

## Empirical Article

## Examining the relationship between metacognitive trust in thinking styles and supernatural beliefs

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van Mulukom, V., Baimel, A., Maraldi, E. & Farias, M. (2024). Examining the relationship between metacognitive trust in thinking styles and supernatural beliefs. *Scandinavian Journal of Psychology*, 65, 206–222.

Conflicting findings have emerged from research on the relationship between thinking styles and supernatural beliefs. In two studies, we examined this relationship through meta-cognitive trust and developed a new: (1) experimental manipulation, a short scientific article describing the benefits of thinking styles; (2) trust in thinking styles measure, the Ambiguous Decisions task; and (3) supernatural belief measure, the Belief in Psychic Ability scale. In Study 1 ( $N = 415$ ) we found differences in metacognitive trust in thinking styles between the analytical and intuitive condition, and overall greater trust in analytical thinking. We also found stronger correlations between thinking style measures (in particular intuitive thinking) and psychic ability and paranormal beliefs than with religious beliefs, but a mixed-effect linear regression showed little to no variation in how measures of thinking style related to types of supernatural beliefs. In Study 2, we replicated Study 1 with participants from the United States, Canada, and Brazil ( $N = 802$ ), and found similar results, with the Brazilian participants showing a reduced emphasis on analytical thinking. We conclude that our new design, task, and scale may be particularly useful for dual-processing research on supernatural belief.

**Key words:** Dual-processing, thinking styles, meta-cognition, trust, paranormal belief, religious belief.

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## INTRODUCTION

A long history of theoretical and empirical work questions the rationality of supernatural beliefs. In the past decade, research (Farias, van Mulukom, Kahane *et al.*, 2017; Finley, Tang & Schmeichel, 2015; Sanchez, Sundermeier, Gray & Calin-Jageman, 2017; Yonker, Edman, Cresswell & Barrett, 2016) has called into question original studies showing a direct causal relationship between decreased analytical thinking and increased religious beliefs (Gervais & Norenzayan, 2012; Pennycook, Cheyne, Seli, Koehler & Fugelsang, 2012). Moreover, the magnitude of the correlation has now been seen to vary considerably in diverse cultural contexts (Gervais, van Elk, Xygalatas *et al.*, 2018).

In this research on dual-processing and supernatural beliefs (see also, Yilmaz, 2021), we hypothesized that since the myriad of this research is conducted in Western countries, a skewed baseline of higher trust in – not necessarily capacity for – analytical than intuitive thinking should be taken into account, both in terms of the experimental design and in terms of how the thinking styles are measured. We moreover hypothesized that paranormal beliefs rather than religious beliefs may be more closely associated with thinking style measures, as they are typically not institutionalized and more closely related to cognitive biases. Of these paranormal beliefs, we hypothesized that belief in psychic ability would be most closely related to trust in thinking styles, in particular intuitive thinking.

To test these hypotheses, we developed: (1) a new experimental design to manipulate the extent of one's trust in either analytical or intuitive thinking; (2) a new measure of thinking styles that

allowed for independent scores on analytical and intuitive thinking without normative statements or statements about one's personality; and (3) a new measure of the supernatural belief in psychic ability.

*Thinking styles measurements*

Traditional dual-processing theories suggest that there are two general *modes* of thinking: System/Type 1, which comprises automatic, fast, and subconscious processing; and System/Type 2, which encompasses reflective, effortful, and conscious processing (Evans, 2008; Stanovich & West, 2000). These modes of thinking are typically measured through intuitive and analytical *thinking styles*, respectively, which in turn are commonly defined as dispositions or traits, namely, as habitual ways of thinking (Evans, 2003).

While in a folk psychological sense System/Type 1 and 2 modes may be considered complementary (i.e., either you think reflectively or you think automatically), in everyday life we use both modes continuously (Stanovich, Toplak & West, 2008). It is unlikely that these cognitive systems work as two sides of the same coin; instead, they are likely to be separate but not opposite types of processing (Evans, 2003), with the crucial distinction that Type 1 processes are automatic, while Type 2 processes are not (Stanovich, 2009a). Type 1 processing takes place in the *autonomous* mind, while Type 2 processes take place in the *algorithmic* and *reflective* mind (Stanovich, 2009a). The algorithmic mind can be thought of as our *cognitive ability* (including inhibition and maintenance of decoupled

representations), whereas the reflective mind is where our (rational) *thinking dispositions* lie (such as the tendency to take time to deliberate, to collect information from various sources, etc.). This means that most experimental manipulations typically operate at the level of the reflective rather algorithmic mind, at meta-level processing rather than object-level processing (Ackerman & Thompson, 2017), targeting cognitive styles.

How cognitive style is experimentally manipulated and measured at a metacognitive level is central to the results of the studies. We suggest that in Western societies, where most of the research on dual-processing and supernatural beliefs has taken place (see for one of the exceptions, Gervais *et al.*, 2018), analytical thinking is generally considered a superior mode of thinking, and intuition eyed with distrust (Harris, 2005). With roots back in the Enlightenment period, critical thinking is emphasized in children's education (e.g., Allen & Scozzi, 2011). This means that we need to use caution when creating experimental manipulation to metacognitively manipulate one style or the other, as a baseline distrust in intuition may influence results. Shenhav, Rand & Greene (2012) neatly circumvented this issue by having participants write about a situation in which using either an intuitive or analytical thinking approach led to a positive or negative outcome, thus directly targeting positive or negative associations with these thinking styles.

A similar issue of an "unbalance" in thinking styles resides in some of its measurements. For example, one of the most used measures of analytical thinking, the Cognitive Reflection Test (CRT; Frederick, 2005) consists of three mathematical puzzles, whereby the analytical answer is always the correct answer, and the intuitive answer incorrect. We suggest that, while useful in certain contexts, the CRT measure conflates analytical thinking with accurate thinking, as in this test the analytical answer is always the correct one, which is a normativist fallacy (Evans & Stanovich, 2013). In everyday life, analytical thought need not be accurate: you can analyze something incorrectly, whilst still being engaged in rational, analytical thinking (Yonker *et al.*, 2016), and in some instances analytical thinking can actively lead you astray, in particular for decisions where there is no clear cut answer, such as those involving personal preferences (Wilson, Dunn, Kraft & Lisle, 1989). The CRT is also problematic to the extent that it measures mathematical ability as well as rational ability (Campitelli & Gerrans, 2014). Finally, a recent paper has indicated that the CRT may be a good measure of analytical thinking, but a poor measure for intuitive thinking (Pennycook, Cheyne, Koehler & Fugelsang, 2016), suggesting it may not be the right measure to use if interested in assessing the independent contributions of analytical and intuitive thinking.

An alternative and commonly employed measure of analytical/intuitive thinking is the Rational-Experiential Inventory (REI; Epstein, Pacini, Denes-Raj & Heier, 1996). This self-report inventory has two subscales, Need for Cognition (NFC) and Faith in Intuition (FII), which aim to measure preference for analytical and trust in intuitive thinking respectively. However, the biases inherent to this scale are evident in the nomenclature – while analytical thinking is something that is considered needed, intuitive thinking is something you have faith in: "I prefer complex to simple problems." (NFC) and "I believe in trusting my hunches." (FII). Rather than measuring analytical or intuitive

thinking style, these subscales may reflect preference for presenting yourself as a "thinker" (who loves complex problems and doing a lot of "long, hard thinking"), or as presenting yourself as someone who trusts in their feelings. While the former explicitly indicates a preference, the latter suggests a belief.

#### *Thinking styles and supernatural beliefs*

In 2012, a number of experimental psychology papers used dual-processing models to demonstrate a link between analytical/intuitive processing and religious belief (Gervais & Norenzayan, 2012; Pennycook *et al.*, 2012; Shenhav *et al.*, 2012), following a series of studies by Aarnio and Lindeman indicating, through self-report measures of cognitive style, that paranormal believers have less analytical and more intuitive thinking dispositions (Aarnio & Lindeman, 2005; Lindeman & Aarnio, 2006, 2007). The research from 2012 and later extended this research to religious belief, on the premise that religious belief is intuitive: a natural (by-)product of the human mind (Atran, 2002; Boyer, 2001; Guthrie, 1995). This theory is based on findings that religious belief is ubiquitous, appearing all over the world at many stages of humans' historical existence (Atran, 2002), and that it appears to be developing early (Barrett, 2012). In line with the idea that religious belief is intuitive, it has been suggested that religious disbelievers inhibit or override intuitive religious cognitions by engaging (more) in System 2 processing (Pennycook, Ross, Koehler & Fugelsang, 2016).

Here we suggest that this particular premise, this view on religious beliefs, is underspecified, and that religious beliefs may be reflective (Baumard & Boyer, 2013; Farias *et al.*, 2017) and that cultural learning is required to develop these intuitions into the specific religious content that is believed in any given cultural context (Gervais, Willard, Norenzayan & Henrich, 2011; Willard & Cingl, 2017). Moreover, the strength of the association between analytical thinking and diverse religious/supernatural beliefs is moderated by other factors. For instance, in typically more religious groups (e.g., politically conservative Americans compared to more politically liberal Americans), the association between analytical thinking and religious/supernatural beliefs is reduced to zero, and sometimes even *positive* (Baimel, White, Sarkissian & Norenzayan, 2021).

Indeed, while religious beliefs are a subset of supernatural beliefs, they are culture-laden and are typically sanctioned by institutions (Gervais *et al.*, 2011). Paranormal beliefs on the other hand are less culturally constrained. While they too are of course shaped by cultural learning, they are not controlled in the same way – there is no Vatican for paranormal believers. An individual in other words is freer to form and choose these beliefs – and thus, we argue, these are more directly associated with their cognitive biases and intuitions. Thus, while longstanding religious beliefs have been found to only be weakly correlated with intuition (e.g., see Gervais *et al.*, 2018), less culturally constrained beliefs like paranormal beliefs may emerge more closely from our evolved cognitive intuitions. This idea is also in line with findings demonstrating that cognitive biases support paranormal beliefs more strongly than religious beliefs (Willard & Norenzayan, 2013).

