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On the disposition to think analytically: Four distinct intuitive-analytic thinking styles

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Abstract

Many measures have been developed to index intuitive versus analytic thinking. Yet it remains an open question whether people primarily vary along a single dimension or if there are genuinely different types of thinking styles. We distinguish between four distinct types of thinking styles: Actively Open-minded Thinking, Close-minded Thinking, Preference for Intuitive Thinking, and Preference for Effortful Thinking. We discovered strong predictive validity across several outcome measures (e.g., epistemically suspect beliefs, bullshit receptivity, empathy, moral judgments), with some subscales having stronger predictive validity for some outcomes but not others. Furthermore, Actively Open-minded Thinking, in particular, strongly outperformed the Cognitive Reflection Test in predicting misperceptions about COVID-19 and the ability to discern between vaccination-related true and false news. Our results indicate that people do, in fact, differ along multiple dimensions of intuitive-analytic thinking styles and that these dimensions have consequences for understanding a wide range of beliefs and behaviors.

Keywords: analytic thinking, cognitive reflection, dual-process theories, intuitive thinking, thinking styles

Introduction

It has long been theorized that people differ in how much they prefer to engage in effortful and deliberative thought (Asch, 1952; Cacioppo & Petty, 1982; Cohen et al., 1955; Maslow, 1943) and, relatedly, that some people may rely more on their intuitions and gut feelings when making judgments (Epstein, 1983; Epstein et al., 1996; Jung, 1953). Scores of empirical studies have shown that individual differences in thinking styles (broadly construed) have apparent widespread consequences, from predicting differences in the judgments and decisions that people make (e.g., Dewberry et al., 2013; Epstein et al., 1996; Haran et al., 2013; Juanchich et al., 2016; Petty et al., 2009; Stanovich & West, 1998, 2000; Toplak et al., 2011), to variation in people's beliefs and values (e.g., Baron et al., 2015; Lindeman, 2011; Pennycook et al., 2012; Pennycook, Fugelsang, et al., 2015a; Pennycook & Rand, 2019; Svedholm & Lindeman, 2013), to academic performance, happiness, health and longevity (Grossmann et al., 2013; Petty et al., 2009; Stevenson & Hicks, 2016; von Stumm et al., 2011). However, the popularity of research on thinking styles is a double-edged sword: There is strong evidence that thinking styles are important, but very little parsimony in the literature.

In particular, there is a lack of theoretical consensus on the nature of the underlying cognitive processes that determine whether someone is relatively “intuitive” or “analytic”. For example, there are meaningful conceptual differences between someone having a “need for cognition”, which is described as enjoying effortful thinking, and someone having an “actively open-minded thinking style”, which is described as someone who is disposed to deeply questioning their prior beliefs and intuitions according to evidence. Furthermore, it is even unclear if people primarily differ in terms of whether they are intuitive or analytic, or if there are

genuinely various different types of intuitive-analytic thinking styles. Relatedly, there are a large number of different measures that purport to index thinking styles (even when defined fairly narrowly). Indeed, a review of the literature on thinking styles reveals *at least* 15 measures that claim to assess variation in how people think – albeit with a broad definition of “thinking” – that include elements related to intuition and reflection. These scales are sometimes related to specific thinking processes, such as whether one trusts their intuitive hunches, but many have items that also relate to information integration and whether one values rationality and so on. Nonetheless, they all relate to higher-order cognition in a broad sense and relate to the way that people form beliefs and make decisions.

Table 1. *Various intuitive-analytic thinking styles measures that have conceptual overlap*

Name of measure	Description of scale and representative item	Source
Actively Open-Minded Thinking Scale	Assesses “the tendency to weigh new evidence against a favored belief, to spend sufficient time on a problem before giving up, and to consider carefully the opinions of others in forming one’s own.” Example item: “Certain beliefs are just too important to abandon no matter how good a case can be made against them”	Stanovich & West (2007)
Actively Open-Minded Thinking Scale – 10	Assesses how an individual’s beliefs are related to how they think people should think. Example item: “People should take into consideration evidence that goes against their beliefs.”	Baron (2019)
Comprehensive Intellectual Humility Scale	Assesses “openness to revising one’s viewpoints, lack of overconfidence about one’s knowledge, respect for the viewpoints of others, and lack of threat in the face of intellectual disagreements.”	(Krumrei-Mancuso & Rouse, 2016)

Name of measure	Description of scale and representative item	Source
	Example item: "I am willing to change my mind once it's made up about an important topic."	
Epistemic Curiosity Scale	<p>"Assesses the degree to which people desire knowledge because they have high intrinsic interest (the Interest subscale) and because they are troubled when they lack information (the Deprivation subscale)."</p> <p>Example item: "I enjoy exploring new ideas."</p>	Litman & Spielberger (2003)
Faith in Intuition Scale	<p>Assesses an individual's trust in their own intuition when making decisions.</p> <p>Example item: "I believe in trusting my hunches."</p>	Epstein et al., (1996)
General Decision-Making Style Questionnaire	<p>Assesses how individuals respond when faced with a decision and distinguishes between 5 decision styles that are used: rational, avoidant, dependent, intuitive, and spontaneous.</p> <p>Example item: "When making a decision, I consider various options in terms of a specified goal."</p>	Scott & Bruce (1995)
Importance of Rationality Scale	<p>Assesses "the strength of one's preference to be epistemically rational", i.e., "how important people think it is that their own beliefs are based on logic and evidence."</p> <p>Example item: "It is important to me personally to be skeptical about claims that are not backed up by evidence."</p>	Ståhl, Zaal, & Skitka (2016)
Intolerance of Ambiguity Scale	<p>Assess "the tendency to perceive ambiguous situations as desirable."</p> <p>Example item: "It is more fun to tackle a complicated problem than to solve a simple one."</p>	Budner (1962)
Need for Closure Scale	Assess "the desire for a definite answer on some topic, <i>any</i> answer as opposed to confusion and ambiguity."	Kruglanski et al., (2013)

Name of measure	Description of scale and representative item	Source
	Example item: "When thinking about a problem, I consider as many different opinions on the issue as possible."	
Need for Cognition Scale	Assess "individuals' tendency to engage in and enjoy effortful cognitive activity." Example item: "Thinking is not my idea of fun."	Cacioppo & Petty (1982)
Need for Evidence Scale	Assesses the "importance of consistency between empirical evidence and beliefs." Example item: "A hunch needs to be confirmed with data."	Garrett & Weeks (2017)
Need to Evaluate Scale	Assesses the tendency to "engage in evaluative responding" and judge objects as good or bad. Example item: "I form opinions about everything."	Jarvis & Petty (1996)
Preference for Intuition and Deliberation Scale	Assesses "individual preferences to base decisions on gut feelings or affect and also assesses preferences for thoughtful, reflective decisions." Example item: "When I have a problem I first analyze the facts and details before I decide."	Betsch (2004)
Resistance to Change	Assesses the "tendency to resist or avoid making changes, to devalue change generally, and to find change aversive across diverse contexts and types of change." Example item: "Once I've come to a conclusion, I'm not likely to change my mind."	Oreg (2003)
Self-Righteousness Scale	Assesses the "conviction that one's behaviors or beliefs are correct, especially in contrast to alternate behaviors or beliefs." Example item: "To me, things don't seem black and white, they're mostly shades of gray."	Falbo & Belk (1985)

Note. Stated description of what the scale assesses and a representative item from the scale are included.

Although a great deal of research has focused on the implications of individual differences in thinking styles, there is no consensus about the nature of these individual differences. Do people primarily differ along a single dimension (from intuitive to analytic) or are there different types of intuitive-analytic thinking styles? And, if so, does this matter? And which types are the most important for the outcomes that have been a major focus of recent research (e.g., epistemically suspect beliefs, vaccination attitudes, etc.). Here we report the findings of two studies that support the idea that there are, in fact, different types of intuitive-analytic thinking styles and that this distinction is important.

Theoretical background

Dual-process (or dual-system) theory connects the various thinking style measures in a broad sense. Dual-process theory states that human cognition can be separated into two fundamentally different types of processes: intuitive processes that are automatic and generally faster and not effortful (“Type 1” or “System 1”) and analytic or reflective processes that are generally slower and more effortful (“Type 2” or “System 2”) (Chaiken & Trope, 1999; Evans, 2008; Evans & Stanovich, 2013; Kahneman, 2011). Many of the thinking style measures explicitly mention concepts that are related to dual-process theory like intuition/emotion versus reflection (Preference for Intuition and Deliberation; Betsch, 2004), rationality versus intuition (Rational-Experiential Inventory; Pacini & Epstein, 1999), and the importance of rationality (Ståhl et al., 2016) and questioning (Intolerance of Ambiguity; Budner, 1962). Even measures with a less obvious connection, such as the Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016) or the Self-Righteousness Scale (Falbo & Belk, 1985), ask questions that are related to this broad perspective such as “I am willing to change my opinions

on the basis of compelling reason” and “To me, things don't seem black and white, they're, mostly shades of gray”. Thus, the general dual-process perspective appears pervasive in a large number of scales (as outlined in Table 1).

Importantly, however, there is a growing appreciation among dual-process theorists that the theory should move away from simply characterizing the distinction between two different types of processes (e.g., by listing features of one versus the other) and toward forming models of how intuitive and analytic processing operate and interact (De Neys, 2017; Pennycook, Fugelsang, et al., 2015b; Pennycook, 2022; Thompson, 2009). This has consequences for the measurement of thinking styles because it implies that there may be other characteristics of how people engage in intuitive versus analytic thinking that are separate from the mere preference for one or the other. Interestingly, the Need for Cognition scale is perhaps the most common thinking style scale across literatures (e.g., the original has been cited more than 7,500 times according to Google Scholar) but it is essentially a measure of the “tendency for an individual to engage in and enjoy thinking” (Cacioppo & Petty, 1982, p. 116).

A central focus of more modern dual-process theories of reasoning is on determining the factors that lead to the *engagement* and *nature* of analytic thinking (Bago & De Neys, 2017; Pennycook, 2022; Pennycook, Fugelsang, et al., 2015b; Thompson et al., 2011). This perspective implies that analytic thinking is (sometimes but not always) centrally focused on *overriding* intuitions (Pennycook, 2022) – an aspect that is featured in some but not all of the above cited thinking styles measures (and, most notably, not a strong feature of “Need for Cognition”). One specific measure that does directly relate to this category of dual-process theories is the Actively Open-minded Thinking scale, which measures the disposition toward reflectivity, the willingness

to consider evidence that goes against held beliefs, and the willingness to consider alternative opinions and explanations (Stanovich & Toplak, 2019). In other words, the Actively Open-minded Thinking scale assesses the tendency to engage in Type 2 processing specifically as it pertains to suppressing and overriding incorrect intuitive (Type 1) responses.

Cognitive reflection

Another common strategy is to assess intuitive-analytic thinking using behavioral measures. By far the most popular measure for this is the Cognitive Reflection Test (CRT; Frederick, 2005; cited over 5,500 times according to Google Scholar). The CRT consists of problems that trigger an intuitive response that is incorrect; for example: “A bat and ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost?” The most common intuitive response is ‘10 cents’, however, the correct response is ‘5 cents.’ People who do well on the CRT are thought to be more reflective because they stop and question their intuition on the problems (Campitelli & Gerrans, 2014; Travers et al., 2016). Suitably, the CRT is associated with other types of intuitive judgments (Campitelli & Labollita, 2010; Koehler & James, 2014; Pennycook, Fugelsang, et al., 2015a; Toplak et al., 2011) as well as thinking styles as measured by self-report scales (such as those discussed above; Pennycook, Cheyne, et al., 2016; Thomson & Oppenheimer, 2016; Toplak et al., 2011). However, the CRT does not capture differences in aspects or types of thinking styles – rather, it can only capture variation along a single dimension. Sole reliance on the CRT may therefore cause oversimplification in the precise nature of people’s thinking styles and how (or whether) these individual differences are consequential.

The present work

Here we set out to investigate potential differences in predictive validity between different types of intuitive-analytic thinking styles. For example, is the mere enjoyment of effortful thinking the reason why deliberative people tend to (for example) be less religious (Pennycook, Ross, et al., 2016), or is the specific tendency to question your beliefs in an actively open-minded way more important (Pennycook, Cheyne, et al., 2020)? Investigating these different types of thinking styles is difficult, however, given the sheer number of measures outlined in Table 1. We therefore constrained the conceptual space by narrowing down the list of potential scale items that measure individual differences in intuitive-analytic thinking styles (the details of these studies are fully described in Appendix B).

For this, we took the 265 unique items from the 12 scales outlined in Table 1 and completed an initial study where participants ($N = 774$) were given a randomly selected subset of the items along with the CRT. We then narrowed down the list empirically by taking only those items that had at least a moderate correlation ($r = .21$, following the benchmark in Gignac & Szodorai, 2016) with the CRT. Then, across 5 additional studies with 1,196 participants, we explored the factor structure of the remaining 50 items and narrowed them down into four unique factors. The scale that emerged from this, the 4-Component Thinking Style Questionnaire, includes 24 items (6 items per subscale). The items are listed in Table 2.

