. First, the overall effect on the whole brain of viewing the pictures as compared to the rest phases (picture > rest contrast) was that activation increased in the left inferior frontal gyrus, middle frontal gyrus, fusiform gyrus, middle occipital gyrus and hippocampus. The reverse contrast (rest > picture) revealed no statistically significant activity.

Second, the region previously associated with cognitive inhibition and therefore chosen a priori as a ROI, displayed the expected difference between paranormal believers and skeptics. Skeptics had a stronger activation than supernatural believers in the pars orbitalis and pars triangularis of the right IFG (Brodmann's area (BA) 45/47; $t = 5.34$; MNI coordinates $x = 52$, $y = 22$, $z = 0$; $p < .05$, FWE-corrected for multiple comparisons).

Third, overall differences between the groups were examined but no other group differences were found. Fourth, the expected group difference in the left IFG, chosen a priori as a ROI based on previous studies indicating it is associated with message interpretation, was not found.

Fifth, in the pooled group of paranormal believers and skeptics, the ratings of seeing signs covaried with the average contrast strength in the picture > rest contrast in the right IFG ROI areas (BA 47; $t = 4.73$; MNI 36, 18, -10; $p < .05$, FWE-corrected for multiple comparisons). The stronger the activation was in these areas, the less the participants reported seeing signs, and vice versa.

5. Discussion

5.1 Core knowledge confusions largely explain PSMS beliefs

5.1.1 Conceptual support

Paper I asked whether there is reason to conceptually separate the concepts of paranormal, superstitious, magical, and supernatural beliefs, or whether they can all be covered with the definition of confusions of the core properties of mental phenomena, material objects, living, and animate organisms, and the processes these engage in. The review found no solid reasons to separate the four concepts. As these concepts are used interchangeably and seem to denote the same beliefs, it is more parsimonious to use one definition to cover them all. However, the domain-general definitions were found to be either too narrow to cover all relevant beliefs, or too broad to differentiate PSMS beliefs from other unfounded beliefs.

In accounting for all PSMS beliefs and only these beliefs, the two domain-specific definitions fared better. Thus, this thesis argues that the most relevant feature of the beliefs is not their form, but their content. As to whether the beliefs should be seen as counterintuitive or intuitive, the review noted the problems associated with the impreciseness of the concept of counterintuitiveness. In comparison, the definition of PSMS beliefs as intuitive is directly related to work on cognitive development and dual-process theories of thinking and thus it is easier to test. However, we noted that intuitiveness is a domain-general concept and as such does not help in differentiating PSMS belief from other beliefs or intuitions. As PSMS beliefs may also transpire with much reflection and conscious thinking, the review advised against incorporating intuitiveness into the definition of PSMS beliefs (even though it may be an important part of the explanation for those beliefs).

It was also noted that it is unclear whether the counterintuitiveness definition is too broad and covers ontological violations that by conventional standards should not be labeled as supernatural, such as a belief in a flying cow. Instead, we argued for the definition of all PSMS beliefs as category errors confusing core knowledge. This definition in effect incorporates many of the characteristics previously suggested to define the beliefs. For instance, the core knowledge confusion definition covers the

criterion that PSMS beliefs should be scientifically impossible, but it makes it more precise by excluding all of those beliefs that are as of yet unsupported, but not scientifically impossible. This definition is also more robust than the criterion that stipulates that paranormal statements should be empirically untestable. The reason is that testability might change with the development of research methods, but core knowledge confusions will remain category mistakes, and circumstances in which the arguments could be true do not exist.

An important practical implication of the definition is that many phenomena that have been suggested to be paranormal are not paranormal after all. For example, belief in the existence of extraterrestrials and the belief that handwriting reveals one's personality should not be classified as PSMS beliefs as they do not include category mistakes.

Importantly, the proposed definition still covers a wide variety of PSMS beliefs. In addition, more specific concepts, such as animism, anthropomorphism, participation, nominal realism, thought-action fusion, artificialism, promiscuous teleological reasoning, and the magical laws of contagion and similarity, can all be interpreted as referring to a particular type of core knowledge confusion.

5.1.2 Empirical support

The three following papers empirically tested the prediction that core knowledge confusions that involve mental phenomena, material objects, living, and animate organisms, and the processes these engage in, are related to PSMS and to related beliefs. All papers supported this prediction. In Paper II, structural equation models of two large datasets showed that models in which core knowledge confusions predicted the tendency to hold paranormal beliefs fit the data well. In comparison to typical figures obtained in this field (reviews: Irwin, 2009; Vyse, 1997), the proportions of variance explained were large (33% and 49%). Study 2 of Paper IV provided a third independent large dataset that also showed that core knowledge confusions were strongly correlated with paranormal beliefs.