We suggest that one paranormal belief may be associated with intuitive thinking in particular, and that is the belief in psychic ability (also known as extrasensory perception, or ESP). Belief in psychic ability encompasses the ability to know the future (precognition), to know other minds (telepathy or mind-reading), to know different times and places (clairvoyance) through anomalous ways, without recourse to usual sensory channels or rational thought. In other words, central to belief in psychic ability is the belief in the ability to know things in a supernatural way. Crucially however, this knowledge is not attributed rational thought or usual sensory channels – the idea is that some people have an extraordinary ability to obtain this knowledge outside of the usual channels, from supernatural sources. As such, we suggest that belief in psychic ability may be considered a “paranormal belief in intuition” – which may be considered an ontological confusion of mental capacities, in particular of intuitive thought (Lindeman, Svedholm-Häkkinen & Lipsanen, 2015). Therefore, we predict that compared to other supernatural beliefs, belief in psychic ability may be specifically related to intuitive thinking. This hypothesis is in line with previous research which has demonstrated that the motivation to use intuitive thinking predicts belief in extrasensory perception best, over a preference for analytical thinking (Branković, 2019).

#### The current research

In the present research we will test our hypotheses that there is a higher baseline of trust in analytical than intuitive thinking in Western countries, that paranormal beliefs rather than religious beliefs will be more closely associated with thinking style measures, and that of the paranormal beliefs, belief in psychic ability will be most closely related to trust in thinking styles, especially intuitive thinking; see Fig. 1 for an overview for the main variables of interest. We will do so through experimentally manipulating metacognitive trust in thinking styles, validating a newly developed task to measure metacognitive trust in thinking

styles, and validating a newly developed scale to measure belief in psychic ability in two studies. Study 1, with a sample from predominantly from the United States, will validate the measures and will be the first test of the experimental manipulation and hypotheses; Study 2 will replicate Study 1 with samples from Canada and Brazil in addition to another United States sample.

#### STUDY 1: INTRODUCTION

Our first study builds on previous research in three crucial ways. First, we employed a new experimental manipulation with two scientific articles describing the benefits of either analytical or intuitive thinking. These allowed us to assess whether and in what ways the manipulation differentially affects trust in analytical and intuitive thinking. To assess trust in thinking styles, we developed a new measure, the Ambiguous Decisions task, which aimed to circumvent some of the issues with previous scales: by presenting the participants with a number of ambiguous decisions, hypothetical persons, and two continuous scales representing support of reliance on analytical and intuitive thinking style respectively (see Fig. 2), we were able to avoid a hydraulic conceptualization of cognitive styles, social desirable valuation of one’s own personality, and valuing analytical thinking as necessarily correct. To help us identify the effectiveness of our manipulation and to assess levels of cognitive styles in our participants, we also included several commonly employed measures of analytical/intuitive thinking: the Cognitive Reflection Test (CRT; Frederick, 2005) and the Rational Experiential Inventory (REI; Epstein *et al.*, 1996).

We also developed and validated a more targeted yet comprehensive measure of paranormal belief in psychic ability, to capture intuitive knowledge believed to be acquired by extrasensory abilities in a more broad way than the Precognition subscale of the Paranormal Beliefs Scale (PBS; Tobacyk, 2004), which only assesses paranormal intuitions about the future. Additional psychic abilities that were included were: mind-

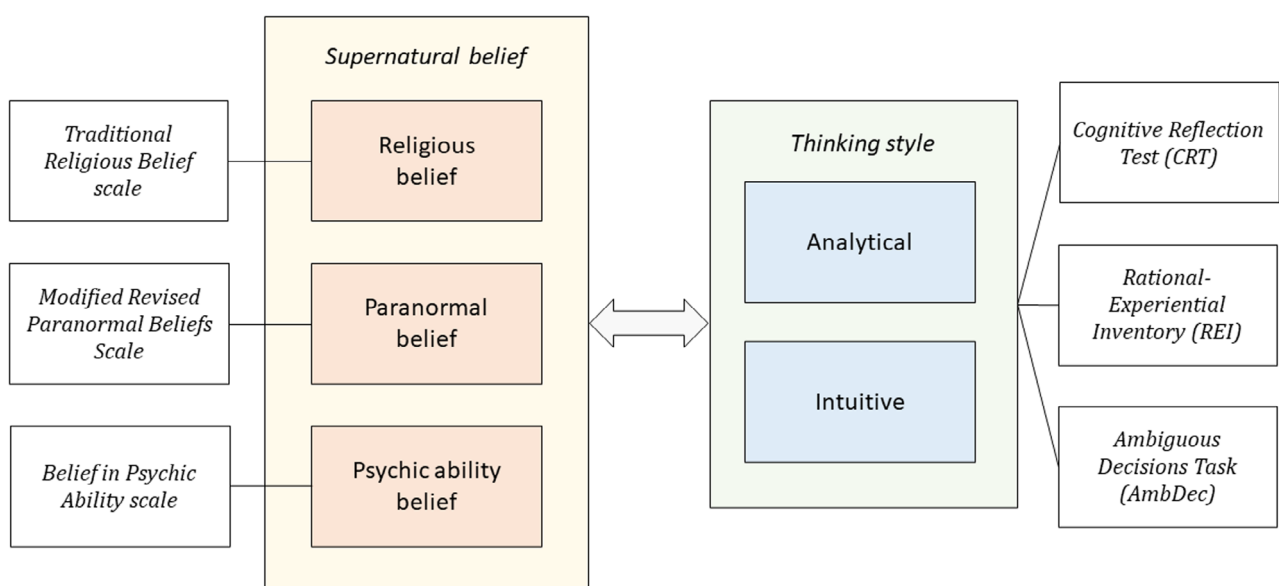


Fig. 1. Overview of the main variables of interest (orange, left, and blue boxes, right) and their assessments (white boxes), in the present research on the relationship between supernatural belief (large yellow box, left) and thinking style (large green box, right).

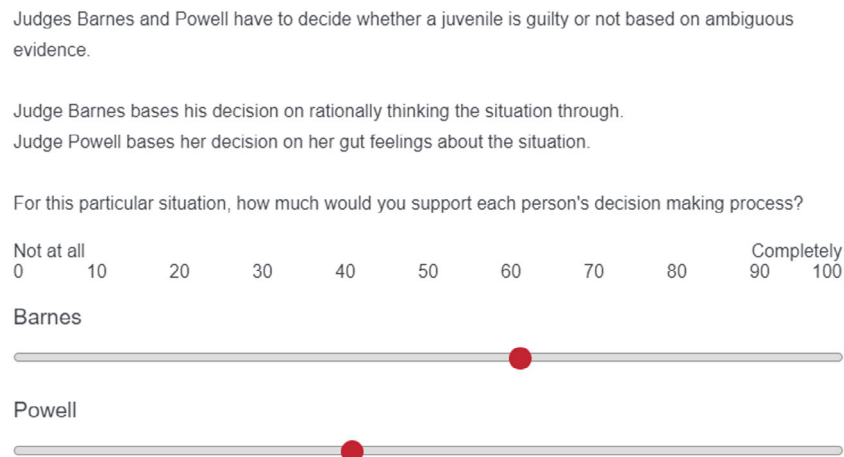


Fig. 2. An example of a question from the Ambiguous Decisions task, which shows that for this scenario, the participant puts support for analytical thinking at about 62%, and support for intuitive thinking at about 41%.

reading/telepathy, sensing other people's feelings, somehow obtaining information about persons/locations/objects through other than normal channels (e.g., sixth sense, seeing signs, or having visions). To validate the Belief in Psychic Ability scale, we included scales measuring paranormal beliefs and traditional religious beliefs (Modified Revised Paranormal Beliefs Scale; Lindeman, Svedholm-Häkkinen & Riekkö, 2016) and a scale measuring spiritual experiences (Mysticism Scale; Hood, Ralph, Ghorbani *et al.*, 2001).

### Materials and methods

**Participants.** Participants were recruited through online social media on predominantly American platforms, such as Reddit and Facebook, with an advertisement that read: "This study contains several sets of questions asking about your preferences for analytical and intuitive thinking, and beliefs, and a number of tasks involving analytical and intuitive thinking skills." Four hundred and fifteen participants completed the survey online (163 female, 246 male, six other), aged 18–79 years ( $M = 34.3$ ,  $SD = 13.6$  years), and with an average of 16 years of education ( $SD = 2.8$ ). The sample comprised Christians (42.4%), atheists (35.7%), agnostics (8.0%), nones (5.1%), spiritual but not religious (SBNR; 2.7%), indifferent (2.4%), humanists (1.0%), and others (1.9%). When clustered by affiliation, non-believers (agnostics, atheists, humanists, and those who are indifferent, or claim no religion) make up 52.0% of the sample, while believers (Christians) make up 42.5% of the sample, with the remaining 5.5% placed in other spiritual categories (such as SBNR, Buddhists, and Other). Ethics approval was obtained from the university's Ethics Committee.

**Measures.** We developed and validated a new measure of belief in psychic ability with 12 items. Items were designed on the basis of two popular books on psychic ability: *The essential guide to psychic powers* (Bartlett, 2012) and *101 ways to jump-start your intuition* (Holland, 2005). These books were read in close detail to glean common themes that could be summarized in the scale's items. These themes include: precognition (knowing the future), telepathy or mind-reading (knowing other minds), clairvoyance (knowledge of different times and places), and the concept of a sixth sense generally. Further details regarding the psychometrics of the items and the scale will follow in the Results section. Participants indicated agreement with the items on a six-point Likert scale with options anchored at: "strongly disagree" (−2.5), "disagree" (−1.5), "somewhat disagree" (−0.5), "somewhat agree" (0.5), "agree" (1.5), "strongly agree" (2.5). The scores of the 12 items were averaged (Cronbach's  $\alpha = 0.94$ ).

In the Modified Revised Paranormal Beliefs Scale (Lindeman *et al.*, 2016), the version of the Revised Paranormal Beliefs Scale (Tobacyk, 2004) with 23 items is adapted for modern Western audiences, and measures belief in the paranormal (Cronbach's  $\alpha = 0.92$ ), captured by a number of subscales, including Precognition (four items;  $\alpha = 0.80$ ), Psi (four items;  $\alpha = 0.71$ ), Spiritualism (four items;  $\alpha = 0.85$ ), Superstition (three items;  $\alpha = 0.85$ ), Traditional Religious Belief (four items;  $\alpha = 0.97$ ), and Witchcraft (four items;  $\alpha = 0.903$ ). Unless specified differently, participants' averages on the overall Paranormal Belief Scale were calculated without the Precognition and Traditional Religious Belief subscales (Cronbach's  $\alpha = 0.88$ ) to avoid overlap with our measures of belief in psychic ability and religious beliefs. Participants indicated agreement on a six-point Likert scale with options anchored at: "strongly disagree" (−2.5), "disagree" (−1.5), "somewhat disagree" (−0.5), "somewhat agree" (0.5), "agree" (1.5), "strongly agree" (2.5).