Table 2. *The 24 item 4-Component Thinking Styles Questionnaire (4-CTSQ)*

Subscale	Item
Actively Open-minded Thinking (AOT)	It is important to be loyal to your beliefs even when evidence is brought to bear against them. (R)
	Whether something feels true is more important than evidence. (R)

	<p>Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong. (R)</p> <p>There may be evidence that goes against what you believe but that does not mean you have to change your beliefs. (R)</p> <p>Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs. (R)</p> <p>Regardless of the topic, what you believe to be true is more important than evidence against your beliefs. (R)</p>
Close-Minded Thinking (CMT)	<p>I think there are many wrong ways, but only one right way, to almost anything.</p> <p>In my experience, the truth is often black and white.</p> <p>Truth is never relative.</p> <p>The truth does not change.</p> <p>Either something is true or it is false; there is nothing in-between.</p> <p>There is no middle ground between what is true and what is false.</p>
Preference for Intuitive Thinking (PIT)	<p>I like to rely on my intuitive impressions.</p> <p>I believe in trusting my hunches.</p> <p>When I make decisions, I tend to rely on my intuition.</p> <p>Using my "gut-feelings" usually works well for me in figuring out problems in my life.</p> <p>Intuition is the best guide in making decisions.</p> <p>I often go by my instincts when deciding on a course of action.</p>
Preference for Effortful Thinking (PET)	<p>I'm not that good at figuring out complicated problems. (R)</p> <p>Thinking is not my idea of an enjoyable activity. (R)</p> <p>I try to avoid situations that require thinking in depth about something. (R)</p> <p>I am not a very analytical thinker. (R)</p> <p>Reasoning things out carefully is not one of my strong points. (R)</p> <p>Thinking hard and for a long time about something gives me little satisfaction. (R)</p>

Note. R = reverse scored item.

Interestingly, despite the number of scales that contributed items to the first and second stage of this validation (12 out of 15 scales provided items to the resulting set¹), three of the factors correspond conceptually to scales that are already in use: 1) Preference for Intuitive Thinking (i.e., “Faith in Intuition” and “Experiential Inventory”), 2) Preference for Effortful Thinking (i.e., “Need for Cognition” and “Rationality Inventory”), and 3) Actively Open-minded Thinking. The final factor, which we refer to as Close-minded Thinking, came out of a mix of other scales and relates to the extent to which people see the truth in black-and-white. It should be noted, however, that Close-minded Thinking and Actively Open-minded Thinking (or the Preference for Intuitive Thinking and Preference for Effortful Thinking, for that matter) should not be considered parallel scales that operate on a continuum. In fact, the scales were derived specifically to represent distinct types of thinking styles. Indeed, each of the four subscales was shown to be reliable and confirmatory factor analyses consistently supported a four-factor structure despite the subscales being moderately intercorrelated.

Finally, it should also be noted that every item in each subscale is in the same direction (or “key”) – this is because positively and negatively worded items tend to form distinct factors (Kam & Meyer, 2015, 2022; Kam & Sun, 2022; McLarnon et al., 2016), as was the case in our own validation (see Appendix B). Thus, to maintain strong reliability within the subscales, all of the items have the same direction. Furthermore, every item across subscales is in the same direction; i.e., a higher score corresponds to what has been considered in past work as greater intuitiveness and a lower score corresponds to greater analyticity. As a consequence, the Actively

¹ The three exceptions were the Epistemic Curiosity, Intolerance of Ambiguity, and Self-Righteousness scales

Open-minded Thinking and Preference for Effortful Thinking subscales are all entirely reverse-scored.

Study 1

In Study 1, we focused on seven measures that have been shown in previous studies to relate to analytic-intuitive thinking styles. One group of these measures relates to people's beliefs. For example, the disposition to think analytically has been associated with religious disbelief (Pennycook et al., 2012; Shenhav et al., 2012; for a meta-analysis, see: Pennycook, Ross, et al., 2016). This is a central finding because it indicates that the tendency to reflect on and question one's prior beliefs (as indexed by measures such as the CRT) is even linked to skepticism about beliefs that are core to one's identity. Critically, this perspective on the association between religious disbelief and analytic thinking implies that Actively Open-minded Thinking may be a particularly salient aspect of thinking styles that is driving the causal association (Pennycook, Cheyne, et al., 2020); however, other theories posit that the association is driven more by the "intuitiveness" of religious beliefs (Shenhav et al., 2012), which suggests that Preference for Intuitive Thinking should be a stronger predictor.

Related work has also shown that paranormal belief is both associated with stronger intuitiveness (based on a self-report measure similar to the Preference for Intuitive Thinking) (Aarnio & Lindeman, 2005) as well as a lower willingness to engage in analytic thinking (based on lower performance on the CRT) (Pennycook et al., 2012). At the same time, paranormal belief has been linked to openness (Eudell & Campbell, 2007) and is generally not predicted by dogmatism, indicating that Close-minded Thinking may not be a particularly strong predictor. This contrasts with conspiratorial belief, which is indicative of dogmatic tendencies and,

potentially, Close-minded Thinking (Prooijen & Krouwel, 2016; Richey, 2017) (conspiracy beliefs have also been associated more broadly with decreased analytic thinking; Binnendyk & Pennycook, 2022; Swami et al., 2014; Yelbuz et al., 2022). Thus, the 4-CTSQ may help distinguish between the underlying mechanisms that produce variation in different types of epistemically suspect beliefs (c/o Lobato et al., 2014) beyond the mere observation that analytic thinking is, in a broad sense, associated with skepticism about such beliefs (Pennycook, 2022).

We also included measures that are focused on judgments that have been linked to intuitive-analytic thinking. A classic and highly influential dual-process model – the social-intuitionist model (Haidt, 2001) – argues that intuitions typically dominate reasoning to such an extent that thinking analytically is unlikely to be predictive in cases where a highly salient intuition is cued. To illustrate this point, Haidt (2001; see also Haidt, 2012) used disgust-based moral dilemmas where people are given a narrative that contains a taboo (and disgusting) act, such as incest between siblings, but that emphasizes that no harm is done. People are then argued to rely on a disgust-based intuition when judging whether the act is morally wrong. Interestingly, however, prior work has shown that people who are more reflective are less likely to rely on disgust when making moral judgments (Pennycook et al., 2014b). One interpretation of this, which is consistent with the social-intuitionist model, is that this occurs because people who are more intuitive (i.e., those with a stronger Preference for Intuitive Thinking) are more strongly compelled by the dilemma (and hence have a stronger disgust-based response). However, an alternative account is that people who are more willing to question their gut feelings and intuitions (i.e., those higher on Actively Open-minded Thinking) are less likely to be influenced by their disgust-based intuitions (Pennycook, 2022; Pennycook et al., 2014b).

Another judgment task that we included is the bullshit receptivity scale, where participants are asked to indicate how profound (or otherwise) they consider random sentences that are constructed using abstract buzzwords (e.g., “Imagination is inside exponential space time events”) (Pennycook, Cheyne, et al., 2015). People who are more analytic tend to rate the sentences as less profound, and hence are thought to be stronger at detecting bullshit (Pennycook, Cheyne, et al., 2015; Pennycook & Rand, 2019b). However, similar to the moral dilemma case, it may be that this trend (evidenced using measures that do not distinguish between different types of intuitive-analytic thinking styles) is driven simply by greater Preference for Intuitive Thinking.

Finally, as more exploratory measures that have high practical relevance, we included subjective happiness (which has been associated with intuitiveness in past work; Stevenson & Hicks, 2016) and empathizing (which has been associated with decreased deliberation; Jack et al., 2016; Svedholm-Häkkinen & Lindeman, 2017).

Method

We report all manipulations, measures, and exclusions in these studies.

Participants

American participants ($n = 509$) were recruited from Prolific. Data from seven participants who did not complete the entire study were discarded before all analyses. Fifteen participants who reported random responding and 15 who failed the attention check were excluded from further analysis. Data from 59 participants who did not respond “strongly disagree” to “I have been to every country in the world” were excluded from further analyses. Four hundred and thirteen participants ($N = 413$) were retained for further analyses (Mean age =

33.5, 222 male, 184 female, 7 who chose another category or did not respond). These exclusion criteria were preregistered (see [OSF](#)). We did not complete a power analysis prior to data collection, however correlations in personality psychology tend to stabilize at an N of 250 (Schönbrodt & Perugini, 2013) and a sample of 413 provides 80% power to detect effect sizes as small as $r = .14$.

Materials

4-Component Thinking Styles Questionnaire. We used the 24-item 4-CTSQ as validated in Appendix B. The scale has four subscales created by using average scores and all had good (and roughly similar) reliability: AOT ($\alpha = .89$, $M = 4.29$, $SD = .99$), CMT ($\alpha = .83$, $M = 2.82$, $SD = .96$), PIT ($\alpha = .92$, $M = 3.59$, $SD = .95$), and PET ($\alpha = .88$, $M = 4.55$, $SD = .94$). AOT and PET were recoded prior to running the analyses (see Appendix A).

Religious Beliefs. Participants were given the 8-item Religious Belief Questionnaire (Pennycook et al., 2014a) which assessed 8 commonly held religious beliefs: afterlife, angels, demons, heaven, hell, miracles, Satan, soul. The measure had excellent reliability ($\alpha = .96$). To index categorical religious belief change, we asked two further questions. First, participants were asked to indicate which of four possible categories best represents their current stance toward God (or gods): “I believe in God” (theism; $N = 153$), “I don’t really take a stance on God” (apathetic; $N = 40$), “I don’t really know if God exists or not” (agnostic; $N = 120$), and “I don’t believe in God” (atheist; $N = 100$). These were chosen because they represent distinct and presumably memorable stances toward God. Critically, we then asked participants a follow-up question where they indicated whether they, at any point in their past, fell into one (or more) of the other categories. We then coded cases where participants indicated a prior stance that was

different from their present stance as indicating categorical religious belief change (47.7% of the sample indicated change based on this measure). This was included as an exploratory (non-preregistered) variable.

Paranormal Belief. Participants completed a slightly revised, 10-item version of the Paranormal Belief Scale without any traditional religious belief or witchcraft items (Pennycook et al., 2012; Tobacyk, 2004). Items covered 4 domains of supernatural belief: Psi (“Mind reading is possible”), Superstition (“If you break a mirror, you will have bad luck”), Spiritualism (“Reincarnation does occur”), Extraordinary life forms (“There is life on other planets that has reached Earth”), and Precognition (“The horoscope accurately tells a person’s future.”). The measure had strong reliability ($\alpha = .89$).

Conspiratorial Beliefs. Participants completed a slightly revised, 10-item version of the Belief in Conspiracy Theory Inventory (Swami et al., 2011). An example of these items is: “Area 51 in Nevada, U.S., is a secretive military base that contains hidden alien spacecraft and/or alien bodies.” The measure had good reliability ($\alpha = .87$).

Moral Judgments. Participants read two disgust-based moral dilemmas by Haidt et al. (1993). One dilemma describes an incestuous relationship between siblings and the other is about sexual relations with a dead chicken. Two follow up questions were given: “Is this morally wrong?” (1 - *not morally wrong* to 7 - *extremely morally wrong*), and “Is this disgusting?” (1 - *not disgusting* to 7 - *extremely disgusting*). Average scores were created for each scale with higher scores reflecting a stronger view that the dilemma is morally wrong ($\alpha = .74$) and disgusting ($\alpha = .54$).

Bullshit Receptivity. Participants completed a shortened 5-item version of the Bullshit Receptivity Scale (Pennycook, Cheyne, et al., 2015), which measures the extent to which people find profundity in randomly generated sentences filled with buzzwords. One example of an item is “Imagination is inside exponential space time events.” The measure had good reliability ($\alpha = .87$).

Empathizing Quotient. Participants were given the 22-item version of the Empathy Quotient (EQ-Short) (Wakabayashi et al., 2006). One example of an item is “I can pick up quickly if someone says one thing but means another.” The measure had good reliability ($\alpha = .89$).

Subjective Happiness. The 4-item Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) was presented to assess how happy participants rate themselves compared to others. Responses are rated on a 7-point Likert scale with varying labels for items; for example, one item, “In general, I consider myself:” is rated from 1 (*not a very happy person*) to 7 (*a very happy person*), whereas other items are rated 1 (*less happy*) to 7 (*more happy*) and 1 (*not at all*) to 7 (*a great deal*). The measure had good reliability ($\alpha = .90$).

Procedure

Participants provided consent then responded to the 24-item 4-CTSQ. Participants then completed measures of religious, paranormal, conspiratorial beliefs, moral dilemma, bullshit receptivity, empathizing quotient, and subjective happiness (in that order). Finally, participants completed a demographics questionnaire.