Further, the core knowledge confusions also predicted supernatural beliefs that are not typically included in measures used to assess PSMS beliefs. In both studies in Paper II, the belief that random events occur for a purpose was explained by the same core

knowledge confusions as the other paranormal beliefs. In fact, the best fit to the data was obtained by a model in which beliefs in purpose and other paranormal beliefs formed part of the same latent general paranormal belief factor. As further support of the notion that all PSMS beliefs are part of the same psychological phenomenon, Study 2 of Paper IV revealed that the pattern of correlations with core knowledge confusions and thinking styles was largely the same for all paranormal belief subscales. These findings are in contrast to the suggestion that different explanations might apply to different sets of beliefs. For example, the laws of sympathetic magic have been considered to explain a subset of beliefs that involve “essences,” but not other types of beliefs (Rozin et al., 1986; Rozin & Nemeroff, 2002). In light of the present findings, however, it seems that all PSMS beliefs can be explained by the same factors.

Many scholars have advocated the view that supernatural beliefs, especially the belief in God or gods, are caused by an overextension of agency (Barrett, 2000; Bering, 2006; Dein & Littlewood, 2011; E. M. Evans & Wellman, 2006; Gjersoe & Hood, 2006; Guthrie, 1993). The results of this thesis expand on this idea to include not only overextension of agency, but also of the core attributes of physical and biological entities, as constituting the foundation of PSMS beliefs. As an illustration, many PSMS beliefs involve an overextension of the idea of “energy” or “force” to inappropriate domains. In Papers II and IV, the confusions expressing the idea of energies and forces that have mental and biological properties, such as knowing their direction and wanting to influence, were equally good if not better (Study 1 of Paper II) predictors of PSMS beliefs than the other confusions.

As evidence of the importance of energy confusions in PSMS beliefs, Lindeman and Saher (2007) have reported that paranormal believers attribute biological processes such as wound healing to the operation of energy. Other researchers have noted that students’ conceptions of energy bear traces of vitalistic thinking (Barak, Gorodetsky, & Chipman, 1997; Chabalengula et al., 2012), but Paper III was, to my knowledge, the first study that expressly investigated whether the energy conceptions found among a nonselect group of study participants are of the same type as those of paranormal believers. The results revealed that they were. Around a third of the students taking physics in three semi-randomly chosen upper secondary schools in Helsinki accepted that energy may

literally be good, mental, or spiritual. Many also conceived of energy as something that can grow, heal, or poison.

As the idea of a healing, spiritual energy is central to many forms of complementary and alternative medicine, we expected to find the ontologically confused energy conceptions associated with trust in CAM. For the conceptions of energy as a mental property, this expected relationship was found. In other words, the study confirmed that the more one thought that energy can be, for example, mental, the more likely one was to believe in the efficacy of treatments that employ mental energy, such as in Reiki treatments. For the other ontologically confused conceptions, the expected relationship was not found. It is, however, possible that the correlations were deflated by the low level of CAM endorsement by this group of participants. Therefore, repeating the study among a population more interested in CAM might produce more easily interpretable results.

Despite holding ontologically confused energy conceptions, all of the students also demonstrated that they were familiar with scientifically valid descriptions of energy. This finding is in line with previous studies that report that intuitive conceptions often co-exist in people's minds with later-learned, scientific conceptions of the same topics (Kelemen & Rosset, 2009; Legare & Gelman, 2008; McCloskey et al., 1980; Shtulman & Valcarcel, 2012). By the present data, the ontologically confused energy conceptions do not seem to be highly robust. The students' confusions did decrease during the course of the study, but the finding that there were no differences between the consecutive course levels in the pretest confusions calls the lastingness of this change into question. If taking physics courses led to deep changes in energy conceptions, we should expect to see fewer ontologically confused conceptions among those taking Physics 3 than among those taking Physics 1. However, this was not found. It also made no difference whether the students attended the lesson that explicitly addressed ontological categories – the students responded in the same manner as their peers who had not attended that lesson. Thus, ideas of spiritual and healing energies seem unresponsive to simple instructional interventions, such as the one used in this study.

5.2 Core knowledge confusions and PSMS beliefs arise from intuitive processing

The finding that PSMS beliefs are associated with a preference for intuitive thinking is well known and has been replicated in several studies, using several different measures of intuition, and on a variety of beliefs (Epstein et al., 1996; Genovese, 2005; King et al., 2007; King & Hicks, 2009; Lindeman & Aarnio, 2006; Sadler-Smith, 2011; Wolfradt et al., 1999). Both of the studies in Paper IV replicated this finding by demonstrating that out of a set of thinking styles, faith in intuition emerged as the best predictor of paranormal beliefs. Paper IV also showed that this relationship extended to core knowledge confusions. The relationships were similar as for PSMS beliefs, even though weaker.