The Mysticism Scale (Hood *et al.*, 2001) was included to measure divergent validity of the Belief in Psychic Ability scale. While often correlated with other measures of spirituality (Klein, Silver, Streib, Hood & Coleman, 2016), we expected that this scale would not correlate with our Belief in Psychic Ability Scale, because it focuses on unitive, ego-dissolving experiences, in contrast to our scale's focus on beliefs in specific abilities (e.g., reading other people's minds). The shortened Mysticism Scale consists of 16 items asking individuals to report whether they have had intense experiences of altered states of consciousness. Examples are: "I have had an experience in which I realized the oneness of myself with all things" and "I have had an experience which was both timeless and spaceless." Participants answered on a five-point Likert scale with options anchored at "definitely not true" (−2), "probably not true" (−1), "cannot decide" (0), "probably true" (1), and "definitely true" (2). The scores on the 16 items were averaged (Cronbach's  $\alpha = 0.88$ ).

The Cognitive Reflection Test (CRT; Frederick, 2005) consists of three quasi-mathematical problems that generate implicit misleading intuitions: there is an intuitively compelling (but wrong) answer and a mathematically correct answer. For example: "A bat and a baseball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost?" Most people's intuitive response is \$0.10 but upon reflection come to realize that the correct answer is \$0.05. Here we have reported the number of both analytical and intuitive answers over the three puzzles, as participants could also give incorrect answers that are neither the analytical nor the intuitive answer.

The Rational-Experiential Inventory (REI; Epstein *et al.*, 1996) consists of 10 items on two subscales (five items each) that measure attitudes towards cognitive styles: the Need for Cognition scale (NFC), reflective of one's preference for analytical thinking (Cronbach's  $\alpha = 0.85$ ), and Faith in Intuition (FII) scale, reflective of one's trust in intuition (Cronbach's  $\alpha = 0.87$ ). Examples are: "I prefer complex to simple problems." (NFC) and "I believe in trusting my hunches." (FII). Scores

were calculated by averaging responses to the items of the subscales on a six-point Likert scale with options anchored at: “strongly disagree” (−2.5), “disagree” (−1.5), “somewhat disagree” (−0.5), “somewhat agree” (0.5), “agree” (1.5), “strongly agree” (2.5).

In the Ambiguous Decisions task, participants are presented with 12 different ambiguous scenarios in which a decision needs to be made; see Fig. 2 for an example. These scenarios included medical, financial, social scenarios, and other contexts (see Appendix S1). The thinking styles are represented by two persons: one person is always described as using an analytical thinking style (e.g., “making his/her decision by logically/rationally thinking the situation through”), and one person is described as using an intuitive thinking style (e.g., “making his/her decision based on his/her intuition/gut feelings of the situation.”); the gender of the hypothetical persons is counterbalanced across items. Participants are asked to rate how much they support each person’s decision-making process for each situation, on a scale from 0 to 100% (for both person A and B, or analytical and intuitive thinking, separately). Other persons, rather than oneself making the decision, were chosen so that the participant would not have to take into account one’s own perceived ability or personality, or whether they would ever be in the described situation.

The scenarios and decision styles were presented with the question: “For this particular situation, how much would you support each person’s decision making process?” Participants recorded their responses by sliding an indicator on a horizontal bar ranging from 0 (with the anchor ‘Not at all’) to 100 (‘Completely’), which showed numbers in increments of 10 as a guidance (but the bar can be left anywhere with 1 point of the scale of 100). This way, participants were able to indicate their trust in analytical thinking, intuitive thinking, neither or both, on a continuous scale, for a variety of decision-making contexts, meaning that the participant does not have to choose between the two thinking styles, and can also rate both low or both high. All analytical (Cronbach’s alpha = 0.83) and all intuitive (Cronbach’s alpha = 0.87) scores were averaged, giving an overall score of trust (0–100) that the participant overall has in the two cognitive styles.

The newly developed tasks and data of this study are openly accessible on OSF at <https://doi.org/10.17605/OSF.IO/M4EKY>.

**Method.** To manipulate metacognitive trust in cognitive style, participant were asked to read a short scientific article (that the authors of the present article wrote) describing the benefits of either analytical or intuitive thinking; this was randomized for all participants. We used scientific articles specifically as the present studies included participants from the United States and Canada, cultural contexts that generally promote analytical thinking. Our intention was to experimentally induce a feeling in the participants that they could trust the information they read about either cognitive style, by stimulating a way of thinking where each of these cognitive styles was presented as positive, beneficial, and socially acceptable. We aimed to achieve this by presenting the information in the shape of a scientific article, which laid out how either style works, followed by a description of an existing (real) scientific study which demonstrated some benefits of that style (see Appendix S2).

The order of the materials was always as follows: information sheet, consent form, the experimental manipulation, Ambiguous Decisions task, Belief in Psychic Ability scale, PBS (including Traditional Religious Beliefs), REI, CRT, Mysticism Scale, and demographics questions.

## Results

**Ambiguous Decisions task.** We ran an exploratory factor analysis on the analytical and intuitive choices for the scenarios of the Ambiguous Decisions task separately, using common principal axis factor analyses to illuminate the shared variance and to explore the number of factors to be extracted. For analytical decisions, the first unrotated factor accounted for 36.9% of the common variance (Eigenvalue = 4.42) and yielded factor loadings between 0.40 and 0.69 (see Table 1). For intuitive decisions, the

Table 1. Scenarios of the Ambiguous Decisions task with factor loadings for analytical (ana) and intuitive (int) answers

Scenario	Ana	Int
	F1	F1
1 Tom and Jessie have to decide whether to leave their current jobs to start working for a promising new company.	0.69	0.64
2 Kathleen and Joshua have to decide who of their friends they will trust to look after their house for a month.	0.64	0.70
3 Judges Barnes and Powell have to decide whether a juvenile is guilty or not based on ambiguous evidence.	0.46	0.44
4 Michelle and Eric have to decide whether to seek new, experimental, treatment for their sick child, who may or may not get better with the current treatment.	0.56	0.51
5 Steve and Jean have to decide how to deal with high levels of stress at their work.	0.59	0.72
6 Rebecca and Kevin have to decide whether they will try to overcome their disagreements and continue with their relationship, or not.	0.50	0.66
7 Swimming coaches Campbell and Hill have to decide whether to include a swimmer with varying levels of performance in their team.	0.58	0.71
8 Members of Congress Williams and Peterson have to decide whether to pass a law on healthcare that is likely to have positive consequences for some, and negative consequences for others.	0.57	0.55
9 Andrew and Laura have to decide which car to buy.	0.40	0.57
10 Sarah and Raymond have to decide whether they will fire one of their current sales team members who has performed badly for the last few months after a good year.	0.62	0.63
11 Patrick and Janet have to decide who of their friends to trust to be their designated driver for a party.	0.59	0.60
12 Kimberly and Gary have to decide which sports team to place their bets on.	0.51	0.58

first unrotated factor accounted for 42.2% of the common variance (Eigenvalue = 5.06) and yielded factor loadings between 0.44 and 0.72 (see Table 1). No further factors were analyzed given a tapering off in the scree plot. Cronbach’s alphas were 0.83 (analytical decisions) and 0.87 (intuitive decisions) indicating sufficiently high reliability and internal consistency which was not meaningfully improved by item elimination.

To test for convergent validity of the Ambiguous Decisions task, we examined the correlations between analytical and intuitive answers on previously validated cognitive style measures and the Ambiguous Decisions task. We found that analytical answers on the Ambiguous Decisions task correlated significantly and positively with the other analytical measures, and negatively with all other intuitive measures, and that intuitive answers correlated significantly and positively with all other intuitive measures and negatively with all other analytical measures; see Table 2. As might be expected, the Ambiguous Decisions task (and particularly the intuitive score) was more closely related, but not particularly strongly, to self-reported *trust* in intuitions as measured by the REI-FII scale than any part of the Ambiguous Decisions task was related to the CRT. This is suggestive evidence that the Ambiguous Decisions task is effectively tapping into a different source of variation regarding metacognitive thinking styles than thinking styles at an object-level.

Table 2. Correlations between cognitive style measures in Study 1

Variable	1	2	3	4	5
1. CRT3 ana	–				
2. CRT3 int	–0.89** [–0.91, –0.87]	–			
3. REI NFC (ana)	0.21** [0.12, 0.30]	–0.21** [–0.30, –0.12]	–		
4. REI FII (int)	–0.20** [–0.29, –0.10]	0.18** [0.09, 0.27]	–0.16** [–0.25, –0.06]	–	
5. AmbDec ana	0.13* [0.02, 0.23]	–0.14** [–0.24, –0.03]	0.18** [0.08, 0.29]	–0.24** [–0.34, –0.14]	–
6. AmbDec int	–0.19** [–0.29, –0.08]	0.16** [0.06, 0.26]	–0.18** [–0.28, –0.08]	0.49** [0.41, 0.57]	–0.22** [–0.31, –0.11]

Notes: Values in square brackets indicate the 95% confidence interval for each correlation. Correlations for  $n = 348$ , except for correlations with Ambiguous Decisions task measures where  $n = 293$ , due to a technical problem with the survey. NFC = Need for Cognition; FII = Faith In Intuition; CRT = Cognitive Reflection Test; AmbDec = Ambiguous Decisions task; int. = intuitive answers, ana = analytical answers.

\* $p < 0.05$ .  
\*\* $p < 0.01$ .

**Belief in psychic ability.** We ran an exploratory factor analysis on the psychic ability scale, using common principal axis factor analysis to illuminate the shared variance and to explore the number of factors to be extracted. The first unrotated factor accounted for 60% of the common variance (Eigenvalue = 7.22) and yielded factor loadings between 0.70 and 0.83 (see Table 3). No further factors were analyzed given a tapering off in the scree plot and an Eigenvalue <1.00 for the next factor (Eigenvalue = 0.89). Cronbach’s alpha was 0.94 indicating high reliability and internal consistency which was not improved by item elimination.