Results

Factor Structure. In our preregistration (available on [OSF](#)), we predicted that our correlated four-factor 4-CTSQ model would fit the data would better than alternative factor structures². We tested the factor structure using confirmatory factor analysis and used full information maximum likelihood estimation to handle missing data within *Mplus* 8.4 (Muthén & Muthén, 2017), which is less biased than listwise or pairwise deletion (Newman, 2014). Four measurement models were compared: (a) a 1-factor model of general 4-CTSQ; (b) an orthogonal (uncorrelated) 4- factor model; (c) an oblique (correlated) 4-factor model; (d) Model C with a second-order 4-CTSQ factor. We compared models by examining whether changes in chi-square exceeded the critical value and whether changes in the CFI model fit exceeded the recommended cut-point of .002 (Meade et al., 2008). The CFA results confirmed that the best-fitting model comprised four correlated factors (Model C), supporting our hypothesis (see Table 3). Factor loadings were very similar to prior validation in Appendix B and are reported in supplementary materials.

Table 3. *Model fit statistics from a confirmatory factor analyses of the 4-CTSQ*

Model	χ^2_m	df _m	$\Delta\chi^2$	Δdf	χ_{cv}	RMSEA [90% CI]	CFI	ΔCFI	TLI	SRMR
1. Single Factor	3139.20	252.00	-	-	-	.167 [.161-.172]	.446	-	.393	.156
2. Uncorrelated 4-Factor	747.03	252.00	2392.17	0	0	.069 [.063-.075]	.905	.459	.896	.161
3. Correlated 4-Factor with	580.93	249.00	166.10	166.10	7.83	.057 [.051-.063]	.936	.031	.929	.065

² We should note, however, that our preregistration was regrettably not clear on the specifications of our models (e.g., with respect to missing data) or how we would compare them. In any case, our analyses are robust to alternative specifications.

Higher Order Factor*										
4. Correlated 4- Factor	568.90	246.00	12.03	3	7.83	.056 [.050-.062]	.938	.002	.930	.057

Note. This table presents model fit statistics from Confirmatory Factor Analyses conducted in *Mplus* 8.4 (Muthén & Muthén, 2017). χ^2_m refers to the chi-square model fit and df_m refers to the model's degrees of freedom. $\Delta\chi^2$ refers to the difference between the model fit and the model above it (e.g., Scaler – Metric) and Δdf examines the corresponding difference in degrees of freedom. χ_{cv} refers to the critical value for the chi-square test. If the $\Delta\chi^2$ exceeds the χ_{cv} or ΔCFI is below .002, the model is rejected and a less strict model is retained. The next columns are, in order, the Root Mean Square Error of Approximation (RMSEA; Steiger, 2000), Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis index (TLI; Bentler, 1990), and Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1998) fit indices for each CFA model

*4-CTSQ higher-order factor was fixed at 1 in Model 3 to allow for model convergence.

Predictive Tests. As preregistered, bivariate Pearson (r) correlations were computed with the four subscales and various outcome measures (see Table 4). The correlation between the subscales was generally moderate, with the strongest correlation ($r = -.46$) being between Actively Open-minded Thinking and Preference for Intuitive Thinking. To disentangle the intercorrelations between our subscales and the various dependent variables, multiple regression analyses were conducted for each of the belief measures with the 4 subscales as predictors (note that these analyses were not preregistered). A summary of the results can be seen in Table 5.

The results indicate strong predictive validity across the subscales. All four subscales were (largely) significantly correlated with most of the outcome measures. There were some distinct patterns that are informative for theory, however. First, Actively Open-minded Thinking was a much stronger predictor of religious belief ($r = -.49$) than Preference for Intuitive Thinking ($r = .25$) (this difference in effect sizes was significant using a post hoc Fisher r -to- z transformation, $z = -9.2$, $p < .001$). Similarly, in a multiple regression predicting religious belief

(Table 5), Actively Open-minded Thinking ($\beta = -.47$) was significantly predictive but Preference for Intuitive Thinking ($\beta = .02$) was not. Interestingly, the mere Preference for Effortful Thought was similarly non-predictive of religious belief relative to Actively Open-minded Thinking (and to a lesser extent, Close-minded Thinking), indicating that thinking in an actively open-minded way, as opposed to simply enjoying thinking, is a more central element of why thinking style is association with skepticism about religious claims. This was supported by our exploratory analysis of categorical religious belief change. Specifically, in a binary logistic regression with belief change (or not) as the dependent variable (and controlling for religious belief), Actively Open-minded Thinking ($B = .33$, $Wald = 5.63$, $p = .018$) and Close-minded Thinking ($B = -.32$, $Wald = 7.18$, $p = .007$) were unique predictors of belief change, but Preference for Intuitive Thinking ($B = -.08$, $Wald = .38$, $p = .537$) and Preference for Effortful Thought ($B = -.21$, $Wald = 2.95$, $p = .086$) were not (and, in fact, PET was in the opposite direction as would be expected).

Table 4. *Pearson correlations (*r*) between the 4-CTSQ subscales and outcome measures*

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. AOT	-											
2. CMT	-.19**	-										
3. PIT	-.46**	.16**	-									
4. PET	.33**	-.25**	-.23**	-								
5. Religious Belief	-.49**	.25**	.25**	-.15**	-							
6. Paranormal Belief	-.36**	-.01	.37**	-.14**	.44**	-						
7. Conspiracy Belief	-.48**	.18**	.37**	-.25**	.37**	.48**	-					
8. Bullshit Receptivity	-.33**	.09	.27**	-.12**	.24**	.41**	.27**	-				
9. Empathizing	-.03	-.02	.13**	.31**	.15**	.13**	.10	.14**	-			
10. Subjective Happiness	-.13*	.10*	.11*	.27**	.24**	.03	.06	.15**	.35**	-		
11. Moral Judgment	-.22**	.24**	.21**	-.05	.42**	.20**	.20**	.22**	.07	.21**	-	
12. Disgust	-.06	.10*	.16**	.04	.27**	.07	.03	.13**	.07	.18**	.64**	-

Note. $N = 399$. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

Cases excluded listwise.

* $p < .05$. ** $p < .01$.

Table 5. *Regression coefficients (β) for the 4-CTSQ subscales on outcome measures*

Dependent Variable	<i>M</i>	<i>SD</i>	AOT	CMT	PIT	PET
Religious Belief	2.84	1.28	-0.47**	0.17**	0.02	-0.05
Paranormal Belief	1.97	.77	-0.25**	-0.11*	0.26**	-0.03
Conspiratorial Belief	1.82	.74	-0.37**	0.06	0.17**	-0.08
Bullshit Receptivity	2.32	.98	-0.26**	0.02	0.15**	< 0.001
Empathizing Quotient	3.66	.56	-0.07	0.04	0.18**	0.38**
Subjective Happiness	4.35	1.34	-0.19**	0.14**	0.09	0.38**
Moral Dilemma	5.32	1.80	-0.14*	0.21**	0.14**	0.07
Disgust	6.14	1.21	0.01	0.10*	0.17**	0.10

Note. Each dependent variable was included in a separate regression analysis with the four subscales as predictors. The coefficient, therefore, represents the unique predictive validity for each subscale while controlling for the other subscales. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

* $p < .05$. ** $p \leq .01$

Second, the results for paranormal and conspiratorial belief offers an interesting contrast. In particular, whereas Close-Minded Thinking is associated with conspiracy belief ($r = .18$), it was not associated with paranormal belief ($r = -.01$) (this difference in effect sizes was significant using a post hoc Fisher r -to- z transformation, $z = -3.7$, $p < .001$). In fact, in a multiple regression analysis predicting paranormal belief (Table 5), Close-Minded Thinking was actually *negatively* predictive of paranormal belief ($\beta = -.11$) once the other subscales were taken into account. However, it is also noteworthy that Actively Open-minded Thinking, and not Close-Minded Thinking, was the strongest predictor of conspiracy beliefs.

Moving on to the judgment tasks, we found that disgustingness ratings for the moral dilemmas was only significantly correlated with Preference for Intuitive Thinking (in both the

zero-order correlations, Table 4, and the regression analysis, Table 5). In contrast, moral judgments were roughly equally predicted by Preference for Intuitive Thinking, Actively Open-minded Thinking, and Close-Minded Thinking (but not Preference for Effortful Thinking). This indicates that intuitiveness does seem to be an important element of moral judgment when there are strong disgust-based intuitions, consistent with the social-intuitionist model (Haidt, 2001); however, one's willingness to question their intuitions also seems to be roughly as important even though it does not predict how disgusting one takes the dilemmas to be, thereby supporting more "default-interventionist" models of moral judgment (e.g., Pennycook, 2022).

A similar conclusion is evidenced in the results for the bullshit receptivity measure. Specifically, both Actively Open-minded Thinking and Preference for Intuitive Thinking were strongly and independently associated with profundity ratings for random pseudo-profound bullshit sentences (in opposite directions, of course, and roughly equally so). Thus, both one's willingness to reflect and one's intuitiveness are linked to detecting pseudo-profound bullshit. Being close-minded or not enjoying effortful thought appear to be less important for this.

Finally, empathizing and subjective happiness (our more exploratory measures) are perhaps surprisingly most strongly associated with the Preference for Effortful Thought. Specifically, people who have a stronger preference are more likely to rate themselves as happy and are more likely to empathize with others – a pattern that is actually the opposite (albeit weakly so) for people who are higher in Actively Open-minded Thinking. This illustrates that the disposition to enjoy effortful thought is, in fact, a unique element of intuitive-analytic thinking styles that has important consequences that differ meaningfully from other elements of thinking styles.

Study 2

Study 1 established that the 4-CTSQ has strong predictive validity for a wide range of important psychological outcomes. We also completed a study, reported in the supplementary materials (“Study 3”), that confirms that the 4-CTSQ is also strongly predictive of actual performance on behavioral tasks that are thought to be influenced by individual differences in analytic thinking. This latter result is not particularly surprising, of course, since the initial winnowing down of items in Study 1 of Appendix B was done by finding only those items that are both thought to measure intuitive-analytic thinking styles and that had at least a moderate correlation with performance on the Cognitive Reflection Test (CRT). A key question, then, is whether the 4-CTSQ is a stronger measure than the CRT.

To investigate this, we turn to an issue of major present concern: COVID-19 misperceptions and vaccination hesitancy. Numerous reports have documented the apparent spread and negative consequences of COVID-19 misinformation (Enders et al., 2020; Loomba et al., 2021; Montagni et al., 2021). Critically, research shows that analytic thinkers are less likely to believe fake news and are better at distinguishing between true and false news, both in the context of political news (Bago et al., 2020; Pennycook & Rand, 2021; Ross et al., 2021) (for a meta-analysis, see Pennycook & Rand, 2021) and news about COVID-19 (Pennycook, McPhetres, et al., 2020). More broadly, misperceptions about COVID-19 and vaccination hesitancy have been associated with decreased analytic thinking as well (Pennycook, McPhetres, et al., 2021). However, these prior studies have relied on behavioral measures of intuitive-analytic thinking style that vary on a single dimension (such as the CRT) – thus, we ask whether distinguishing between different aspects of thinking styles may improve predictive validity. Following the results of Study 1, it is expected that Actively Open-minded Thinking, in particular should be a key element (see also Roozenbeek et al., 2022).

In Study 2, we also set out to replicate the exploratory religious belief change analysis from Study 1 with a much larger and more representative sample. For this, we administered the categorical God-belief question and the follow-up asking about whether one held any other position on the question of God in the past.

Method

We report all manipulations, measures, and exclusions in these studies.

Participants

Nationally representative samples were recruited via YouGov (who fielded the survey) in the U.S. ($n = 1090$; Mean age = 49, 429 male, 620 female, 39 who chose another category or did not respond) and Canada ($n = 1001$; Mean age = 51, 448 male, 529 female, 22 who chose another category or did not respond) in August 2020. The surveys were identical, apart from some minor differences in how the demographics were recorded in each country. We did not complete a power analysis prior to data collection.

Materials

Cognitive Reflection Test (CRT). We used a 6-item version of the CRT that included reworded versions of the original 3-item CRT (Frederick, 2005; Shenhav et al., 2012) and 3 items from the non-numeric CRT (excluding the “dirt in a hole” item; Thomson & Oppenheimer, 2016). The measure had good reliability in both samples (Canada $\alpha = .70$, $M = .40$, $SD = .30$; U.S. $\alpha = .70$, $M = .40$, $SD = .30$).

4-Component Thinking Styles Questionnaire. We used the 24-item 4-CTSQ as specified in Study 1. The subscales had good reliability in both samples: AOT (Canada $\alpha = .88$, $M = 3.37$, $SD = 1.33$; U.S. $\alpha = .89$, $M = 3.48$, $SD = 1.34$), CMT (Canada $\alpha = .78$, $M = 3.84$, $SD = 1.23$; U.S. $\alpha = .80$, $M = 3.93$, $SD = 1.24$), PIT ($\alpha = .89$, $M = 4.53$, $SD = 1.11$; U.S. $\alpha = .90$, $M =$

4.49, $SD = 1.12$), and PET (Canada $\alpha = .85$, $M = 3.77$, $SD = 1.19$; U.S. $\alpha = .86$, $M = 3.81$, $SD = 1.25$).