Why is reliance on intuition related to PSMS beliefs? The present experimental results support the idea that it is because PSMS beliefs emerge from intuitive processing. In Study 1 of Paper IV, people accepted more core knowledge confusions when instructed to respond quickly than when the response time was unlimited. This finding can be interpreted in light of the default-interventionist dual-process theories, which posit intuition as primary (J. St. B. T. Evans, 2010). As evidence for these theories, studies indicate that manipulations, such as limiting response time or burdening the reasoner with a secondary task, disrupt the ability of analytical processes to intervene with intuition (De Neys, 2006; J. St. B. T. Evans & Curtis-Holmes, 2005). In cases where two different representations of the same topic co-exist, these types of manipulations appear to bring out earlier-developing intuitive biases (Kahneman, 2003; Kelemen & Rosset, 2009). One might note the similarity of these results with the findings revealing that when not paying attention, even people with higher education in physics resort to intuitive mechanics biases that they normally suppress (McCloskey et al., 1980).

Thus, the increase in core knowledge confusions in the speeded response condition supports the suggestion that core knowledge confusions are expressions of intuitive biases. Previous studies have demonstrated that manipulating thinking to be more intuitive increases teleological judgments (Kelemen & Rosset, 2009) and people's assessments of their own belief in God (Shenhav et al., 2012). Study 1 of Paper IV indicates that the same effect applies more generally to PSMS beliefs, even increasing

agreement with statements such as “the Moon strives forward,” “A mind touches another mind,” and “Force aims to influence.”

5.3 Reflective thinking restrains PSMS beliefs

Even if PSMS beliefs originate in intuitive processing, this does not imply that analytical thinking does not play a part in determining who holds the beliefs and who does not. In fact, in the two studies in Paper IV, a tendency for reflective thinking accounted for a large proportion of the variance in the beliefs. On theoretical grounds, and based on studies using experimental manipulations (Gervais & Norenzayan, 2012), this result was expected. Nevertheless, this represented a departure from previous studies on analytical thinking and PSMS beliefs, which have shown inconsistent or even contradictory findings (Epstein et al., 1996; Genovese, 2005; King et al., 2007; Lindeman & Aarnio, 2006; Sadler-Smith, 2011; Wolfradt et al., 1999; Yates & Chandler, 2000). A decisive difference, however, might be in the methods used to assess this type of thinking. Most of the previous studies operationalized analytical thinking as a need for cognition. In contrast, the present studies used methods that have been developed to tap into the reflective component of “Type 2” processing (Sá et al., 1999; Stanovich & West, 1997).

Earlier dual-process theories have not incorporated the distinction between algorithmic and reflective level “Type 2” processes. For example, Epstein’s cognitive-experiential self-theory is a well-elaborated theory of intuitive-experiential and rational-analytical ways of processing information, but it has discussed the rational-analytical “system” as a unitary entity (Denes-Raj & Epstein, 1994; Epstein et al., 1996). Therefore, it is possible that methods developed to fit the division into only two types of processing, such as the NFC scale (Cacioppo et al., 1984), do not capture individual differences at the reflective level. The scale developers themselves declare that NFC is not a measure of a tendency to think “rationally,” but rather a tendency to think extensively in general (Petty, Briñol, Loersch, & McCaslin, 2009).

In contrast, the methods adopted in this thesis have been designed to capture the attitudes, motivations, values and epistemological goals (or “dispositions”; Stanovich, 1999) that predict whether people will strive to use their analytical capacity to its fullest. As predicted, both of these measures, the AOT and the AET, were negatively related to

PSMS beliefs and to core knowledge confusions. Especially the AOT turned out to be strongly negatively related to the beliefs and was a better predictor of beliefs than NFC. Even among the upper secondary school students who were studied for Paper III, the AOT seemed to capture the essential dispositions that make people critical of phenomena such as CAM, but as the relationships were weak and nonsignificant, this finding must be taken as tentative.