To test for convergent and divergent validity of the scale, we examined the correlations between the Belief in Psychic Ability Scale and existing measures of supernatural beliefs, as well as one experiential measure of spirituality, the Mysticism Scale. We found a high correlation of belief in psychic ability and other

paranormal beliefs overall ( $r = 0.79$ , 95% CI = [0.75, 0.82],  $p < 0.001$ ), a moderate correlation with traditional religious beliefs ( $r = 0.45$ , 95% CI = [0.37, 0.53],  $p < 0.001$ ), but no correlation with mystical experiences ( $r = -0.06$ , 95% CI = [–0.15, 0.04],  $p = 0.27$ ). Next, we examined the association between the Belief in Psychic Ability scale and all subscales of the PBS (Precognition, Psi, Spiritualism, Superstition, and Witchcraft, excluding the Traditional Religious Beliefs). We found that these subscales were all significantly correlated with the Belief in Psychic Ability scale ( $r_s > 0.47$  [0.39, 0.83],  $p_s < 0.001$ ). To investigate which PBS subscales were especially predictive of belief in psychic ability, we ran a linear regression of all PBS subscales on belief in psychic ability scores. We found that all PBS subscales significantly predicted belief in psychic ability scores,  $F(5,409) = 192.02$ ,  $p < 0.001$  (see Table 4), but belief in precognition especially so ( $\beta = 0.47$ ), as expected. Together, these findings show convergent and divergent validity for the new Belief in Psychic Ability scale.

Table 3. Items of the Belief in Psychic Ability scale with factor loadings

Scale item	F1
1 People are sometimes able to gain information about the thoughts or feelings of another person, in a way that does not depend on rational prediction or normal sensory channels.	0.72
2 Mind-reading is possible.	0.78
3 It is possible to send “mental messages” to other people.	0.80
4 Some people are able to read other people’s minds.	0.79
5 Sometimes people are able to obtain information about lost people and objects with no previous knowledge about them.	0.78
6 Some people have an ability to predict the future.	0.77
7 It is sometimes possible to foresee events that later really happen.	0.72
8 Some people are able to interpret certain “signs” in the world that provide them with accurate information about the future or a distant past.	0.70
9 People sometimes sense when their loved ones are in danger even when physically far away and in the absence of communication.	0.80
10 Some people are able to accurately describe distant locations without any prior experience or knowledge of these places.	0.83
11 Some individuals have a sixth sense.	0.80
12 Some people have visions which contain accurate information about other times and places.	0.80

**Experimental manipulation.** Next we examined the effects of the experimental manipulation – reading a scientific article about the benefits of either analytical or intuitive thinking – on our measures of analytical and intuitive thinking and supernatural beliefs; see Table 5. We did not find any significant differences in answers on the CRT (analytical or intuitive answers) following the analytical or intuitive thinking condition. Instead, we found that analytical and intuitive decisions on the Ambiguous Decisions task differed significantly (with a medium-sized effect

Table 4. Regression predicting belief in psychic ability by the paranormal belief scale subscales

PBS subscale	$\beta$	95% CI	$t$	$p$	Fit
Precognition	0.47	[0.37, 0.57]	9.45	<0.001	$R^2 = 0.701^{**}$ , 95% CI = [0.65, 0.73]
Psi	0.14	[0.07, 0.21]	3.81	<0.001	
Spiritualism	0.23	[0.14, 0.32]	5.02	<0.001	
Superstition	–0.09	[–0.16, –0.02]	–2.50	0.01	
Witchcraft	0.18	[0.11, 0.25]	5.08	<0.001	

\*\* $p < 0.01$ .

Table 5. Descriptive and comparative statistics for cognitive styles measures and supernatural belief measures for the analytical and intuitive condition in Study 1

	Range	Analytical condition ( <i>n</i> = 390)	Intuitive condition ( <i>n</i> = 412)	<i>F</i>	<i>p</i>	$\eta^2$	$\eta^2$ 90% CI
Cognitive style measures							
CRT ( <i>n</i> analytical answers)	0 to 3	1.94 (1.16)	1.93 (1.09)	0.02	0.88	<0.001	[<0.01, <0.01]
CRT ( <i>n</i> intuitive answers)	0 to 3	0.82 (1.02)	0.79 (0.99)	0.12	0.73	<0.001	[<0.01, 0.01]
REI need for cognition	-2.5 to 2.5	1.43 (0.77)	1.35 (0.79)	1.11	0.29	0.003	[<0.01, 0.02]
REI faith in intuition	-2.5 to 2.5	-0.08 (0.92)	0.24 (0.93)	11.89	<b>0.001</b>	0.03	[0.01, 0.06]
AmbDec (analytical decisions) <sup>a</sup>	0 to 100	78.09 (11.43)	74.52 (12.05)	7.96	<b>0.005</b>	0.02	[<0.01, 0.05]
AmbDec (intuitive decisions) <sup>a</sup>	0 to 100	45.76 (15.81)	54.37 (17.23)	23.37	<b>&lt;0.001</b>	0.06	[0.03, 0.11]
Supernatural belief measures							
Religious beliefs	-2.5 to 2.5	-0.049 (2.08)	-0.38 (2.13)	0.32	0.57	0.001	[<0.01, 0.01]
Paranormal beliefs	-2.5 to 2.5	-1.87 (0.78)	-1.74 (0.74)	2.96	0.09	0.007	[<0.01, 0.03]
Belief in Psychic Ability	-2.5 to 2.5	-1.09 (1.08)	-0.86 (1.05)	4.78	<b>0.03</b>	0.01	[<0.01, 0.03]

Notes. Means (standard deviations) are shown for the scores. CRT = Cognitive Reflection Test; REI = Rational-Experiential Inventory; AmbDec = Ambiguous Decisions task; Paranormal belief = Modified Revised Paranormal Beliefs Scale calculated without Precognition and Traditional Religious Belief subscales; Religious beliefs = PBS Traditional Religious Belief subscale. Significant *p*-values in bold.

<sup>a</sup>For *F*-statistics, degrees of freedom are (1,413) for all measures except for the Ambiguous Decisions task where (1,342), due to a technical problem with the survey which meant some participants did not complete the Ambiguous Decisions task (completed responses *n* = 175 for the analytical condition, and *n* = 169 for the intuitive condition).

for intuitive decisions), as well as scores on the Faith in Intuition subscale, but not on the Need for Cognition subscale. As for supernatural beliefs, belief in psychic ability was significantly higher in the intuitive condition than in the analytical condition, with a trend for paranormal beliefs (small effect size), and no difference in religious beliefs. Note, however, that the effect of condition on psychic ability did not replicate in Study 2. Given this effect's relatively high *p*-value (*p* = 0.03) and this later non-replication, we do not stress the importance of this initial finding.

In line with our hypothesis, we found that, regardless of condition, analytical scores on the Ambiguous Decisions task were greater than intuitive scores,  $t(343) = 21.46$ , mean difference = 26.34 [23.93, 28.76],  $p < 0.001$ ,  $d = 1.16$ . Similarly, scores on REI Need for Cognition were greater than on the REI Faith in Intuition subscale,  $t(414) = 20.40$ , mean difference = 1.31 [1.19, 1.44],  $p < 0.001$ ,  $d = 1.00$ .

*Supernatural beliefs and dual-processing styles.* First, we explored the correlations between thinking style measures and supernatural belief measures, see Table 6 and Fig. 3. From this table and figure it appears that, in line with our hypothesis, correlations are strongest for belief in psychic ability, followed by paranormal beliefs, followed by religious beliefs, which only

correlate (positively) with Faith in Intuition and intuitive scores on the Ambiguous Decisions task.

We next examined whether these correlations of the supernatural beliefs with the thinking styles differed significantly in magnitude (Steiger, 1980), see Table 7. These comparisons indicate in line with our hypothesis that correlations of thinking styles (with the exception of analytical decisions on the Ambiguous Decisions task) with religious beliefs differ significantly (i.e., are smaller) than both the correlations of thinking styles with paranormal beliefs and with belief in psychic ability, which did not differ between each other (with a small trend for Faith in Intuition, which reflects a slightly larger correlation with belief in psychic ability than paranormal beliefs).

However, as the comparisons of correlations do not take into account how all these correlations vary *within* people (as the above correlations are over the entire sample) nor the differences in the way these thinking style measures relate to each belief type within one model (rather than running these bivariate correlations separate from each other and then comparing them), we next ran a mixed effect linear regression, which is able to do these things in one place simultaneously. This mixed effect regression assesses the relative contributions of thinking style as measured by the CRT and Ambiguous Decisions task to supernatural belief by

Table 6. Correlation table for correlations between thinking style measures (rows) and supernatural beliefs (columns) in Study 1

	Religious beliefs	Paranormal beliefs	Belief in psychic ability
CRT ( <i>n</i> analytical answers)	-0.08 [-0.18, 0.01]	-0.29** [-0.37, -0.20]	-0.29** [-0.38, -0.20]
CRT ( <i>n</i> intuitive answers)	0.13** [0.03, 0.22]	0.27** [0.18, 0.36]	0.27** [0.18, 0.36]
REI need for cognition	-0.01 [-0.11, 0.08]	-0.16** [-0.25, -0.07]	-0.19** [-0.28, -0.10]
REI faith in intuition	0.18** [0.08, 0.27]	0.35** [0.26, 0.43]	0.46** [0.38, 0.53]
AmbDec (analytical decisions)	-0.10 [-0.20, 0.01]	-0.19** [-0.29, -0.08]	-0.19** [-0.29, -0.09]
AmbDec (intuitive decisions)	0.22** [0.12, 0.32]	0.36** [0.26, 0.45]	0.41** [0.32, 0.50]

Notes: Values in square brackets indicate the 95% CI for each correlation. Correlations for 415 observations (344 observations for the Ambiguous Decisions task scores).

\*\**p* < 0.01.