COVID-19 Vaccination Intentions and Attitudes. We asked 7 questions relating to COVID-19 vaccinations (Pennycook et al., 2021). Three of the questions related to vaccination intentions (note that this study was completed in August 2020 when the COVID-19 vaccines were not yet approved or available): “I am, in general, willing to get vaccinated for COVID-19”, “I would vaccinate my children for COVID-19, given the opportunity”, and “If a COVID-19 vaccination were available for free, would you get vaccinated?”. The first two items were rated on a 7-point Likert scale (1 = strongly disagree; 7 = strongly agree) and the third item was rated on a 5-point scale from “definitely not get it” to “definitely get it”. To create one COVID-19 vaccination intention scale, we z-scored the three questions and computed the mean. We also asked four questions about vaccination attitudes: “We can rely on a SARS-CoV-2 vaccine to stop the spread of COVID-19”, “The COVID-19 vaccine is not likely to cause unforeseen problems in children”, “Authorities will promote the COVID-19 vaccination for financial gain, not for people’s health” (reverse-scored), and “Being exposed to COVID-19 naturally is safer for the immune system than being exposed through vaccination” (these were all rated the same 7-point Likert scale as above). Although the vaccination attitudes measure had excellent reliability in both countries (Canada $\alpha = .87$, U.S. $\alpha = .87$), the measure of vaccination intentions had relatively poor reliability (Canada $\alpha = .59$, U.S. $\alpha = .62$), and therefore should be interpreted with caution.

COVID-19 Misperceptions. A 12-item measure of popular misperceptions about COVID-19 was used (Pennycook et al., 2021). It included items like “The seasonal flu is just as dangerous as COVID-19”, and “The coronavirus that causes COVID-19 was engineered as a

bioweapon in a Chinese lab”. The measure had excellent reliability in both countries (Canada $\alpha = .84$, $M = 2.73$, $SD = 1.18$; U.S. $\alpha = .85$, $M = 2.98$, $SD = 1.29$)

News Discernment. A 20-item measure was used which consists of 10 fake (false) and 10 real (true) news headlines about COVID-19 vaccinations in the format of a Facebook post (as in Pennycook, McPhetres, et al., 2020). The false headlines were taken by fact-checking websites such as snopes.com and factcheck.org. The true headlines were from mainstream media sources and reported accurately on true events (see Pennycook, Binnendyk, et al., 2020). The headlines were randomized and presented one at a time (see [OSF](#) for the headlines). Each headline was paired with the following question: “To the best of your knowledge, how accurate is the claim in the above headline?” which was rated on a 4-point scale (1 = Not at all accurate; 4 = Very accurate) (Pennycook & Rand, 2019a). An average score was created for accuracy on the fake headlines and the true headlines, respectively. We will focus on “news discernment”, which is the overall accuracy of people’s judgments (for a discussion focusing on news discernment instead of mere belief in fake news, see Pennycook & Rand, 2021) and is calculated by subtracting the average scores for fake headlines from the average score for true headlines.

Religious belief. We used the same categorical belief change questions that were administered in Study 1. The breakdown for the theism question is as follows: “I believe in God” (theism; $N_{\text{Canada}} = 533$, $N_{\text{USA}} = 685$), “I don’t really take a stance on God” (apathetic; $N_{\text{Canada}} = 125$, $N_{\text{USA}} = 101$), “I don’t really know if God exists or not” (agnostic; $N_{\text{Canada}} = 150$, $N_{\text{USA}} = 175$), and “I don’t believe in God” (atheist; $N_{\text{Canada}} = 190$, $N_{\text{USA}} = 127$). Given the large combined sample size, we were able to also investigate change within each category (albeit by combining data from Canada and the U.S.). In total, 29.4% of Canadians and 29.7% of Americans in the sample indicated change based on this measure – this is smaller than in Study 1

owing to the higher level of religious belief overall; i.e., across countries, theists reported belief change in only 13.6% of cases whereas non-theists reported change in 51.8% of cases.

Political ideology. Participants in both countries were asked about both social and economic political ideology and rated their political ideology on the following 5-point scale: 1) strongly liberal, 2) liberal, 3) moderate, 4) conservative, 5) strongly conservative. For simplicity, we combined the social and economic ideology questions (which correlated very highly in both countries: $r = .78$ in Canada, $r = .82$ in U.S.) into a single conservatism measure. We also created a categorical ideology measure by combining all of those who rated themselves as lower than 3 as liberal, as higher than 3 as conservative, and at 3 as moderate.

Procedure

The survey began with basic demographics (location, age, gender). The first measure was the vaccination attitude/intention questions, followed by the misperceptions measure, and finally the news discernment measure. The CRT and 4-CTSQ always came after, and the CRT was always completed before the 4-CTSQ. There were also some measures included in the survey (intermixed among the aforementioned measures) that are outside the scope of the present investigation. These include questions about general flu vaccinations, perceptions of risks and other attitudes relating to COVID-19, a basic science knowledge test, bullshit receptivity, media trust questions, and a public service announcement image regarding COVID-19 vaccines, and various demographic and political questions. A full list of the materials in the order that they were presented for both countries is available on [OSF](#).

Results

We calculated bivariate Pearson (r) correlations between the four subscales and four key dependent measures (Table 6). The four subscales were all significantly correlated with COVID-

19 vaccination attitudes, COVID-19 vaccination behaviors, misperceptions about COVID-19, and news discernment. Furthermore, most correlations were in the medium to large range for effect sizes and, critically, many were larger than the correlations between the CRT and the outcome measures. Specifically, the 4-CTSQ subscales significantly outperformed the CRT for 15 out of 32 correlations (using Fisher's r -to- z transformation; the correlations that are significantly stronger for a 4-CTSQ subscale than for the CRT are in bold in Table 6; see supplementary materials for full statistics). However, this wasn't equally distributed across subscales. Indeed, the Actively Open-minded Thinking significantly out-predicted the CRT in 6 out of 8 cases and Preference for Intuitive Thinking out-predicted the CRT in 4 out of 8 cases. Close-Minded Thinking (2 out of 8) and Preference for Effortful Thinking (3 out of 8) were not quite as strong for these outcomes. In contrast, the CRT only outperformed the 4-CTSQ in 3 out of 32 cases.

Table 6. *Pearson correlations (r) between the 4-CTSQ subscales and COVID-19 related measures*

	Vaccine attitudes		Vaccine intentions		Misperceptions		News discernment	
	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A
CRT	.14**	.16**	.08*	.14**	-.26**	-.30**	.23**	.35**
AOT	.27**	.21**	.16**	.16**	-.52**	-.58**	.41**	.45**
CMT	-.14**	-.16**	-.10**	-.14**	.37**	.38**	-.24**	-.27**
PIT	-.25**	-.20**	-.16**	-.15**	.31**	.37**	-.30**	-.29**
PET	.13**	.14**	.05	.08**	-.41**	-.41**	.33**	.39**

Note. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking. Bolded correlations for 4-CTSQ subscales are significantly different from CRT correlations.

* $p < .05$. ** $p < .01$.

Turning to the pattern across measures, Actively Open-minded Thinking emerged as the strongest predictor of misperceptions about COVID-19 and news discernment (with very robust correlations in both countries, r 's $> .50$ for misperceptions and r 's $> .40$ for discernment) – a

result that offers a strong parallel to Study 1. Actively Open-minded Thinking was also one of the strongest predictors of COVID-19 vaccination attitudes and intentions, although in this case, Preference for Intuitive Thinking had similar correlations. In contrast, Preference for Effortful Thought was not a strong predictor of attitudes and behavior even though it was a strong predictor of misperceptions and discernment. These results are paralleled in the regression analyses (Table 7).

Table 7. *Regression coefficients (β) of the 4-CTSQ subscales with COVID-19 related measures*

	Vaccine attitudes		Vaccine intentions		Misperceptions		News discernment	
	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A	Canada	U.S.A
CRT	.04	.08*	.02	.08*	-.05	-.05	.07*	.16**
AOT	.19**	.08*	.11**	.07	-.34**	-.39**	.25**	.25**
CMT	-.04	-.09**	-.05	-.10**	.18**	.20**	-.06*	-.09**
PIT	-.14**	-.13**	-.10**	-.10**	.04	.10**	-.11**	-.07*
PET	-.02	.00	-.05	-.05	-.17**	-.10**	.14**	.15**

Note. Each dependent variable was included in a separate regression analysis with the four subscales as predictors. Each analysis was completed for the Canadian and American sample separately. The coefficient therefore represents the unique predictive validity for each subscale while controlling for the other subscales. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking. * $p < .05$. ** $p < .01$

Finally, turning to the issue of political ideology, previous work found that thinking disposition measures were less predictive of several outcome measures for conservatives relative to liberals in a U.S. sample (Pennycook, Cheyne, et al., 2020). Furthermore, attitudes about COVID-19 (including vaccinations) are strongly associated with political ideology in both the U.S. and Canada (Calvillo et al., 2020; Havey, 2020; Pennycook, McPhetres, et al., 2021; Shepherd et al., 2020). Thus, we investigated the predictive validity of the 4-CTSQ separately for liberals ($N_{\text{Canada}} = 398$; $N_{\text{U.S.A}} = 351$), moderates ($N_{\text{Canada}} = 317$; $N_{\text{U.S.A}} = 338$), and conservatives

($N_{\text{Canada}} = 286$; $N_{\text{U.S.A}} = 401$) as another robustness test. These results are displayed in Table 8, which support several key conclusions. First, in the case of misperceptions and news discernment, the CRT and 4-CTSQ subscales are all significantly predictive regardless of political ideology or country. Furthermore, in most cases, Actively Open-minded Thinking, in particular, emerges as a stronger predictor than the CRT for misperceptions and news discernment. Although the measures are generally more predictive for liberals than conservatives, the results are quite robust even for conservatives (e.g., Actively Open-minded Thinking correlates with misperceptions at $r = -.40$ for Canadian conservatives and $r = -.38$ for American conservatives).

The results for vaccine attitudes and intentions among moderates and conservatives are notably weaker. For example, although Actively Open-minded Thinking and Preference for Intuitive Thinking predicted vaccination attitudes consistently for liberals and moderates in both countries, this is not the case for American conservatives (AOT $r = .072$, $p = .148$, PIT $r = -.064$, $p = .202$). Interestingly, Close-Minded Thinking is the only significant predictor of vaccine attitudes among U.S. participants ($r = -.139$, $p = .005$). A similar pattern emerged for vaccination intentions, where Preference for Intuitive Thinking (but not Actively Open-minded Thinking) predicts intentions among conservatives in Canada, but not conservatives in the U.S. or moderates in either country. This serves as a good case study for the value in measuring thinking dispositions in a more comprehensive way: Based solely on the CRT, it appears that analytic thinking disposition is not relevant for COVID-19 vaccination attitudes or intentions among American conservatives. However, the 4-CTSQ reveals that a specific aspect of thinking disposition, namely Close-minded Thinking, is predictive of vaccination attitudes and intentions among conservatives.

Table 8. *Pearson Correlations Between the Subscales and COVID-19 Related Measures as a Function of Political Ideology*

Canada	Vaccine attitudes			Vaccine intentions			Misperceptions			News discernment		
	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative
CRT	.18**	.07	.10	.15**	.00	.03	-.29**	-.19**	-.23**	.29**	.15**	.20**
AOT	.34**	.17**	.17**	.20**	.07	.11	-.59**	-.45**	-.40**	.42**	.41**	.33**
CMT	-.14**	-.10	-.08	-.08	-.04	-.11	.39**	.31**	.32**	-.22**	-.18**	-.25**
PIT	-.25**	-.20**	-.26**	-.15**	-.10	-.18**	.33**	.24**	.31**	-.32**	-.23**	-.31**
PET	.19**	.04	.06	.09	.01	-.03	-.51**	-.40**	-.24**	.36**	.27**	.28**

U.S.A	Vaccine attitudes			Vaccine intentions			Misperceptions			News discernment		
	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative	Liberal	Moderate	Conservative
CRT	.25**	.16**	.02	.31**	.09	-.05	-.40**	-.35**	-.17**	.47**	.32**	.20**
AOT	.24**	.13*	.07	.23**	-.01	.03	-.66**	-.46**	-.38**	.55**	.36**	.25**
CMT	-.13*	-.08	-.14**	-.11*	-.03	-.13**	.29**	.26**	.36**	-.25**	-.22**	-.18**
PIT	-.22**	-.22**	-.06	-.22**	-.05	-.04	.35**	.22**	.29**	-.29**	-.20**	-.20**
PET	.18**	.06	.06	.14**	.00	-.03	-.49**	-.37**	-.30**	.45**	.32**	.28**

Note. AOT = Actively Open-minded Thinking, CRT = Cognitive Reflection Test, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking

* $p < .05$. ** $p < .01$

Turning now to categorical religious belief change, our results replicated what we found in Study 1 and, more importantly, indicate that Actively Open-Minded Thinking and Close-minded Thinking are stronger predictors of belief change (or a lack of change, for CMT) than performance on the Cognitive Reflection Test. To assess this, we entered belief change as the dependent variable in a binary logistic regression with our key measures as independent variables (and controlling for country and one's stance on God). As in Study 1, Actively Open-minded Thinking ($B = .18$, $Wald = 11.79$, $p = .001$) and Close-Minded Thinking ($B = -.18$, $Wald = 15.62$, $p < .001$) were unique predictors of belief change. However, there was no significant correlation for Preference for Intuitive Thinking ($B = .06$, $Wald = 1.20$, $p = .274$), Preference for Effortful Thought ($B = .01$, $Wald = .05$, $p = .814$), and performance on the CRT ($B = .17$, $Wald = 2.72$, $p = .099$).