5.4 Cognitive inhibition correlates with skepticism

Another way to look at the relationship of intuitive and analytical or reflective processing to PSMS beliefs is to analyze what enables one to restrain one's intuitive biases. I propose that a key to understanding this interaction might be cognitive inhibition. First, Study 1 of Paper IV found that a better capacity to withhold inappropriate responses, as measured by the Stroop test (MacLeod, 2001, 2005), was related to accepting fewer core knowledge confusion statements. The speeded response condition accentuated this relationship to such an extent that after accounting for the Stroop scores, none of the thinking styles added to the predictive power. A notable finding is that the Stroop scores in this study were not related to PSMS beliefs. Previously, Stroop scores have been related to teleological biases in which natural phenomena are envisioned as existing to benefit each other, such as "mosses form around rocks to stop soil erosion" (Kelemen & Rosset, 2009). Taken together, these results may indicate that cognitive inhibition influences the intuitive biases that constitute the basis for PSMS beliefs more than it influences the knowingly held beliefs.

Second, Paper V found that when presented with stories and pictures that may be interpreted as supernatural signs of what is to come, skeptics and paranormal believers differed in terms of their activation in a brain area that has been linked to cognitive inhibition. This area, BA 45/47 in the right IFG, has been linked to cognitive inhibition in studies using several different methods, and using tasks engaging both basic and higher cognition (Aron et al., 2004; De Neys et al., 2008; Tsujii & Watanabe, 2010). In the present data, the skeptics as a group had stronger activations in this area during the task than the believers did. As stronger support than can be obtained by looking at group differences, the activation in this area also covaried with the participants' self-assessments of how much they would think the stimulus materials contained

supernatural signs. To put it more simply, regardless of whether an individual was classified as a skeptic or as a believer, the more the area in question was activated, the less that individual thought that seeing a given picture would be an omen.

However, as the present fMRI study included no direct assessments of cognitive inhibition, the conclusion that the right IFG activations reflected cognitive inhibition is based on a reverse inference from earlier studies linking this area to this cognitive process (Poldrack, 2006). It therefore comes with an inherent degree of uncertainty. To support the inference that skepticism involves inhibiting supernatural intuitions, the relationship between right IFG activation and skepticism towards supernatural signs should be replicated in studies that include converging behavioral measures of cognitive inhibition.

5.5 Limitations of the study

Some issues remain open for future studies. One issue is the need to further develop the core knowledge confusion statements and to develop a set of statements that most reliably and validly measures the biases they are designed to measure. Currently, the reliabilities of some of the core knowledge confusions subscales are poor. One possible reason for this poor reliability is that some of the items might not reflect intuitive biases as well as other items do. Therefore, more research is needed to particularize the content of the items and to improve the psychometric properties of these measures. Following the hypothesis that core knowledge confusions arise from intuitive processing, there is, in particular, a need for measures that can be used under speeded conditions and other conditions that may increase intuitive processing.

Another issue for future research is to specify the conclusions that concern cognitive inhibition. At present, researchers disagree on whether inhibition should be conceptualized as an active process in which competing responses are inhibited, or whether the research findings can be interpreted with reference to other cognitive processes, such as working memory maintenance (Aron, 2007) or interference on response execution (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003). If the concept of cognitive inhibition is specified in more detail, our understanding of the processes behind PSMS beliefs may also increase.

Furthermore, the relationships between cognitive inhibition and the dual-process theories of reasoning are still understudied. The present findings indicate that both cognitive inhibition, as measured by the Stroop test (an algorithmic level process), and a reflective thinking style, as measured by the actively open-minded thinking scale and the argument evaluation test (reflective level processes) have complementary effects on restraining PSMS beliefs. Thus, the present results fit well with the model of the reasoning system advocated by Stanovich (1999, 2009a, 2009b), in which these two components of Type 2 thinking are distinguished. However, the division of different measures into these two levels, and the implications for PSMS beliefs that follow, must nevertheless be taken as preliminary, as the relationships of cognitive inhibition to dual-process theories have not been firmly established.

Moreover, conclusions based on the localization of brain activations must be interpreted with caution for a multitude of reasons. Localization efforts rest on the overall assumption that cognitive functions can be localized to discrete areas in the brain. It is, however, not clear that this assumption is valid, as large networks might be involved in producing each mental function (Logothetis, 2008). Even if the localization approach is substantiated, the right IFG might not be specific for cognitive inhibition. Some studies suggest that the right IFG might be related to attentional demands more generally and furthermore, that tasks requiring inhibition also activate many other areas besides the right IFG (Hampshire, Chamberlain, Monti, Duncan, & Owen, 2010). Thus, the reverse inference (Poldrack, 2006) that the right IFG activation of the skeptics in the present thesis specifically indicates a stronger cognitive inhibition, and not some other process (such as attentional demands), must be taken as tentative. To make this conclusion, the result must be substantiated by further studies that measure cognitive inhibition more directly.