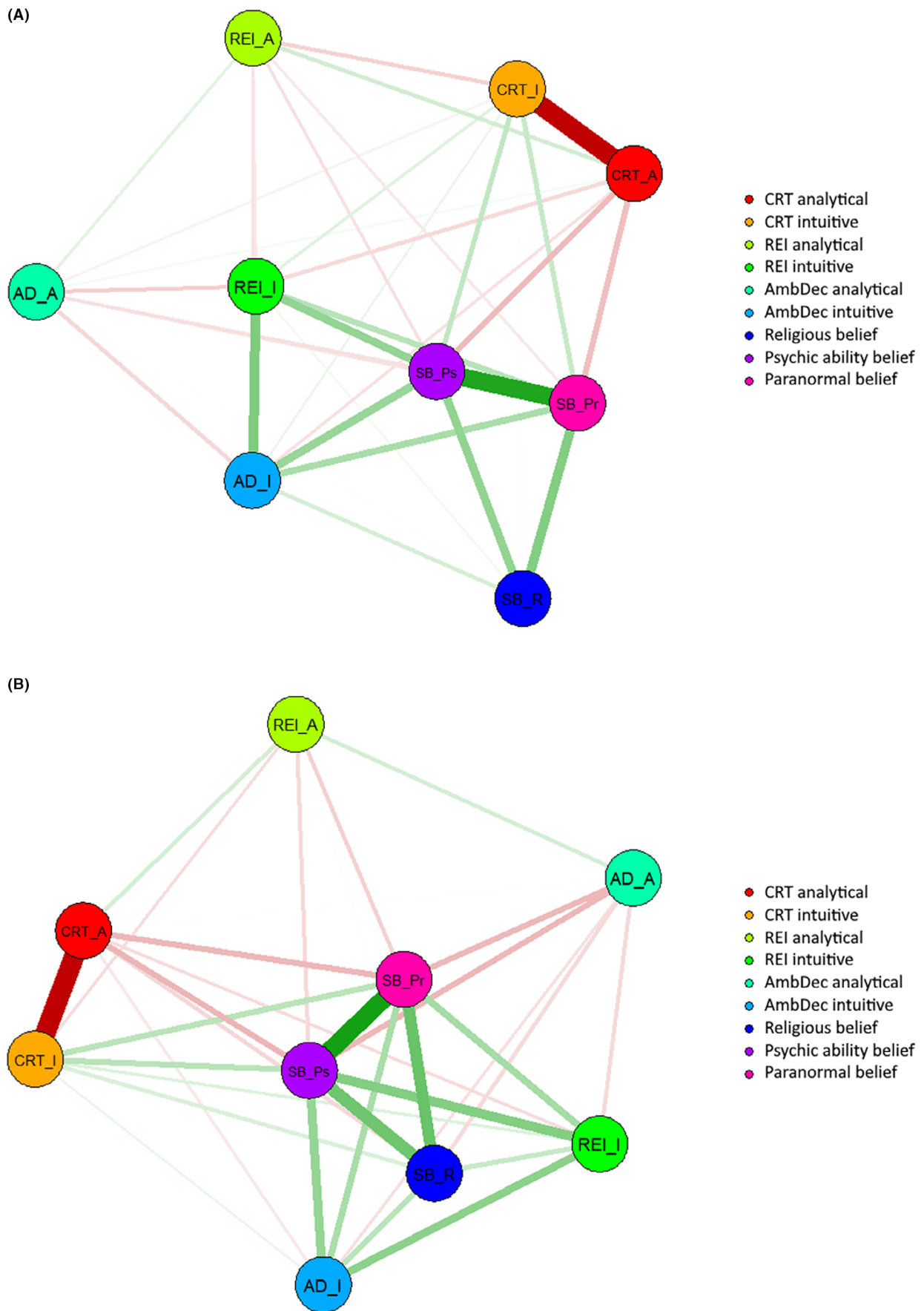


Fig. 3. Plot of correlations between thinking style and supernatural belief variables of interest in (A) Study 1 and (B) Study 2; green lines reflect positive correlations, red lines negative correlations, and thickness and opacity of line reflects the strength of the relationship.

Table 7. Comparison of thinking style-supernatural belief correlations in Study 1

	Religious vs. paranormal belief	Religious vs. psychic ability belief	Paranormal vs. psychic ability belief
CRT (analytical)	$z = 3.13, p = 0.002$	$z = 3.13, p = 0.002$	$z = 0.00, p = 1.00$
CRT (intuitive)	$z = -2.10, p = 0.03$	$z = -2.10, p = 0.03$	$z = 0.00, p = 1.00$
REI need for cognition	$z = 2.17, p = 0.03$	$z = 2.62, p = 0.009$	$z = 0.44, p = 0.66$
REI faith in intuition	$z = -2.63, p = 0.008$	$z = -4.53, p < 0.001$	$z = -1.89, p = 0.06$
AmbDec (analytical)	$z = 1.20, p = 0.23$	$z = 1.20, p = 0.23$	$z = 0.00, p = 1.00$
AmbDec (intuitive)	$z = -2.00, p = 0.05$	$z = -2.76, p = 0.006$	$z = -0.77, p = 0.44$

Note: Significant z-scores in bold. AmbDec = Ambiguous Decisions task.

regressing CRT (analytical) scores and both the analytical and intuition scores from the Ambiguous Decisions task on each type of supernatural belief. Belief endorsement was modeled with a random-intercept for belief type (religious, paranormal, and psychic ability), and the effect of each measure of thinking style was estimated as varying by belief type. This analysis allows us to estimate the contributions of thinking styles to these diverse beliefs while accounting for the within-person variability in belief endorsement. The results of which (see Table 8) indicate that supernatural beliefs are significantly negatively associated with CRT scores and analytical scores of the Ambiguous Decisions task, and positively associated with intuition scores on the Ambiguous Decisions task. We note that after accounting for mean differences in endorsement of these different beliefs, the random effects estimated by this model suggest that there is little to no variation in how these measures of thinking style are differentially related to these three types of supernatural beliefs (see Table S1 in Appendix S3 for comparable results with the REI and Ambiguous Decisions task rather than the CRT). Of these three measures of thinking style, it is trust in intuitive decisions on the Ambiguous Decisions task that is most strongly associated with supernatural belief.

### Discussion

To further examine the relationship between thinking styles and supernatural beliefs, we developed an experimental design, a

Table 8. Model summary of mixed effect linear regression with thinking style measures predicting supernatural beliefs in Study 1

Predictors	Belief		
	Estimates	CI	<i>p</i>
(Intercept)	0.04	[-0.52, 0.59]	0.89
CRT ( <i>n</i> analytical answers)	-0.10	[-0.18, -0.02]	<b>0.01</b>
AmbDec (analytical decisions)	-0.06	[-0.12, -0.00]	<b>0.04</b>
AmbDec (intuitive decisions)	0.23	[0.13, 0.33]	<b>&lt;0.001</b>
Random effects			
$\sigma^2$	0.81		
$\tau_{00ITEM}$	0.24		
$\tau_{11ITEM.CRT3\_Freq\_Ana}$	0.00		
$\tau_{11ITEM.AmbDec\_ANA}$	0.00		
$\tau_{11ITEM.AmbDec\_INT}$	0.00		
$N_{ITEM}$	3		
Observations	1,032		

Notes: Variables are mean centered and scaled by their standard deviation. Significant *p*-values in bold.

thinking style measure, and a new supernatural belief scale, to test our hypotheses that there is a baseline trust in analytical versus intuitive thinking in Western countries such as the United States, and that paranormal beliefs – in particular belief in psychic ability – would be more closely related to thinking styles than religious beliefs.

The newly developed Ambiguous Decisions task was aimed at measuring trust in analytical and intuitive thinking whilst allowing participants to score both styles simultaneously and whilst attempting to reduce the influence of the participant's own ability or perceived personality. We found that the analytical and intuitive decisions for the scenarios of this task were reliable and loaded onto a single factor for analytical and intuitive thinking respectively. In line with our hypothesis, we found that, regardless of (analytical or intuitive) condition, analytical scores were higher than intuitive scores (on both the Ambiguous Decisions task and the REI-Need for Cognition scale).

Our experimental manipulation – reading a short scientific article on the benefits of either analytical or intuitive thinking – was successful in that it was associated with increased trust in the respective thinking styles in participants. We did not find a result of the analytic versus intuitive condition on CRT scores, which is contrary to some of the previous findings for comparisons of analytical thinking versus control conditions (Pennycook, Cheyne, Barr, Koehler & Fugelsang, 2014; Pennycook *et al.*, 2012; Pennycook, Ross, Koehler & Fugelsang, 2016). Since the CRT is hailed primarily as a measure of analytical thinking (Pennycook *et al.*, 2016), we suggest that the experimental manipulation affected people's beliefs about the utility of each cognitive style without affecting their actual capacities for them. This idea is supported by further findings that participants who received the intuitive condition did not have significantly lower scores on the Need for Cognition scale, as compared to those who had the analytical condition. We did, however, find significant higher scores on the Faith in Intuition scale in the intuitive condition participants as compared to analytical condition participants. We suggest that reading a short scientific article on the benefits of intuitive thinking may have increased the participants' trust in intuition, and may therefore be deemed more permissible as a valid decision making procedure. This is supported by the higher intuitive scores on the Ambiguous Decisions task in the intuitive condition than in the analytical condition.

We hypothesized that of supernatural beliefs, paranormal beliefs rather than religious beliefs may be more closely associated with individual differences (such as in thinking style) and therefore also more malleable (such as in experimental set-

ups). In other words, we hypothesized that thinking styles will be more closely related to paranormal than religious beliefs, and more likely to be influenced by this study's experimental manipulation. Of these supernatural beliefs, we moreover hypothesized that one often overseen paranormal belief – belief in psychic ability – may be directly associated with an intuitive thinking style. To measure this belief in a more fine-grained manner, we developed and validated the Belief in Psychic Ability scale. The scale's items loaded positively onto one factor, and the items were reliable, and correlated positively and significantly with the Paranormal Belief Scale subscales. The rationale behind developing this scale was that we needed a specific and comprehensive scale measuring belief in psychic ability or extrasensory perception that includes a variety of knowledge from supernatural sources.

Whilst eyeballing the correlation analyses, it appeared that belief in psychic ability was more strongly correlated with thinking style measures than other paranormal beliefs, which in turn appeared more strongly correlated again than religious beliefs. This was partially confirmed by a comparison of the correlations, whereby correlations of thinking styles measures with religious belief were smaller than correlations of thinking styles with belief in psych ability and with paranormal belief, but contrary to our hypothesis, correlations did not differ between these latter two types of belief. Moreover, an inferential mixed effect linear regression demonstrated that there is little to no variation in how thinking style measures are differentially related to the three types of supernatural beliefs when accounting for variation in belief endorsement within and across individuals. This means that even after taking into account the differences in how much people believe in these things on average, the relationship between thinking styles and supernatural beliefs is quite similar across different individuals. This suggests that the way thinking styles are connected to these beliefs is fairly consistent among people. That being said, the results of these regressions do provide support for the hypothesis that trust in these thinking styles as measured by the Ambiguous Decisions task is a better predictor of belief than the CRT or the REI. More specifically, the *intuition* scores on the Ambiguous Decisions task were the clearest, and most consistent, predictor of supernatural belief endorsement.