To provide a better sense of the pattern of results, Figure 1 shows the mean level of Actively Open-Minded Thinking as a function of one's stance towards God and whether one reported having taken a different stance than their present stance at some point in their life. The data clearly shows two main effects: Actively Open-Minded Thinkers are both stronger in their disbelief in God and (across categories) more likely to have changed belief at some point in their life (indeed, there is no interaction between belief and belief change for Canada, the U.S., or when the data is combined, all F 's < 2 , all p 's $< .122$).

Figure 1. *Actively Open-Minded Thinking as a function of one's stance towards God (theist, apathetic, agnostic, atheist) and whether one reported having taken a different stance than their present stance at some point in their life (no change, change). Error bars are 95% Confidence Intervals. Theist No Change N = 1052, Theist Change N = 166, Apathetic No Change N = 100, Apathetic Change N = 126, Agnostic No Change N = 151, Agnostic Change N = 174, Atheist No Change N = 167, Atheist Change N = 150.*

General Discussion

People differ not only in *what* they think but *how* they think. Importantly, this variation is predictive of a wide range of important psychological outcomes. Accordingly, individual differences in intuitive-analytic thinking styles has been used to support various broad theories of human social and cognitive psychology. We investigated whether there are important differences between different types of thinking styles using a 4-Component Thinking Styles Questionnaire (4-CTSQ; see Appendix A). Study 1 provided evidence that the 4-CTSQ – and each of the subscales – were broadly predictive of a number of outcomes, although this varied depending on the type of thinking style in question. Study 2 then demonstrated that different types of thinking

styles can out-predict the Cognitive Reflection Test (CRT) in the context of COVID-19 misperceptions, fake news discernment, and vaccination attitudes/intentions.

Distinguishing between types of thinking styles: Theoretical implications

The present studies support the idea that people vary across at least four different elements of intuitive-analytic thinking styles and that these elements differentially predict different outcomes in ways that can inform theories about why, exactly, intuitive-analytic thinking dispositions have consequences for our beliefs and behaviors. For example, there was a clear distinction in the predictors of paranormal versus religious belief. Whereas Actively Open-minded Thinking was a particularly robust predictor of religious belief, Preference for Intuitive Thinking was a relatively more robust predictor of paranormal belief. Previous work using behavioral measures of intuitive-analytic thinking found similar correlations for religious and paranormal belief (Pennycook et al., 2012), which was taken to imply that the underlying mechanism for each was similar. This is of particular consequence because earlier explanations of why intuitive responding on the CRT was correlated with religious belief argued that religious beliefs evolved to be particularly intuitive (Shenhav et al., 2012). In conflict with this, our data indicate that intuitiveness (PIT) is actually more strongly correlated with *paranormal* belief than religious belief, whereas questioning one's prior beliefs by engaging with evidence (AOT) is relatively more important for religious belief. We also found that Actively Open-minded Thinking was more strongly associated with prior categorical changes in religious belief than Preference for Intuitive thinking.

In further contrast, Close-Minded Thinking (CMT) was associated *positively* with religious belief but *negatively* with paranormal belief in our regression models, adding to the

literature on critical differences between these related forms of belief (Aarnio & Lindeman, 2007).

Another clear contrast in the 4-CTSQ is the distinction between the preference for intuitive versus effortful thinking. Our validation studies support earlier work on the Rational-Experiential Inventory in which “Faith in Intuition” and “Need for Cognition” emerged as separate thinking style factors (Epstein et al., 1996; Pacini & Epstein, 1999). Indeed, our Preference for Intuitive Thinking items came largely (four out of six items) from the Faith in Intuition measure and our Preference for Effortful Thinking items came entirely from the Need for Cognition measure. Still, our measure has strong psychometric properties and predictive validity despite only consisting of 6 items for each subscale³.

Interestingly, the Need for Cognition scale is likely the most commonly used thinking style scale. Despite this, the Preference for Effortful Thinking scale (which is parallel to Need for Cognition) had generally weaker predictive validity than the other scales in our studies, and most starkly the Actively Open-minded Thinking scale. This resonates with the developments in the literature around dual-process theory that were discussed in the introduction: Having a specific tendency to question one’s intuitions and evaluate new evidence is apparently more impactful than the mere preference for thinking in an effortful way (at least in terms of the outcomes we focus on here). For example, in Study 1, Actively Open-minded Thinking was strongly associated with skepticism about religious⁴, paranormal, and conspiratorial claims as well as

³ We have elected to re-name the scales to avoid confusion between our 6-item measures and the previous scales. Our names also imply fewer assumptions. For example, is the preference for effortful thinking really a *need*? Does one need to have *faith* in their intuitions?

⁴ Note however that the correlation between AOT and religious belief may have been inflated by the presence of the word “belief” in the items, which religious participants may take to refer to religious beliefs in particular (Pennycook, Cheyne, et al., 2020; Stanovich & Toplak, 2019).

lower bullshit receptivity, but Preference for Effortful Thinking did not significantly predict these factors in the regression model. Similarly, in Study 2, Preference for Effortful Thinking did not predict vaccination attitudes or intentions (and was generally a weaker predictor of COVID misperceptions and fake news discernment). Although having a preference for effortful thinking may be important for some things (and, in fact, it did consistently correlate with decision-making performance in the supplemental Study 3 and was most strongly associated with subjective happiness), it is evidently not characteristic of critical thinking and skepticism. Therefore, studies that rely on a single dimension measure to index thinking styles, such as the Need for Cognition scale, may fail to detect cases where intuitive-analytic thinking styles are playing important role.

Limits on generality and directions for future research

There are some limitations of this work that would benefit from further investigation. Most notably, our samples are focused only on U.S. and Canadian participants. Although there has been work on thinking styles across the globe using past measures (Bahçekapili & Yilmaz, 2017; Browne et al., 2014; Marjaana Lindeman et al., 2019; Stagnaro et al., 2019; Yilmaz & Saribay, 2016), the present research needs to be validated cross-culturally. It would be informative, in particular, to administer the 4-CTSQ to an Eastern sample as Asian cultures tend to be more collectivistic compared to Western individualistic Americans (Nisbett et al., 2001). For example, an Asian sample may score lower on the close-minded and intuitive thinking subscales as they assess thinking based on personal feelings and maintaining personal (individual) beliefs and convictions. Additionally, there is some evidence that Western cultures tend to think linearly, whereas Easterners think more dialectically (Nisbett et al., 2001). Since dialectical thinking assesses how an individual interacts with contradictions to form a

comprehensive opinion, Eastern samples may score higher on actively open-minded and effortful thinking and lower on close-minded and intuitive thinking.

Another limitation of the 4-CTSQ comes from the way that it was created. Our goal was to add breadth to the way that intuitive-analytic thinking styles are assessed and found four consistent factors that, apparently, have strong predictive validity. However, each subscale only consists of 6 items and each item is in the same “direction” (i.e., either positively or negatively worded, depending on the name of the scale). Thus, the subscales do not provide much depth in measurement for the underlying types of thinking styles. Future studies that expand on the four factors discovered here may find that they actually consist of sub-factors themselves. Our research indicates that intuitive-analytic thinking styles are not as unidimensional as past research would lead one to believe. Future work will hopefully clarify this potential diversity in thinking styles.

Also related to our scale validation, we initially selected items for further validation based how strongly they correlated with the CRT (see Appendix B), a broadly used measure to index the propensity to override an incorrect intuitive response. This selection criteria limits the use of the scale to conceptualizations of dual-process theory that align with the CRT. As our data highlight, there are good reasons to believe that people vary across several types of thinking styles. Our 4-CTSQ scale cannot reasonably capture every underlying thinking style. Rather, the 4-CTSQ can be used to capture multiple distinct thinking styles unlike commonly used measures that are limited to one domain.

Although the outcome measures used to validate the 4-CTSQ were selected based on theoretical relevance indicated by prior research, we expect that there are more outcomes that may differently relate to each subscale that were not included in our study. Furthermore, our

studies included self-report measures which are subject to biases, despite our best efforts to reduce them. Future studies could use behavioural outcome measures to further support the predictive validity of the 4-CTSQ.

Finally, further work is required to more systematically investigate different types of thinking styles. Although we included a relatively large number of unique measures, the literature on thinking styles is vast and there may be many areas of research where some aspects of intuitive-analytic thinking styles just are not relevant. For example, in financial decision-making, it may be that the mere preference for effortful thinking is more important than taking an actively open-minded stance to evidence. Or, in terms of creativity where prior work has shown that people who are more analytic (in general terms) tend to be better at complex creative tasks (Barr et al., 2015), it may be that a combination of low close-minded thinking and high preference for intuitive thinking are the most critical. Future work may also help clarify whether factors like Actively Open-minded Thinking and Close-Minded Thinking should be considered “thinking” styles, or rather they are better thought of as values or tendencies that relate to how information is approached. Past research on thinking styles has approached this issue with a relatively inclusive definition of what is considered “thinking” and subsequent scale validation may help add further conceptual clarity to the field.

Conclusions

In the present research we employed a scale that distinguishes between 4 correlated but independent intuitive-analytic thinking styles. The data indicates that some different types of thinking styles are relevant for some different outcomes and therefore that classifying people as “intuitive” or “reflective” (absent further specification) is an oversimplification. Furthermore, using single-dimension measures, such as the Need for Cognition scale or the Cognitive

Reflection Test, as a proxy for intuitive-analytic thinking styles may lead to incorrect conclusions or, at the very least, an underestimation of the importance of intuitive-analytic thinking styles. Such investigations would benefit theoretically from taking other types of thinking styles into account, such as with the 4-Component Thinking Styles Questionnaire.

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Appendix: 4-Component Thinking Styles Questionnaire

Response format: Strongly disagree (1), Disagree (2), Somewhat Disagree (3), Somewhat Agree (4), Agree (5), Strongly agree (6)

Scoring: Calculate a mean score for each subscale. The items indicated by (R) are reversed scored.

Subscales: Actively Open-minded Thinking (items 1 – 6), Close-minded Thinking (items 7 – 12), Preference for Intuitive Thinking (items 13 – 18), Preference for Effortful Thinking (items 19 – 24)

Please indicate the extent to which you agree or disagree with the following statements.

1. It is important to be loyal to your beliefs even when evidence is brought to bear against them. (R)
2. Whether something feels true is more important than evidence. (R)
3. Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong. (R)
4. There may be evidence that goes against what you believe but that does not mean you have to change your beliefs. (R)
5. Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs. (R)
6. Regardless of the topic, what you believe to be true is more important than evidence against your beliefs. (R)
7. I think there are many wrong ways, but only one right way, to almost anything.
8. In my experience, the truth is often black and white.
9. Truth is never relative.
10. The truth does not change.
11. Either something is true or it is false; there is nothing in-between.
12. There is no middle ground between what is true and what is false.
13. I like to rely on my intuitive impressions.
14. I believe in trusting my hunches.
15. When I make decisions, I tend to rely on my intuition.
16. Using my "gut-feelings" usually works well for me in figuring out problems in my life.
17. Intuition is the best guide in making decisions.
18. I often go by my instincts when deciding on a course of action.
19. I'm not that good at figuring out complicated problems. (R)
20. Thinking is not my idea of an enjoyable activity. (R)
21. I try to avoid situations that require thinking in depth about something. (R)
22. I am not a very analytical thinker. (R)
23. Reasoning things out carefully is not one of my strong points. (R)
24. Thinking hard and for a long time about something gives me little satisfaction. (R)

Appendix B – Scale Validation

Study 1

The purpose of Study 1 was to narrow down the large list of unique items ($N = 265$) that emerged from the various measures of thinking styles outlined in Table 1 into a more manageable set that we could be confident were relatively strong individual measures of intuitive-analytic thinking styles. We took a unique approach to this problem that benefited from the fact that intuitive-analytic thinking styles can also be measured (in a broad sense) behaviorally via the Cognitive Reflection Test (CRT). Although the CRT does not capture differences in aspects of thinking styles (as noted above), it is reasonable to assume that items that fail to have even a moderate correlation with the CRT are likely to be relatively weak measures of intuitive-analytic thinking. Thus, the goal of Study 1 is simply to narrow the very large list of unique items into a set that are at least modestly reflective of individual differences in intuitive-analytic thinking for investigations of factor structure and standard psychometric validation (Studies 2-6). This approach represents an empirical stand-in for standard considerations of face validity that would be used to narrow down items for validation. Of course, the scales chosen for inclusion in Study 1 were done so based on face validity – however, this was done with a broad focus and thus this initial validation step is worthwhile. Notably, we find in Study 8 that the resulting measure is an even more robust predictor of important outcomes than the CRT.