Similarly, the exact significance of the Stroop results must be clarified. The present results indicated that PSMS beliefs and core knowledge confusions decreased with stronger cognitive inhibition both as assessed by a Stroop test and as indicated by brain imaging. Nevertheless, it is unclear whether the results obtained using these two different methods reflect the same underlying process. Imaging studies indicate that the neurocognitive basis of the Stroop effect overlaps with the right IFG region studied in the present thesis, but that it also includes several other frontal regions, such as the

anterior cingulate cortex, which is usually associated with conflict detection (Egner & Hirsch, 2005; Kerns, Cohen, MacDonald, Cho, Stenger, & Carter, 2004; Strauss, Sherman, & Spreen, 2006). Thus, our understanding of the specific executive functions involved in regulating PSMS beliefs may also become more nuanced along with further research.

Concerning the representativeness of the present data, a large proportion of the participants in the present studies were university students, and all of the participants were Finnish. As Finnish university students are among the most skeptical populations used in studies on PSMS beliefs (Tobacyk & Pirttilä-Backman, 1992), the findings need to be further validated in populations with higher levels of belief, and in cultural environments that are more open to the supernatural. It is not likely that the relationships with the factors that we have found to be related to PSMS beliefs would not apply elsewhere. Rather, it is possible that other factors that were not examined in this thesis and that could not be detected among this population are also related to PSMS beliefs. These additional factors might provide interesting new insights into understanding these beliefs.

5.6 Conclusion

To sum up the present thesis, evidence was presented to support the assertion that PSMS beliefs can be defined as core knowledge confusions. These confusions predict both traditional paranormal beliefs, as well as beliefs not previously included in assessments of paranormal beliefs. These confusions are more common among people who prefer to trust their intuition and they are less common among those who strive for rational thinking. In addition, these confusions increase when analytical thinking is disrupted, and with less effective cognitive control of responses and thoughts. Lastly, they are found even in a nonselect group of upper secondary school students, and are not easily influenced by instruction.

The present results indicate that PSMS beliefs are rooted in early-developing biases, but that there is large individual variation in how effectively a person's reasoning system suppresses these biases. The picture that takes shape from these results is that perhaps people are universally prone to confuse core knowledge. For those whose cognitive inhibition is weaker, life is full of experiences and impressions that feel

wondrous: Stones and trees are no less animate than people are, and everything that happens to oneself, happens for a reason. Meanwhile, for others, strong cognitive inhibition prevents impressions such as these from reaching consciousness. Therefore, adopting paranormal, superstitious, magical, and supernatural beliefs that are available in one's surrounding culture feels natural for others, while it feels foreign to others. Depending on one's education and cultural environment, and one's individual cognitive style, one might also replace these supernatural intuitions with non-supernatural explanations and adopt a non-supernatural worldview. Future studies will show whether a model such as this receives support.

It is also possible that individual differences in inhibition explain the underlying causes as to why the intuitive and reflective styles are related to the beliefs. The present findings suggest that intuition is more easily accessible to people with weaker inhibition, and perhaps they therefore come to rely on it more. Conversely, people with stronger inhibition may find it easier to disregard their supernatural intuitions and to concentrate on examining them critically.

If cognitive inhibition can explain individual differences in PSMS beliefs to the extent that the present thesis suggests, future studies may also investigate whether cognitive inhibition explains paranormal believers' poorer performance on deductive reasoning tasks. Out of the domain-general "cognitive deficits" studied in relation to PSMS beliefs, deductive reasoning is the only type of task showing fairly consistently that PSMS believers are at a disadvantage (reviews: French & Wilson, 2007; Wiseman & Watt, 2006). As deductive reasoning tasks require reasoners to inhibit intuitive beliefs in favor of logical validity (De Neys & Franssens, 2009), and as success on these tasks activates the same brain area (De Neys et al., 2008; Goel & Dolan, 2003; Tsujii & Watanabe, 2010) that the present thesis found to be related to rejecting PSMS beliefs, the relationship of deduction with PSMS beliefs may turn out to be a consequence of the believers' weaker ability to resist intuitions.

Importantly, the present data concern individual differences in beliefs. By comparison, theories that assume PSMS beliefs to be universal neglect to address why many people do not hold these beliefs. The cognitive science of religion has also largely overlooked the question of individual differences and instead has discussed religious beliefs as if they were universal. In contrast, explaining the beliefs in terms of one's

strength of cognitive inhibition and preferences for intuitive or reflective thinking leaves us in a better position to understand the intriguing question why some people adopt paranormal, superstitious, magical, and supernatural beliefs and others do not.

6. References

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