## STUDY 2: INTRODUCTION

In Study 2, we aimed to replicate Study 1 with a bigger sample and with additional samples from Canada and Brazil.

### Materials and methods

**Participants.** Eight hundred and two participants were targeted through online social media as well as recruited from Prolific in the US, Canada, and Brazil. For the US, we had 288 participants (114 female, 170 male, four other), who had the following religious affiliations: 34.5% Christian, 25.8% atheist, 13.7% agnostic, 10.9% no religion, 6.2% other, 3.4% spiritual but not religious, 3.1% indifferent, 1.6% Jewish, 0.9% Buddhist. In the Canadian sample we had 307 participants (126 female, 178 male, three other), of which 25.9% Christians, 17.6% atheists, 16.3% no religion, 14.0% agnostic, 11.0% spiritual but not religious, 5.5% indifferent, 3.9% other, 1.7% Muslim, 1.7% Jewish, 1.4% Hindu, 0.6%

Buddhist, 0.6% Sikh. For Brazil, we had 207 participants (94 female, 111 male, two other), with the following religious affiliations: 25.3% atheist, 18.2% Christian, 16.7% spiritual but not religious, 15.6% Espírita, 6.7% no religion, 5.9% agnostic, 3.7% other, 2.6% indifferent, 2.6% Umbandista, 2.2% Buddhist, 0.4% Jewish. For the full demographics of the groups, see Table S3 in Appendix S4. Ethics approval was obtained from the university's Ethics Committee.

**Measures.** We used the same scales and response Likert options as in Study 1: the Rational-Experiential Inventory (REI; Epstein *et al.*, 1996) with the Need for Cognition ( $\alpha = 0.786$ ) and Faith in Intuition ( $\alpha = 0.873$ ) subscales, the Cognitive Reflection Test (CRT; Frederick, 2005), and the Modified Revised Paranormal Beliefs Scale (Lindeman *et al.*, 2016), which included paranormal beliefs ( $\alpha = 0.935$ ) and traditional religious belief ( $\alpha = 0.934$ ), and Belief in Psychic Ability scale ( $\alpha = 0.959$ ). Moreover, the Ambiguous Decisions task again showed good reliability for analytical ( $\alpha = 0.846$ ) and intuitive ( $\alpha = 0.890$ ) thinking scores. In addition, analytical scores on the task correlated significantly and positively with scores on the Need for Cognition scale ( $r = 0.21$ , 95% CI = [0.14, 0.27],  $p < 0.001$ ), and intuitive scores correlated significantly and positively with scores on the Faith in Intuition scale ( $r = 0.44$ , 95% CI = [0.38, 0.49],  $p < 0.001$ ; see also Table S4 in Appendix S4), demonstrating convergent validity.

All measures were translated into Brazilian-Portuguese by the Brazilian researcher on this project (EM), and back-translated and compared to the English version to ensure adequate translations.

The data of this study are openly accessible on OSF at <https://doi.org/10.17605/OSF.IO/M4EKY>.

**Method.** We used the same experimental manipulation as in Study 1. The order of the materials was always as follows: information sheet, consent form, the experimental manipulation, Ambiguous Decisions task, PBS (including Traditional Religious Beliefs), Belief in Psychic Ability scale, REI, CRT, and demographics questions.

## Results

**Experimental manipulation.** We again first examined the effects of reading a scientific article about the benefits of either cognitive style on our measures of analytical and intuitive thinking and supernatural beliefs, see Table 9 (see Tables S5–S7 in Appendix S5 for this table by country). As in Study 1, the experimental manipulation had a significant effect on Faith in Intuition scale and both the analytical and intuitive measures of the Ambiguous Decisions task, with no effect on our supernatural belief measures.

We also investigated whether analytical scores were higher than intuitive scores on the REI and Ambiguous Decisions task, regardless of condition, but taking into account the three countries. Repeated measures ANOVAs, with country added as between-subject factor, indicated that scores on the REI-NFC were higher than those of the REI-FII,  $F(1,799) = 123.24$ ,  $p < 0.001$ ,  $\eta^2 = 0.148$ . The between-subjects effect of country was also significant,  $F(2,799) = 26.81$ ,  $p < 0.001$ ,  $\eta^2 = 0.063$  (see Table S8 for country averages), as was the interaction between REI subscales and country,  $F(2,799) = 16.19$ ,  $p < 0.001$ ,  $\eta^2 = 0.039$ . Bonferroni-corrected post hoc comparisons demonstrated that this effect was driven by the difference in REI-NFC and REI-FII, which was significantly different for participants from Canada ( $p < 0.001$ ) and participants from the United States ( $p < 0.001$ ), who did not differ from each other ( $p > 0.99$ ). More specifically, for participants from Brazil did not demonstrate a significant

Table 9. Descriptive and comparative statistics for cognitive styles measures and supernatural belief measures for the analytical and intuitive condition in Study 2

	Range	Analytical condition ( <i>n</i> = 390)	Intuitive condition ( <i>n</i> = 412)	<i>F</i>	<i>p</i>	$\eta^2$	$\eta^2$ 90% CI
Cognitive style measures							
CRT ( <i>n</i> analytical answers)	0 to 3	1.86 (1.16)	1.72 (1.19)	2.96	0.09	<0.01	[<0.01, 0.02]
CRT ( <i>n</i> intuitive answers)	0 to 3	0.94 (1.07)	1.00 (1.07)	0.60	0.44	<0.01	[<0.01, 0.01]
REI need for cognition	-2.5 to 2.5	0.92 (0.88)	0.84 (0.95)	1.83	0.18	<0.01	[<0.01, 0.01]
REI Faith in Intuition	-2.5 to 2.5	0.19 (0.97)	0.39 (0.96)	9.15	<b>&lt;0.001</b>	0.01	[<0.01, 0.03]
AmbDec (analytical decisions)	0 to 100	81.30 (11.50)	78.41 (12.65)	11.38	<b>&lt;0.001</b>	0.01	[<0.01, 0.03]
AmbDec (intuitive decisions)	0 to 100	46.69 (20.36)	54.72 (18.31)	34.62	<b>&lt;0.001</b>	0.04	[0.02, 0.07]
Supernatural belief measures							
Religious beliefs	-2.5 to 2.5	-0.79 (1.63)	-0.72 (1.67)	0.35	0.55	<0.01	[<0.01, <0.01]
Paranormal beliefs	-2.5 to 2.5	-1.51 (0.96)	-1.47 (1.02)	0.44	0.51	<0.01	[<0.01, <0.01]
Belief in psychic ability	-2.5 to 2.5	-0.75 (1.32)	-0.65 (1.34)	1.29	0.23	<0.01	[<0.01, 0.01]

Notes: Means (standard deviations) are shown for scores.  $F(1,800)$ . CRT = Cognitive Reflection Test; REI = Rational-Experiential Inventory; AmbDec = Ambiguous Decisions task; Paranormal belief = Modified Revised Paranormal Beliefs Scale calculated without Precognition and Traditional Religious Belief subscales; Religious beliefs = Traditional Religious Belief subscale of the Modified Revised Paranormal Beliefs Scale. Significant *p*-values in bold.

difference between REI-NFC and REI-FII scores ( $p = 0.10$ ), whereas participants from Canada showed a significantly higher score on the REI-NFC than the REI-FII ( $p < 0.001$ ), as did participants from the United States ( $p < 0.001$ ). This effect was also driven by a difference on the REI-NFC between the countries, where Brazilian participants scored significantly lower than Canadian ( $p < 0.001$ ) and US participants ( $p < 0.001$ ), who did not differ from each other ( $p > 0.99$ ), with no significant differences in REI-FII between the countries ( $p > 0.54$ ).

Similar repeated measures ANOVAS with country entered as between-subject factor for the Ambiguous Decisions task also demonstrated that analytical scores were higher than intuitive scores,  $F(1,799) = 1125.79$ ,  $p < 0.001$ ,  $\eta^2 = 0.585$ . The between-subjects effect of country was also significant,  $F(2,799) = 11.37$ ,  $p < 0.001$ ,  $\eta^2 = 0.028$  (see Table S8 for country averages), as was the interaction between Ambiguous Decisions task scores and country,  $F(2,799) = 11.34$ ,  $p < 0.001$ ,  $\eta^2 = 0.028$ . Bonferroni-corrected post hoc comparisons showed that this effect was driven by the difference in analytical and intuitive Ambiguous Decisions scores for participants from Brazil,

who showed a significantly larger difference between analytical and intuitive Ambiguous Decisions scores as compared to participants from Canada ( $p < 0.001$ ) and participant from the United States ( $p < 0.001$ ), who did not differ from each other ( $p > 0.99$ ). More specifically, while participants from all three countries had significantly higher analytical than intuitive scores on the Ambiguous Decisions task ( $p < 0.001$ ), Brazilian participants had significantly lower analytical scores than Canadian participants ( $p = 0.005$ ), with no further country differences ( $p > 0.19$ ), and they also had significantly lower intuitive scores than both Canadian participants ( $p < 0.001$ ) and US participants ( $p < 0.001$ ), with no significant difference between those two North American samples ( $p = 0.09$ ).

*Supernatural beliefs and dual-processing styles.* We again explored the correlations between thinking style measures and supernatural belief measures, see Table 10 and Fig. 3. From this table and figure, it again generally appears that correlations are strongest for belief in psychic ability, followed by paranormal beliefs (with the exception of REI Need for Cognition), followed

Table 10. Correlation table for correlations between thinking style measures (rows) and supernatural beliefs (columns) in Study 2

	Religious beliefs	Paranormal beliefs	Belief in psychic ability
CRT ( <i>n</i> analytical answers)	-0.20** [-0.26, -0.13]	-0.30** [-0.36, -0.24]	-0.31** [-0.37, -0.24]
CRT ( <i>n</i> intuitive answers)	0.19** [0.12, 0.26]	0.29** [0.23, 0.35]	0.30** [0.23, 0.36]
REI need for cognition	-0.07* [-0.14, -0.00]	-0.22** [-0.28, -0.15]	-0.19** [-0.26, -0.12]
REI faith in intuition	0.25** [0.18, 0.31]	0.36** [0.30, 0.42]	0.47** [0.41, 0.52]
AmbDec (analytical decisions)	-0.19** [-0.25, -0.12]	-0.30** [-0.36, -0.23]	-0.30** [-0.36, -0.24]
AmbDec (intuitive decisions)	0.29** [0.23, 0.35]	0.34** [0.28, 0.40]	0.41** [0.36, 0.47]

Notes: Values in square brackets indicate the 95% confidence interval for each correlation. Correlations for 802 observations.