Table 1. *Various intuitive-analytic thinking styles measures that have conceptual overlap*

Name of measure	Description of scale and representative item	Source
Actively Open-Minded Thinking Scale	Assesses “the tendency to weigh new evidence against a favored belief, to spend sufficient time on a problem before giving up, and to consider	Stanovich & West (2007)

Name of measure	Description of scale and representative item	Source
	carefully the opinions of others in forming one's own." Example item: "Certain beliefs are just too important to abandon no matter how good a case can be made against them"	
Actively Open-Minded Thinking Scale – 10	Assesses how an individual's beliefs are related to how they think people should think. Example item: "People should take into consideration evidence that goes against their beliefs."	Baron (2019)
Comprehensive Intellectual Humility Scale	Assesses "openness to revising one's viewpoints, lack of overconfidence about one's knowledge, respect for the viewpoints of others, and lack of threat in the face of intellectual disagreements." Example item: "I am willing to change my mind once it's made up about an important topic."	(Krumrei-Mancuso & Rouse, 2016)
Epistemic Curiosity Scale	"Assesses the degree to which people desire knowledge because they have high intrinsic interest (the Interest subscale) and because they are troubled when they lack information (the Deprivation subscale)." Example item: "I enjoy exploring new ideas."	Litman & Spielberger (2003)
Faith in Intuition Scale	Assesses an individual's trust in their own intuition when making decisions. Example item: "I believe in trusting my hunches."	Epstein et al., (1996)
General Decision-Making Style Questionnaire	Assesses how individuals respond when faced with a decision and distinguishes between 5 decision styles that are used: rational, avoidant, dependent, intuitive, and spontaneous. Example item: "When making a decision, I consider various options in terms of a specified goal."	Scott & Bruce (1995)
Importance of Rationality Scale	Assesses "the strength of one's preference to be epistemically rational", i.e., "how important people think it is that their own beliefs are based on logic and evidence."	Ståhl, Zaal, & Skitka (2016)

Name of measure	Description of scale and representative item	Source
	Example item: "It is important to me personally to be skeptical about claims that are not backed up by evidence."	
Intolerance of Ambiguity Scale	Assess "the tendency to perceive ambiguous situations as desirable." Example item: "It is more fun to tackle a complicated problem than to solve a simple one."	Budner (1962)
Need for Closure Scale	Assess "the desire for a definite answer on some topic, <i>any</i> answer as opposed to confusion and ambiguity." Example item: "When thinking about a problem, I consider as many different opinions on the issue as possible."	Kruglanski et al., (2013)
Need for Cognition Scale	Assess "individuals' tendency to engage in and enjoy effortful cognitive activity." Example item: "Thinking is not my idea of fun."	Cacioppo & Petty (1982)
Need for Evidence Scale	Assesses the "importance of consistency between empirical evidence and beliefs." Example item: "A hunch needs to be confirmed with data."	Garrett & Weeks (2017)
Need to Evaluate Scale	Assesses the tendency to "engage in evaluative responding" and judge objects as good or bad. Example item: "I form opinions about everything."	Jarvis & Petty (1996)
Preference for Intuition and Deliberation Scale	Assesses "individual preferences to base decisions on gut feelings or affect and also assesses preferences for thoughtful, reflective decisions." Example item: "When I have a problem I first analyze the facts and details before I decide."	Betsch (2004)
Resistance to Change	Assesses the "tendency to resist or avoid making changes, to devalue change generally, and to find change aversive across diverse contexts and types of change." Example item: "Once I've come to a conclusion, I'm not likely to change my mind."	Oreg (2003)

Name of measure	Description of scale and representative item	Source
Self-Righteousness Scale	Assesses the “conviction that one's behaviors or beliefs are correct, especially in contrast to alternate behaviors or beliefs.” Example item: “To me, things don't seem black and white, they're mostly shades of gray.”	Falbo & Belk (1985)

Note. Stated description of what the scale assesses and a representative item from the scale are included.

Method

Participants

Participants were recruited from Amazon’s Mechanical Turk (MTurk) and provided consent before the study. Considering the range of effect sizes in previous studies on analytic thinking (e.g., Pennycook & Rand, 2019) and the finding that correlations stabilize at $n = 161$ (Schönbrodt & Perugini, 2013), 892 participants (18 years and older) were recruited to obtain strong power (each participant only received a subset of the items, see below). To be eligible for the study, participants had to be U.S. citizens with English as their first language. Eighty-eight participants who reported random responding and 2 who failed an attention check were excluded from further analysis. Data from 31 participants who did not complete the entire study were discarded before all analyses. Thus, 774 participants were retained for further analyses. The entire study took approximately 15 minutes to complete. Demographic information for all studies are presented in Table 2.

Table 2

Participant Demographic Characteristics for Studies 1-6

Variable	Study					
	1	2	3	4	5	6
Number of participants, n	774	204	262	271	199	260
Age in years						

Variable	Study					
	1	2	3	4	5	6
<i>Mean</i>	39.85	35.91	32.19	31.12	32.48	31.99
<i>Mi. - Max.</i>	18 - 81	20 - 80	18 - 72	18 - 75	18 - 64	18 - 68
Gender, <i>n</i>						
Male	429	120	108	100	69	117
Female	335	84	149	158	123	140
Transgender Female	1	0	0	0	1	2
Transgender Male	1	0	2	6	1	1
Trans/Non-Binary	2	0	3	6	5	0
Not listed	1	0	0	0	0	0
Prefer not to answer	5	0	0	1	0	0
Highest education level, <i>n</i>						
Less than high school degree	4	0	4	3	5	0
High school graduate	74	26	37	40	33	32
Some college but no degree	164	32	72	68	62	54
Associate degree in college (2-year)	94	18	19	24	18	33
Bachelor's degree in college (4-year)	310	90	100	88	52	97
Master's degree	105	33	24	39	24	31
Doctoral degree	9	3	0	3	1	5
Professional degree (JD, MD)	13	1	5	6	4	8
Ethnicity, <i>n</i>						
White/Caucasian	640	162	212	219	156	228
Black or African American	83	22	25	20	15	14
American Indian or Alaska Native	13	2	7	5	4	1
Asian	45	13	19	22	16	22
Native Hawaiian or Pacific Islander	2	1	1	1	3	3

Variable	Study					
	1	2	3	4	5	6
Middle Eastern	1	0	3	0	3	2
Not listed	21	7	15	13	13	12

Data Quality

Additional steps were taken to ensure high data quality. Only MTurk workers with a history of providing good-quality responses (i.e., an acceptance ratio of > 95%) were allowed to participate in this study. Studies employing MTurk workers who meet this criterion have obtained results comparable to those of studies conducted in the laboratory (Johnson & Borden, 2012). To prevent individuals from completing the same study multiple times or participating in more than one of the studies presented here-in, only one response associated with a given MTurk ID (a unique identifier assigned to each MTurk worker) was accepted.

Materials

Cognitive Reflection Test (CRT). We used a 7-item version of the CRT which includes reworded versions of the three original items (Frederick, 2005; Shenhav et al., 2012) and four additional non-numeric items (Thomson & Oppenheimer, 2016). Correct responses were coded as 1 and incorrect responses as 0 for each item. A higher mean score indicates greater reflection and less intuition. The measure had good reliability ($\alpha = .77$, $M = .63$, $SD = .29$).

Thinking Styles Questionnaires. We searched databases for scales using the following search terms: “analytic thinking”, “decision-making style”, “deliberate”, “intuitive”, “intuition”, “rational”, “thinking”, and “thinking-style”. This was not intended to be a systematic review of all possible thinking style scales, but we collected enough to be fairly comprehensive and, as mentioned, were liberal in terms of what to include. We also endeavored to include the scales

that are the most frequently used and most highly cited. The 15 scales that we identified for inclusion in Study 1 are presented in Table 1.

Actively Open-minded Thinking (AOT; Stanovich & West, 2007). The AOT scale consists of 41-items that assess the willingness to consider new information despite personal beliefs and the motivation to delay cognitive closure and engage in reflective thinking. The AOT has seven subscales: NFC, AOT, openness-values, dogmatism, categorical thinking, belief identification, and counterfactual thinking.

Actively Open-minded Thinking-10 (AOT-10; Baron, 2019). The AOT-10 is a shortened version of the AOT-41 and tests the extent to which the way people think is related to their beliefs about how they should think. This is the recommended version for assessing belief identification, a subscale of the AOT-41, because of the clearer wording of items. Thus, items from the 41-item AOT belief identification subscale that overlapped with the AOT-10 were removed and replaced with the AOT-10 item.

Comprehensive Intellectual Humility Scale (Krumrei-Mancuso & Rouse, 2016). The Comprehensive Intellectual Humility Scale is a 22-item measure of intellectual humility, that is, the extent to which people consider that their beliefs may be erroneous. Items are loaded across four subscales relating to the domains of intellectual humility, including independence of intellect and ego, openness to revising one's viewpoint, respect for others' viewpoints, and lack of intellectual overconfidence.

Epistemic Curiosity (Litman & Spielberger, 2003). The Epistemic Curiosity scale is a 10-item measure of an individual's motivation to learn new information due to gaps in knowledge or conceptual puzzles, as well as interest in cognitively processing information related to ambiguous stimuli. The items load evenly across two factors, intellectual interest (I-

type) and informational deprivation (D-type), which are related to information-seeking strategies. I-type Epistemic Curiosity refers to intrinsically motivated information seeking to increase knowledge, whereas D-type Epistemic Curiosity refers to need-based information seeking to reduce uncertainty.

Faith in Intuition (Pacini & Epstein, 1999). The Faith in Intuition scale assesses the ability and tendency to engage in emotional or intuitive (experiential) thinking. It consists of 20 items loaded across two subscales, experiential ability and experiential engagement.

General Decision-Making Style (Scott & Bruce, 1995). The General Decision-Making Style scale is a 25-item measure of how individuals approach making decisions. The 25 items are evenly loaded onto five subscales which represent the five decision-making styles: rational, intuitive, dependent, avoidant, and spontaneous.

Importance of Rationality (Ståhl et al., 2016). The Importance of Rationality consists of six items that assess the extent to which perceiving rationality as personally important is essential when forming and evaluating beliefs.

Intolerance of Ambiguity Scale (Budner, 1962). The Intolerance of Ambiguity Scale is a 16-item measure of attitudes toward situations that cannot be classified due to a lack of information, that is, ambiguity.

Need for Closure Scale (Kruglanski et al., 1997). The Need for Closure Scale is a 42-item measure of the need for eliminating ambiguity and having definite conclusions, that is, cognitive closure. There are 5 subscales: desire for predictability, Preference for order and structure, discomfort with ambiguity, decisiveness, and closed-mindedness.

Need for Cognition (Cacioppo & Petty, 1982). The Need for Cognition scale consists of 20 items across two scales, rational ability and rational engagement, that assess the tendency to engage in analytic or logical (rational) thinking.

Need for Evidence Scale (Garrett & Weeks, 2017). The Need for Evidence Scale consists of four items and tests if held beliefs are likely to change based on contradictory evidence.

Need to Evaluate Scale (Jarvis & Petty, 1996). The Need to Evaluate Scale is a 16-item measure of the tendency to form a value judgment about the worth of situations or objects, that is, evaluative responding.

Preference for Intuition and Deliberation (Betsch, 2004). The Preference for Intuition and Deliberation is an 18-item measure of the inclination to engage in slower, complicated, cognitive-based decision-making.

Resistance to Change (Oreg, 2003). The Resistance to Change is a 16-item measure of the tendency to diminish change and avoid making changes.

Self-Righteousness Scale (Falbo & Belk, 1985). The Self-Righteousness Scale is a 7-item measure of an individual's conviction that their beliefs and actions are correct compared to others, that is, self-righteousness. The items are loaded across three factors: belittling of those who disagree with oneself, acceptance of others, and uncertainty regarding beliefs.

Demographics. Participants were given a demographic questionnaire that included the following items: age, education, and gender.

Procedure

All items were entered into a spreadsheet and duplicate items were removed. The retained 265 items were inserted into Qualtrics in the form of a questionnaire. After completing the

consent form, participants were presented with a subset of 90 items randomly selected from the 13 scales above (all items were intermixed across scales). Participants were asked to rate how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the CRT and demographic questions. There was an attention check question and a check for random responding.

Results

We used an effect size cut-off of (r) .21 (positive or negative) to narrow down the items based on their correlation with CRT performance. This effect size was selected as it was determined to be the average effect size for the published effects in social psychology that were surveyed by Richard et al. (2003) (see also Fraley & Marks, 2007; c/f Funder & Ozer, 2019). A more recent analysis of the individual differences literature in social psychology found an average effect size of $r = .19$ (Gignac & Szodorai, 2016), leading to the suggestion that $r = .20$ should be considered a “medium” effect size. In any case, we used the slightly larger but effectively identical effect size of $r = .21$ for our cut-off. A summary of the 50 individual items that met the cut-off and their correlation with the CRT is presented in Table 3. As can be seen, they were taken from a large number of different scales.

Table 3

Correlation (Pearson r) of Items From Various Measures That Exceed the Cut-Off of ± 0.21

With the Cognitive Reflection Test (CRT)

Scale	Item	Correlation (r) with CRT
Need for Closure	I usually make important decisions quickly and confidently.	-0.21
Rational-Experiential Inventory	Thinking is not my idea of an enjoyable activity. (R)	0.21
Need to Evaluate	I often prefer to remain neutral about complex issues. (R)	0.22
Need for Closure	It's annoying to listen to someone who cannot seem to make up his or her mind.	-0.22
Need for Cognition	Thinking hard and for a long time about something gives me little satisfaction. (R)	0.22
Preference for Intuition and Deliberation	I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience of life.	-0.22
Actively Open-minded Thinking	Certain beliefs are just too important to abandon no matter how good a case can be made against them. (R)	0.22
Actively Open-minded Thinking	I think that if people don't know what they believe in by the time they're 25, there's something wrong with them. (R)	0.23
Actively Open-minded Thinking	My blood boils over whenever a person stubbornly refuses to admit he's wrong. (R)	0.23
Actively Open-minded Thinking	It is a noble thing when someone holds the same beliefs as their parents. (R)	0.23
Actively Open-minded Thinking-10	People should take into consideration evidence that goes against conclusions they favor.	0.23
Intolerance of Ambiguity Scale	A good job is one where what is to be done and how it is to be done are always clear.	-0.24
Need for Evidence	I trust the facts, not my instincts, to tell me what is true.	0.24
Need to Evaluate	I like to decide that things are really good or really bad.	-0.24
Actively Open-minded Thinking	It makes me happy and proud when someone famous holds the same beliefs that I do. (R)	0.24
General Decision-Making Style	I often make impulsive decisions.	-0.25
Actively Open-minded Thinking	I think there are many wrong ways, but only one right way, to almost anything.	0.25

Scale	Item	Correlation (r) with CRT
Actively Open-minded Thinking-10	People should revise their conclusions in response to relevant new information.	0.25
Intolerance of Ambiguity Scale	People who fit their lives to a schedule probably miss most of the joy of living. (R)	0.25
Comprehensive Intellectual Humility Scale	I have at times changed opinions that were important to me, when someone showed me I was wrong.	-0.25
Faith in Intuition	Using my "gut-feelings" usually works well for me in figuring out problems in my life.	0.26
Need for Cognition	Knowing the answer without having to understand the reasoning behind it is good enough for me. (R)	0.26
Actively Open-minded Thinking	No one can talk me out of something I know is right. (R)	0.26
Comprehensive Intellectual Humility Scale	When someone disagrees with ideas that are important to me, it feels as though I'm being attacked. (R)	0.26
Need for Cognition	Reasoning things out carefully is not one of my strong points. (R)	0.27
Need for Cognition	I try to avoid situations that require thinking in depth about something. (R)	0.27
Actively Open-minded Thinking	I believe that loyalty to one's ideals and principles is more important than "open-mindedness." (R)	0.27
Actively Open-minded Thinking	I tend to classify people as either for me or against me. (R)	0.27
General Decision-Making Style	When I make a decision, it is more important for me to feel the decision is right than to have a rational reason for it.	-0.27
Actively Open-minded Thinking	Changing your mind is a sign of weakness. (R)	0.27
Need to Evaluate	I am pretty much indifferent to many important issues. (R)	0.28
Resistance to Change	When someone pressures me to change something, I tend to resist it even if I think the change may ultimately benefit me.	-0.28
Faith in Intuition	I believe in trusting my hunches.	-0.29
Actively Open-minded Thinking	Coming to decisions quickly is a sign of wisdom. (R)	0.30
Actively Open-minded Thinking-10	It is OK to ignore evidence against your established beliefs. (R)	0.30
Faith in Intuition	I am not a very analytical thinker. (R)	0.30
Need for Cognition	I'm not that good at figuring out complicated problems. (R)	0.31

Scale	Item	Correlation (r) with CRT
Actively Open-minded Thinking	There are two kinds of people in this world: those who are for the truth and those who are against the truth. (R)	0.32
Actively Open-minded Thinking	It is important to be loyal to your beliefs even when evidence is brought to bear against them. (R)	0.32
Actively Open-minded Thinking-10	Being undecided or unsure is the result of muddled thinking.	-0.33
Preference for Intuition and Deliberation	I am a very intuitive person.	-0.33
Need to Evaluate	It is very important to me to hold strong opinions.	-0.34
Faith in Intuition	I often go by my instincts when deciding on a course of action.	-0.34
Faith in Intuition	I like to rely on my intuitive impressions.	-0.35
Actively Open-minded Thinking	Of all the different philosophies which exist in the world there is probably only one which is correct. (R)	0.35
Intolerance of Ambiguity Scale	The sooner we all acquire similar values and ideals the better.	-0.35
Intolerance of Ambiguity Scale	An expert who doesn't come up with a definite answer probably doesn't know too much.	-0.39
Actively Open-minded Thinking	Intuition is the best guide in making decisions. (R)	0.39
Preference for Intuition and Deliberation	With most decisions it makes sense to completely rely on your feelings.	-0.42
General Decision-Making Style	When I make decisions, I tend to rely on my intuition.	-0.44

Note. $N = 774$. Reverse-scored items are denoted with (R).

Study 2

Having reduced the full list of items down to 50 items that exceeded the cut-off of $\pm .21$, we next set out to explore the factor structure.

Method

Participants

American participants ($n = 257$) were recruited from Amazon's Mechanical Turk (MTurk). Forty-five participants who reported random responding and 1 who failed the attention

check were excluded from further analysis. Data from 7 participants who did not complete the entire study were discarded before all analyses. For further analyses, 204 participants were retained. The entire study took approximately 15 minutes to complete.

Procedure

After providing consent, participants were presented with all 50 items retained from Study 1. Participants were asked to rate how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the same demographics items from Study 1.

Results

Principal Component Analysis (PCA) was the primary analysis we used to reduce the correlated observed variable to a smaller subset. Before running the PCA, the data was analyzed to see if it was appropriate for PCA based on four assumptions. The data had multiple variables measured at the continuous level and there was a linear relationship between all variables. Furthermore, correlations tend to stabilize at N's of around 160 (Schönbrodt & Perugini, 2013) and 204 participants gave us over 95% power to detect medium effects sizes ($\rho = .3$) and over 80% power to detect small-to-medium effect sizes ($\rho = .2$). Thus, the data met the assumptions of PCA and was suitable for the analysis.

PCA with orthogonal (Varimax) rotation was conducted to reduce the 50 items that correlate with the CRT. Seven factors were retained as they had a Kaiser's eigenvalue (a measure of variance explained; Kaiser, 1960) above 1.0 criterion, as seen in Table 4, which is a commonly used criterion for extracting factors (Fabrigar et al., 1999).

Table 4

Total Variance Explained by the Seven Factors With Eigenvalues Above 1.0 in Study 2.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	23.441	46.883	46.883	23.441	46.883	46.883	8.771	17.542	17.542
2	3.242	6.483	53.366	3.242	6.483	53.366	8.083	16.165	31.707
3	2.407	4.814	58.180	2.407	4.814	58.180	7.748	15.495	47.202
4	1.914	3.828	62.008	1.914	3.828	62.008	3.464	6.927	54.129
5	1.434	2.868	64.876	1.434	2.868	64.876	2.338	4.676	58.805
6	1.265	2.529	67.405	1.265	2.529	67.405	2.205	4.411	63.216
7	1.062	2.125	69.530	1.062	2.125	69.530	2.156	4.312	67.528

The first factor accounts for approximately 47% of the variance and all seven factors explain approximately 70% of the variance (Table 4). After rotation, the factors still explain approximately 70% of the total variance, with most of the variance spreading almost evenly across the first three factors. This finding suggests that there may be three factors that best represent the data, not seven as proposed by the eigenvalues. This may be because the method of extracting factors based on Keiser's eigenvalues oversimplifies the data and overestimates the number of factors to retain (Zwick & Velicer, 1986).

Parallel analysis was also done in SPSS (v. 25) using the parallel.sps script developed by O'Connor (2000) to confirm the number of factors to retain. One hundred data sets were generated and eigenvalue estimates were generated above the 95th percentile. These model specifications were used for all parallel analyses. The parallel analysis indicated that four factors (instead of three, as noted above) should be retained (see supplementary materials). Thus, there is some ambiguity about the number of factors, which will be explored in subsequent studies.

Factor loadings for specific items are presented in Table 5. Loadings less than $|\cdot 30|$ are considered relatively low while loadings of $|\cdot 40|$ – $|\cdot 70|$ are generally considered to be moderately high (Fabrigar et al., 1999).

Table 5*Results of a Factor Analysis of the Thinking Styles Items*

Item	Factor loading						
	1	2	3	4	5	6	7
I think there are many wrong ways, but only one right way, to almost anything.	.717	.188	.318	.179	.044	.083	.131
I like to decide that things are really good or really bad.	.703	.262	.201	.075	-.074	.266	.115
Of all the different philosophies which exist in the world there is probably only one which is correct.	.653	.289	.364	.205	.026	-.031	.139
Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.652	.395	.295	.183	.116	-.005	.050
The sooner we all acquire similar values and ideals the better.	.649	.296	.384	.030	-.027	.026	.095
There are two kinds of people in this world: those who are for the truth and those who are against the truth.	.619	.206	.226	.230	.023	.390	.150
It is very important to me to hold strong opinions.	.610	.204	.039	.111	-.064	.247	.353
I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.609	.377	.424	.307	.070	.051	.135
I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.607	.132	.389	.318	.087	.137	.130
It is a noble thing when someone holds the same beliefs as their parents.	.564	.367	.400	.242	.082	.131	-.084
It is OK to ignore evidence against your established beliefs.	.557	.371	.393	.305	.183	.043	-.077
It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.556	.356	.300	.379	.238	.080	.108
I tend to classify people as either for me or against me.	.549	.245	.268	.313	.113	.383	.186
Knowing the answer without having to understand the reasoning behind it is good enough for me.	.534	.283	.533	.054	.086	.176	.122
With most decisions it makes sense to completely rely on your feelings.	.514	.512	.371	.261	.112	.160	.064
It makes me happy and proud when someone famous holds the same beliefs that I do.	.494	.408	.264	.075	-.058	.191	-.046
I like to rely on my intuitive impressions.	.216	.840	.155	.100	.065	.163	.024
I believe in trusting my hunches.	.193	.819	.235	.128	-.026	.048	.126
When I make decisions, I tend to rely on my intuition.	.265	.815	.187	.124	.085	.018	.067
I am a very intuitive person.	.161	.795	-.029	.210	-.011	-.042	.180
Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.227	.746	.165	.166	.042	.137	.035
Intuition is the best guide in making decisions.	.368	.742	.190	.199	.139	.129	.095

I often go by my instincts when deciding on a course of action.	.253	.733	.204	.110	.150	.139	.085
I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience of life.	.248	.601	.276	.055	.006	-.007	.246
When I make a decision, it is more important for me to feel the decision is right than to have a rational reason for it.	.448	.578	.322	.123	.171	.113	.003
I'm not that good at figuring out complicated problems.	.216	.092	.850	.084	-.037	.090	.011
Thinking is not my idea of an enjoyable activity.	.323	.104	.794	-.015	.069	.015	.206
I try to avoid situations that require thinking in depth about something.	.292	.138	.790	.036	.080	.148	.114
I am not a very analytical thinker.	.245	.183	.788	.195	.008	.014	.037
Reasoning things out carefully is not one of my strong points.	.252	.231	.736	.262	.086	.149	.042
Thinking hard and for a long time about something gives me little satisfaction.	.417	.191	.666	-.008	.066	.040	.215
I am pretty much indifferent to many important issues.	.050	.335	.604	.455	-.032	.166	.042
I often prefer to remain neutral about complex issues.	.162	.208	.497	.401	.074	.068	-.153
I often make impulsive decisions.	.101	.378	.487	.318	.040	.409	-.043
An expert who doesn't come up with a definite answer probably doesn't know too much.	.399	.192	.438	.433	.067	.167	.210
I usually make important decisions quickly and confidently.	.412	.311	.037	.601	.078	-.059	.192
People who fit their lives to a schedule probably miss most of the joy of living.	.375	.299	.200	.539	-.006	.182	.027
Coming to decisions quickly is a sign of wisdom.	.484	.303	.301	.528	.051	.070	.101
Changing your mind is a sign of weakness.	.424	.230	.490	.514	.099	.227	.057
Being undecided or unsure is the result of muddled thinking.	.370	.257	.322	.490	.078	.169	.336
I have at times changed opinions that were important to me, when someone showed me I was wrong.	.013	-.094	.075	.073	.760	-.033	-.002
People should revise their conclusions in response to relevant new information.	-.002	-.001	.172	.119	.745	-.087	.092
People should take into consideration evidence that goes against conclusions they favor.	.287	.205	-.041	-.010	.662	.060	.028
I trust the facts, not my instincts, to tell me what is true.	-.123	.361	-.079	-.095	.580	.048	-.134
My blood boils over whenever a person stubbornly refuses to admit he's wrong.	.191	.028	.072	.080	-.206	.707	.383
When someone disagrees with ideas that are important to me, it feels as though I'm being attacked.	.413	.184	.366	.084	.080	.586	.111
When someone pressures me to change something, I tend to resist it even if I think the change may ultimately benefit me.	.344	.323	.376	.207	.177	.416	-.002

It's annoying to listen to someone who cannot seem to make up his or her mind.	.112	.109	.084	.226	.046	.113	.789
A good job is one where what is to be done and how it is to be done are always clear.	.239	.280	.153	-.220	-.071	.284	.600
No one can talk me out of something I know is right.	.432	.356	.188	.211	.154	.031	.438

Note. $N = 257$. The extraction method was principal component analysis with an orthogonal (varimax with Kaiser normalization) rotation. Factor loadings above .40 are in bold.