\* $p < 0.05$ ,

\*\* $p < 0.01$ .

Table 11. Comparison of thinking style-supernatural belief correlations in Study 2

	Religious vs. paranormal belief	Religious vs. psychic ability belief	Paranormal vs. psychic ability belief
CRT (analytical)	$z = 2.13, p = 0.03$	$z = 2.35, p = 0.02$	$z = 0.22, p = 0.83$
CRT (intuitive)	$z = -2.12, p = 0.03$	$z = -2.34, p = 0.02$	$z = -0.22, p = 0.83$
REI need for cognition	$z = 3.07, p = 0.002$	$z = 2.44, p = 0.01$	$z = -0.63, p = 0.53$
REI faith in intuition	$z = -2.43, p = 0.02$	$z = -5.09, p < 0.001$	$z = -2.66, p = 0.008$
AmbDec (analytical)	$z = 2.34, p = 0.02$	$z = 2.34, p = 0.02$	$z = 0.00, p = 1.00$
AmbDec (intuitive)	$z = -1.11, p = 0.27$	$z = -2.74, p = 0.006$	$z = -1.63, p = 0.10$

Note: Significant comparisons in bold.

by religious beliefs. However, contrary to Study 1, religious beliefs also significantly correlated with each of the thinking styles measures, not just the intuitive scores on these measures.

We examined whether these correlations differed significantly from each other given the sample size (Steiger, 1980), and found that the correlation of the thinking style measures with religious beliefs was indeed generally smaller than that with paranormal belief or belief in psychic ability, with the exception of intuitive scores on the Ambiguous Decisions task, where the correlation between these intuitive scores and religious beliefs was smaller than the correlation of these intuitive scores with belief in psychic ability but not smaller than the correlation coefficient of the paranormal belief correlation. The correlation between the thinking styles measures and paranormal beliefs did generally not differ significantly in size from the correlations between the thinking styles measures and belief in psychic ability, with the exception of REI Faith in Intuition, where the correlation was greater with belief in psychic ability than paranormal beliefs.

We also conducted these correlations (as in Table 10) and comparisons (as in Table 11) for each of the three countries separately, see Tables S9–S14 in Appendix S5. Given that the country samples individually are smaller (ranging from 207 to 307 observations each) the effects are of course reduced. Nonetheless, we find that the correlation of REI Faith in Intuition and religious belief is significantly smaller than the correlation of REI-FII with belief in psychic ability in all three samples.

Table 12. Model summary of mixed effect linear regression with thinking style measures predicting supernatural beliefs in Study 2

Predictors	Belief		
	Estimates	CI	<i>p</i>
(Intercept)	0.03	[−0.19, 0.25]	0.82
CRT ( <i>n</i> analytical answers)	−0.15	[−0.19, −0.11]	<0.001
AmbDec (analytical decisions)	−0.15	[−0.21, −0.09]	<0.001
AmbDec (intuitive decisions)	0.31	[0.23, 0.39]	<0.001
Random effects			
$\sigma^2$	0.72		
$\tau_{00ITEM:COUNTRY}$	0.11		
$\tau_{11ITEM:COUNTRY.CRT3\_FreqAna}$	0.00		
$\tau_{11ITEM:COUNTRY.AmbDec\_ANA}$	0.01		
$\tau_{11ITEM:COUNTRY.AmbDec\_INT}$	0.01		
$N_{ITEM}$	3		
$N_{COUNTRY}$	3		
Observations	2,406		

Notes: Variables are mean centered and scaled by their standard deviation. Significant *p*-values are bold.

Moreover, in the Canadian and Brazilian samples, the correlation between intuitive answers on the Ambiguous Decisions task and religious beliefs was also significantly smaller than the correlation with belief in psychic ability (United States,  $p = 0.12$ ), with no further overlapping significant comparisons between the countries. In none of the separate countries do correlations of thinking styles with paranormal beliefs and with belief in psychic ability differ from each other.

Next we assessed the relative contributions of thinking style as measured by the CRT and Ambiguous Decisions task to supernatural belief as we did in Study 1, in order to take into account how the correlations vary within people, differences in the way these thinking style measures relate to each belief type, and mean differences in belief endorsement between countries. We modeled belief and the contributions of thinking style with fully-crossed random intercepts and slopes. In so doing, we allow the association of each measure of analytical thinking to supernatural belief to be estimated as varying between countries (see Table 12 for summary results). Largely replicating the results reported in Table 8 in Study 1, we find a similarly sized: (1) negative association between CRT and analytical scores on the Ambiguous Decisions task and supernatural beliefs; and (2) a larger positive association between intuitive scores on the Ambiguous Decisions task and supernatural beliefs. After accounting for between-belief type and between-country variance in belief endorsement, the random effects estimated by this model again indicate little to no variation in the contributions of thinking style to each belief type. Taken together, these results provide additional evidence that the Ambiguous Decisions task is a stronger predictor of beliefs than CRT scores, and that this measure's predictive utility holds in diverse cultural contexts and in predicting diverse sets of beliefs (see Table S2 in Appendix S3 for results with the REI and Ambiguous Decisions task; in which independent but similarly sized associations between belief and the REI and the Ambiguous Decision intuitive scores are observed).

### Discussion

In Study 2, we replicated Study 1 with samples from the United States ( $n = 288$ ), Canada ( $n = 307$ ), and Brazil ( $n = 207$ ). Overall the results were the same as in Study 1: there were significant differences in REI-Faith in Intuition, and intuitive and analytical scores on the Ambiguous Decisions task between the conditions, though for this study there was no difference in belief in psychic ability between the two conditions. In terms of overall

trust in thinking styles, scores on the REI-Need for Cognition were significantly higher than REI-Faith in Intuition scores in the Western countries (Canada and the United States), while scores on these scales did not differ significantly for the Brazilian sample, an effect which may have been driven by a significantly lower REI-Need for Cognition score in the Brazilian participants as compared to the other participants. This is in line with our hypothesis that there is a higher baseline trust in analytical thinking than intuitive thinking in Western countries. In terms of the Ambiguous Decisions task however, all three countries showed higher scores on analytical than intuitive choices, though Brazilian participants had lower analytical scores than Canadian participants.

The correlations between all thinking styles and religious belief were significantly smaller than the correlations between these styles and belief in psychic ability, and paranormal belief (except for intuitive answers on the Ambiguous Decisions task). Interestingly, the correlation between REI-Faith in Intuition and belief in psychic ability was also larger than this correlation with paranormal belief (with no further differences between these two types of belief). With regards to the mixed effect linear regression, we found further support that intuition scores on the Ambiguous Decisions task are more closely related to belief endorsement than the CRT. The unique contributions of REI-FII and these intuitions scores to belief are comparable in magnitude. That being said, the Ambiguous Decisions task explains additional variance in belief to that of the typically used REI-FII scale.

## GENERAL DISCUSSION

The aim of this project was to make better sense of some of the conflicting previous findings in thinking styles and supernatural belief research. We hypothesized that there would be a higher baseline trust in analytical than intuitive thinking in participants from Western countries that our experimental design could influence, the effects of which would be best measured by our new Ambiguous Decisions task. We moreover hypothesized that of the supernatural beliefs, paranormal beliefs rather than religious beliefs would be most closely linked to thinking style effects, in particular intuitive thinking, and that of paranormal beliefs, in particular belief in psychic ability would be closely and positively linked to trust in intuitive thinking. To test these hypotheses, we developed a new experimental design aimed at increasing metacognitive trust in either analytical or intuitive thinking, a new thinking styles measure that measured support for analytical and intuitive thinking separately but within the same measure, and a new scale that measured belief in psychic ability in more detail. Our project involved two studies: Study 1 with participants predominantly from North America ( $N = 415$ ); and Study 2 as a replication of Study 1 with participants from the United States, Canada, and Brazil ( $N = 802$  in total).

First, we validated our newly developed measures, the Belief in Psychic Ability scale and the Ambiguous Decisions task. The items of the Belief in Psychic Ability scale all loaded positively onto one factor, and showed convergent and divergent validity. While some items on their own may not refer to psychic ability exclusively (which would interfere with face validity), none of the

items were presented in isolation, and good factor loadings and a good internal reliability suggest that the items were interpreted as all referring to the same construct. Indeed, given the high Cronbach's alpha, future studies may consider removing a number of redundant items in future uses.

For the Ambiguous Decisions task, analytical and intuitive scores each loaded on a separate factor with satisfactory factor loadings ( $>0.40$ ), and demonstrated good reliability and internal consistency ( $\alpha > 0.83$ ). The scores on the Ambiguous Decisions task furthermore showed convergent validity through correlations with other thinking style measures. The Ambiguous Decisions task was nonetheless particularly adept at showing differences as a result of our experimental manipulation, and was also shown to be the strongest predictor of belief in two mixed effect linear regressions, as compared to the CRT and REI. This importantly suggests that the Ambiguous Decisions task may be better able to assess changes at the level of the reflective mind and meta-level processing (Ackerman & Thompson, 2017), where many experimental manipulations generally operate. As such, we suggest this task may be used for future research examining thinking styles; it may elucidate effects that are otherwise obscured by assessments less able to demonstrate changes in meta-level processing. It is possible that this is part of the reason why some previous studies did not find a relationship between thinking styles and supernatural belief (e.g., Yonker *et al.*, 2016).

Our experimental manipulation was successful too: the difference in trust in analytical over intuitive thinking was diminished after the intuitive condition in both studies: participants in the intuitive thinking condition (reading a scientific article on the benefits of intuitive thinking) had higher scores on REI-Faith in Intuition (REI-FII) and higher intuitive scores and lower analytical on the Ambiguous Decisions task than after the analytical thinking condition (reading a scientific article on the benefits of analytical thinking). There were no differences for the CRT scores, which makes sense since we investigated metacognitive trust in thinking styles rather than cognitive ability (or thinking styles on the object-level, Ackerman & Thompson, 2017).

We suggest that the differences found were due to an increase in trust in the intuitive condition as a result of the experimental manipulation, though we are not able to distinguish this suggestion from an increase or decrease in trust in analytical thinking, as we did not have baseline trust scores of the participants as it was only a short survey. A longitudinal set-up would be able to tease these effects apart through within-subject tests. However, given the overall higher scores on analytical measures (regardless of condition) suggests to us that the manipulation was able to metacognitively increase trust in intuitive thinking. Given that the baseline for trust in analytical thinking was higher than trust in intuitive thinking in the sample of all countries we assessed, we suggest that our experimental manipulation may be used in future studies interested in intuition, especially in samples and contexts where intuition is typically considered a trivial thinking style.

In line with our hypothesis we found that on average trust in analytical thinking was higher than trust in intuitive thinking, as measured by the Ambiguous Decisions task, for participants of all countries, regardless of experimental condition. Interestingly, both

analytical and intuitive Ambiguous Decisions scores were lower for Brazilian participants as compared to Canadian and US participants, perhaps indicating a more cautious approach for these participants. Participants from Brazil also scored significantly lower on the REI-Need for Cognition (REI-NFC) than the other participants, and only the Brazilian participants showed no significant difference in scores on the REI-NFC and REI-FII, in line with our hypothesis that there is an emphasis on analytical thinking in Western countries, and as also evidenced by significantly lower analytical Ambiguous Decisions task scores for Brazilian participants as compared to the Canadian (but not US) participants, with no differences for intuitive scores. Thus, we suggest that thinking style research should be particularly cautious in their sampling from Western countries (see also, Gervais *et al.*, 2018), and keep in mind and make explicit possible underlying differences in regard of the thinking styles, given the effects this can have on thinking style assessments. Indeed, experimental research involving interventions generally would do well to examine the underlying beliefs people have regards the interventions (e.g., see Rahmani, van Mulukom & Farias, 2023).

We furthermore hypothesized that paranormal beliefs rather than religious beliefs would be associated with thinking styles, given their closer connection to cognitive biases, and that belief in psychic ability in particular would be associated with trust in intuitive thinking. We have argued that belief in psychic ability should be considered a type of “paranormal belief in intuition”: knowing something without knowing how, but basing the knowledge on an anomalous source or through extrasensory perception. Thus, we hypothesized that increased trust in intuition would be associated with belief in psychic ability. We found that participants in the intuitive condition in Study 1 showed higher levels of belief in psychic ability (though participants still expressed disbelief on average), but not higher levels of other paranormal beliefs or religious beliefs, as compared to those in the analytical condition. However, this effect did not replicate in Study 2, which had a larger sample, and as such we will refrain from making any strong inferences about this between-condition effect.

We found that in terms of correlations, belief in psychic ability generally had the strongest correlation with the thinking styles measures, in both studies. Our hypothesis that paranormal beliefs are more strongly associated with thinking style measures than religious beliefs, and in particular that paranormal belief in psychic ability would be associated with trust in intuitive thinking, was only partially confirmed however: Statistical comparisons of correlations demonstrated that correlations between all thinking styles (except analytical scores on the Ambiguous Decisions task) and religious belief were smaller than correlations between these thinking styles and belief in psychic ability or paranormal beliefs, correlations of which did not differ between each other in Study 1. In Study 2, we found similar results across all countries and within countries, where the correlation between thinking styles and religious belief was smaller than thinking styles and paranormal belief or psychic ability belief. In addition, the correlations between belief in psychic ability and REI-Faith in Intuition, and intuitive answers on the Ambiguous Decisions task (except for in the United States), were also larger than the correlation with religious belief.

However, in none of the separate countries did correlations of thinking styles with paranormal beliefs and with belief in psychic ability differ from each other. Moreover, in the mixed effect linear regressions in both Study 1 and Study 2, we did not find a significant effect of different supernatural beliefs.

Together, these results suggest that, of the thinking styles, intuitive thinking style is most closely related to supernatural beliefs, and of the supernatural beliefs, paranormal beliefs are most closely related to thinking styles, in particular belief in psychic ability. However, paranormal beliefs generally and belief in psychic ability specifically often did not differ from each other in terms of correlations with intuitive thinking. There may be several reasons for this: First, belief in psychic ability is of course a paranormal belief itself, so there may be too much overlapping variance. Second, it is possible that we still need larger samples for this relatively subtle effect to be borne out: while Study 2 comprised 802 participants, this was divided over three countries, which was taken into account in the analyses. We thus consider this a promising start to further investigation on the connection between belief in psychic ability and trust in intuition.

Of course, intuitive thinking is neither a sole or even primary correlate of supernatural beliefs (e.g., Baimel *et al.*, 2021; Gervais, Najle & Caluori, 2021). Future work should aim to identify how different features of human cognitive systems and or thinking styles contribute and potentially interact in sustaining supernatural beliefs. Some research, for example, highlights that the contributions of empathic concern and intuitive thinking are both small but unique predictors of beliefs, and that these relationships vary in different cultural contexts and between beliefs in different types of supernatural agents (e.g., see Baimel, 2019). Other research has proposed a thinking style division that includes analytical thinking (“head thinking”), intuitive thinking (“gut thinking”), but also empathic thinking, or “heart thinking” (Soosalu, Henwood & Deo, 2019). Interestingly, a similar extension has recently been made by Newton, Feeney and Pennycook (2023), who propose that the presence of open-mindedness or close-mindedness should be added to analytical versus intuitive thinking. More work is needed to understand more clearly how and when these intuitions or thinking styles are deployed in reasoning about the vast diversity of supernatural concepts in different cultural contexts.

Something else which has not been addressed here is how the individual differences in trust in analytical/intuitive thinking relate to differences in analytical/intuitive thinking *ability*. The manipulations of the current study had an effect on the metacognitive level or reflective mind rather than object-level or algorithmic mind. In previous research based on large surveys in the United States, it was found that higher-educated people were more likely to believe in extrasensory perception, psychic healing, and déjà vu, than those with less education (Rice, 2003), suggesting that there may not be a straight-forward translation between the levels of processing. However, given that paranormal beliefs are predominantly associated with intuitive thinking rather than analytical thinking (see also, Lindeman & Aarnio, 2007), and given that analytical and intuitive thinking work independently (Stanovich & West, 2008), that means that one can hold rational, highly educated worldviews together with belief in psychic ability and other paranormal beliefs. On the other hand, there has also

been research reporting negative associations between reasoning ability (but not critical thinking ability) and paranormal beliefs more broadly (e.g., Hergovich & Arendasy, 2005). Research such as that by Gray & Gallo (2016) complicates the picture further: They found differences between psychic believers and skeptics on their analytical thinking tasks, but not for cognitively demanding memory tasks. Thus, more research is needed in disentangling the relationship between thinking style (including trust in said style) and thinking ability.

We found that intuitive thinking was most closely related to supernatural beliefs. Given that the CRT may be a poor measure for intuitive thinking (Pennycook *et al.*, 2016), it therefore may come as no surprise that the relationship between the CRT and supernatural belief is a “cross-culturally weak and fickle phenomenon” (Gervais *et al.*, 2018), and we urge future research to use more appropriate assessments of intuitive thinking. However, an additional issue in this research is that it is hard to design a task in which intuitive thinking is measured quantitatively as it happens, given that it is an automatic, subconscious thinking style. More studies including measurements of responses outside of our conscious awareness such as physiological skin conductance may be a way forward (Luftiyanto, Donkin & Pearson, 2016). Other promising research that uses a bottom-up approach focuses on implicit pattern learning (Weinberger, Gallagher, Warren *et al.*, 2020).

## CONCLUSIONS

Are thinking styles associated with supernatural beliefs? The majority of studies on this topic has taken place in the West, where a greater metacognitive trust in analytical thinking as opposed to intuitive thinking is typically present; something which we confirmed in our samples. This means that baseline trust may influence experimental results when investigating the relationship between analytical and intuitive thinking and supernatural beliefs, something which we manipulated here through a design with scientific articles, and then measured with our new Ambiguous Decisions task. Moreover, not all supernatural beliefs are alike – religious beliefs are often institutionally based which makes them more strongly related to cultural context, whereas individuals are freer to form and choose their paranormal beliefs, which makes them more independent of cultural context, and possibly more closely related to cognitive biases and intuitions. And indeed, in the present study we found that thinking styles were more strongly related to paranormal than religious beliefs, and in particular belief in psychic ability, which we considered a “paranormal belief in intuition” or an ontological confusion of intuitive thought. Thus, the connection between thinking styles and supernatural beliefs may be explained through differences in metacognitive trust in thinking styles, and in the type of supernatural belief.

We thank the late Tommy Coleman Junior III for his input on this project. We also thank Marjaana Lindeman for her knowledgeable comments on an earlier version of the manuscript. These studies were supported by awards from the BIAL Foundation (380/14) and John Templeton Foundation (57676). The authors declare that they have no known competing financial interests or personal relationships that could have appeared to

influence the work reported in this paper. The data set is openly available on OSF: <https://doi.org/10.17605/OSF.IO/M4EKY>

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article:

**Appendix S1.** Ambiguous decisions task.

**Appendix S2.** Analytical and intuitive thinking condition texts.

**Table S1.** Model summary of mixed effect linear regression with thinking style measures (REI & AmbDec) predicting supernatural beliefs in Study 1.

**Table S2.** Model summary of mixed effect linear regression with thinking style measures (REI & AmbDec) predicting supernatural beliefs in Study 2.

**Table S3.** Descriptive demographics for Study 2.

**Table S4.** Correlations between cognitive style measures in Study 2.

**Table S5.** Descriptive and comparative statistics for cognitive styles measures and supernatural belief measures for the analytical and intuitive condition (Study 2), for Canada only.

**Table S6.** Descriptive and comparative statistics for cognitive styles measures and supernatural belief measures for the analytical and intuitive condition (Study 2), for United States only.

**Table S7.** Descriptive and comparative statistics for cognitive styles measures and supernatural belief measures for the analytical and intuitive condition (Study 2), for Brazil only.

**Table S8.** Average thinking styles scores (regardless of condition) and difference scores for each of the countries.

**Table S9.** Correlation table for correlations between thinking style measures (rows) and supernatural beliefs (columns) in Study 2 for Canada only.

**Table S10.** Comparison of thinking style-supernatural belief correlations in Study 2 for Canada only.

**Table S11.** Correlation table for correlations between thinking style measures (rows) and supernatural beliefs (columns) in Study 2 for United States only.

**Table S12.** Comparison of thinking style-supernatural belief correlations in Study 2 for United States only.

**Table S13.** Correlation table for correlations between thinking style measures (rows) and supernatural beliefs (columns) in Study 2 for Brazil only.

**Table S14.** Comparison of thinking style-supernatural belief correlations in Study 2 for Brazil only.

Received 30 November 2022, Revised 21 July 2023, accepted 10 August 2023