All items loaded above $|.30|$ on at least one factor and there were several cross-loaded items with coefficients greater than $|.40|$ that loaded on more than one factor. We considered these items relatively poor at discriminating between factors and did not include them in further analyses. One exception was the item, “I believe that loyalty to one's ideals and principles is more important than “open-mindedness”.” which was retained as it loaded on the first factor with a coefficient of .609 but only .424 on Factor 3. This difference seemed substantial, so the item was included in further studies. Additionally, weak factors, with three items or less (Fabrigar et al., 1999), were removed; this includes Factors 4, 6, and 7 after removing cross-loaded items. Factor 5 consisted of 4 items that seemed to assess resistance to change. However, these items were the only 4 recoded items in the study which suggests that something about the nature of these items, like positive keying (McLarnon et al., 2016), influenced responding (as opposed to the meaning of the items). Thus, these items (and Factor 5) were removed from further analyses.

Based on these criteria, 24 items in total were removed. The 26 retained items and their factor loadings are presented in Table 6. The first 12 items, which appear to index Actively Open-minded Thinking, had strong loadings on the first factor. The next 8 items, which appear to index Preference for Intuitive Thinking, had high loadings on the second factor, and the last six items, which seemed to index Preference for Effortful Thinking, loaded highly on the third

factor. The results of Study 2 suggest that a three-factor structure would be suitable for the data.

Note, however, that the parallel analysis suggested four factors and our subsequent studies indicate that the first Actively Open-minded Thinking factor may be two separate factors. We turn to this issue next.

Table 6

Results of a Factor Analysis of the Thinking Styles Items

Original scale	Item	Factor loading		
		1	2	3
Factor 1: Actively Open-minded Thinking				
Rational-Experiential Inventory	I think there are many wrong ways, but only one right way, to almost anything.	.717		
Need to Evaluate	I like to decide that things are really good or really bad.	.703		
Actively Open-minded Thinking	Of all the different philosophies which exist in the world there is probably only one which is correct.	.653		
Actively Open-minded Thinking	Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.652		
Intolerance of Ambiguity Scale	The sooner we all acquire similar values and ideals the better.	.649		
Actively Open-minded Thinking	There are two kinds of people in this world: those who are for the truth and those who are against the truth.	.619		
Need to Evaluate	It is very important to me to hold strong opinions.	.610		
Actively Open-minded Thinking	I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.609		
Actively Open-minded Thinking	I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.607		
Actively Open-minded Thinking-10	It is OK to ignore evidence against your established beliefs.	.557		
Actively Open-minded Thinking	It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.556		
Actively Open-minded Thinking	I tend to classify people as either for me or against me.	.549		
Factor 2: Preference for Intuitive Thinking				
Rational-Experiential Inventory	I like to rely on my intuitive impressions.		.840	
Rational-Experiential Inventory	I believe in trusting my hunches.		.819	
General Decision-Making Style	When I make decisions, I tend to rely on my intuition.		.815	

Original scale	Item	Factor loading		
		1	2	3
Preference for Intuition and Deliberation	I am a very intuitive person.		.795	
Rational-Experiential Inventory	Using my "gut-feelings" usually works well for me in figuring out problems in my life.		.746	
Actively Open-minded Thinking	Intuition is the best guide in making decisions.		.742	
Rational-Experiential Inventory	I often go by my instincts when deciding on a course of action.		.733	
Preference for Intuition and Deliberation	I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience of life.		.601	
Factor 3: Preference for Effortful Thinking				
Rational-Experiential Inventory	I'm not that good at figuring out complicated problems.			.850
Rational-Experiential Inventory	Thinking is not my idea of an enjoyable activity.			.794
Rational-Experiential Inventory	I try to avoid situations that require thinking in depth about something.			.790
Rational-Experiential Inventory	I am not a very analytical thinker.			.788
Rational-Experiential Inventory	Reasoning things out carefully is not one of my strong points.			.736
Rational-Experiential Inventory	Thinking hard and for a long time about something gives me little satisfaction.			.666

Note. $N = 257$. The extraction method was principal component analysis with an orthogonal (varimax with Kaiser normalization) rotation. Factor loadings below .40 are suppressed.

Study 3

The purpose of this study is to confirm the three-factor structure from Study 2 using the 26 items identified in Table 6. The three factors were labeled Actively Open-minded Thinking (AOT), Preference for Intuitive Thinking (PIT), and Preference for Effortful Thinking (PET).

Method

Participants

First, a pilot study was done with 29 American participants via Prolific to get a picture of the factor structure before recruiting a larger sample. The results indicated that the items were

loading as expected, thus we could proceed with a full launch. This data was not used in further analyses. A larger study was then launched with 310 American participants from Prolific. Data from nine participants who did not complete the entire study were discarded before all analyses. Six participants who reported random responding and eleven who failed the attention check were excluded from further analysis. The 22 participants who did not respond "strongly disagree" to the question "I have been to every country in the world" were removed from further analyses. For future analyses, 262 participants were retained. The entire study took approximately 5 minutes to complete.

Procedure

After providing consent, participants completed the 26 items that were retained from Study 2. Participants were asked to rate how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the same demographics items from Study 1.

Results

PCA with orthogonal (Varimax) rotation was conducted to assess the underlying structure of the 26 items. Before running the PCA, the data was analyzed to see if it was appropriate for PCA based on four assumptions stated in Study 1. Five factors were retained as they had a Kaiser's eigenvalue (1960) above 1.0 criterion, as seen in Table 7. The first factor accounts for approximately 25% of the variance and all five factors explain approximately 58% of the variance. After rotation, the factors still explain approximately 58% of the total variance, with most of the variance spreading across the first four factors. This finding suggests that there may be four factors that best represent the data, not five as proposed by the eigenvalues. A

parallel analysis was also done which suggests that three factors should be extracted (see supplementary materials). We extracted four factors, however, for the reasons explained next.

Table 7

Total Variance Explained by the Five Factors with Eigenvalues Above 1.0 for Study 3.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.635	25.520	25.520	6.635	25.520	25.520	5.146	19.791	19.791
2	3.938	15.147	40.668	3.938	15.147	40.668	3.269	12.572	32.363
3	2.224	8.556	49.223	2.224	8.556	49.223	2.873	11.051	43.415
4	1.370	5.271	54.494	1.370	5.271	54.494	2.545	9.790	53.204
5	1.045	4.020	58.513	1.045	4.020	58.513	1.380	5.309	58.513
6	.986	3.792	62.305						

The results of the PCA, seen in Table 8, suggest that four factors would be more suitable for the data than the 3-factor solution suggested in Study 2. This change occurred because the AOT items, which loaded on one factor in Study 2, loaded across three factors in this study. The first two factors, PIT and PET loaded as expected: Factor 1 included the 8 items identified as PIT from Study 2, and Factor 2 included the 6 PET items from Study 2. The third, fourth, and fifth factors included the AOT items from Study 2. The fifth factor was removed from further analyses as it included only two items, one of which loaded below the acceptable threshold of .40, which constitutes a weak factor (Fabrigar et al., 1999). The third and fourth factors were retained for future studies as separate factors instead of one as suggested by the parallel analysis. This is because of the conceptual difference in what each factor assesses. The third factor included 6 items that seemed to index the tendency to think in black-and-white or close-minded thinking (similar to dogmatism), so it was named Close-minded Thinking (CMT) for future studies. The fourth factor was comprised of 4 items that tapped the tendency to uphold beliefs

despite conflicting evidence, so it was called Actively Open-minded Thinking (AOT). Whether these emerge as genuinely different factors is the issue that we turn to next.

Table 8

Results of a Factor Analysis of the Thinking Styles Items

Item	Factor loading				
	1	2	3	4	5
Factor 1: Preference for Intuitive Thinking					
Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.872	-.052	.039	.106	.011
I like to rely on my intuitive impressions.	.850	.009	.092	.042	.005
I believe in trusting my hunches.	.824	.065	-.003	.035	.168
I often go by my instincts when deciding on a course of action.	.809	.090	.030	.093	.018
When I make decisions, I tend to rely on my intuition.	.801	.068	.085	.159	.095
Intuition is the best guide in making decisions.	.747	.138	.081	.171	.007
I am a very intuitive person.	.723	-.222	.085	-.004	.164
I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience of life.	.600	.157	.003	.208	-.143
Factor 2: Preference for Effortful Thinking					
I try to avoid situations that require thinking in depth about something.	-.038	.771	.115	.162	.144
Thinking is not my idea of an enjoyable activity.	-.140	.767	.106	.166	.228
I'm not that good at figuring out complicated problems.	.061	.711	.253	.019	-.180
Thinking hard and for a long time about something gives me little satisfaction.	.114	.667	.043	.048	.373
Reasoning things out carefully is not one of my strong points.	.139	.652	.140	.135	-.125
I am not a very analytical thinker.	.085	.561	-.041	.004	-.342
Factor 3: Close-minded Thinking					
I think there are many wrong ways, but only one right way, to almost anything.	.032	.119	.721	.181	.082
The sooner we all acquire similar values and ideals the better.	.096	.195	.705	-.006	.092
Of all the different philosophies which exist in the world there is probably only one which is correct.	.024	.088	.646	.323	-.018
There are two kinds of people in this world: those who are for the truth and those who are against it.	.091	.006	.644	.043	.155
I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.004	.038	.606	.145	-.012
I tend to classify people as either for me or against me.*	.108	.277	.389	.197	.285
Factor 4: Actively Open-minded Thinking					

It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.182	.089	.190	.810	.111
Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.205	.088	.186	.716	.060
It is OK to ignore evidence against your established beliefs.	.174	.224	.103	.705	-.094
I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.083	.068	.322	.647	.263
Factor 5: Actively Open-minded Thinking					
It is very important to me to hold strong opinions.	.194	-.057	.216	.099	.742
I like to decide that things are really good or really bad.*	.022	.265	.359	.241	.391

Note. $N = 262$. The extraction method was principal component analysis with an orthogonal (varimax with Kaiser normalization) rotation. Factor loadings above .40 are in bold, except two, as indicated by *.

Study 4

Our studies so far reveal two highly consistent factors that appear to index the Preference for Intuitive Thought and the Preference for Effortful Thought. They also consistently indicate a separate factor related to Actively Open-minded Thinking (AOT). However, the results of Study 3 (unlike Study 2) suggest that a four-factor structure would be a more suitable fit than a three-factor solution for the data, with the fourth factor being labeled Close-Minded Thinking (CMT). However, these factors did not clearly separate in Study 2 using PCA analysis (although they were more evident in Study 2 using parallel analysis). Thus, this study aims to resolve this ambiguity by further testing the factor structure with a new sample. To aid with this, we shifted to a content-driven strategy and decided to bolster the AOT/CMT subscales with more items.

Method

Participants

Three hundred and ten American participants were recruited using Prolific. Data from six participants who did not complete the entire study were discarded before all analyses. Six participants who reported random responding and five who failed the attention check were

excluded from further analysis. Data for 22 participants who did not respond "strongly disagree" to the question "I have been to every country in the world" were removed from further analyses. Thus, 271 participants were retained for further analyses. The entire study took approximately 5 minutes to complete.

Materials

AOT/CMT. Four items from the AOT factor in Study 3 formed a separate factor. In an attempt to bolster this subscale, four items from Study 1 were reintroduced. These items were initially excluded from further analyses because correlation with the CRT was below the cut-off or $\pm .21$ (but above $\pm .20$; see supplemental material Table S10, AOT11-AOT14). It was suspected that the positive wording of these eight items, otherwise known as positive keying, influenced participants to agree with those items as similar items that were worded negatively elicited negative responses ("disagree" or "strongly disagree"). This belief is consistent with research done by McLarnon et al. (2016) who found that positively keyed items were related to social desirability and rule-consciousness, and negatively keyed items were related to acquiescence, social desirability, and rule-consciousness. Additionally, negatively worded items correlated higher with the CRT. Thus, positively keyed items were reworded. For example, the original item, "I have at times changed opinions that were important to me, when someone showed me I was wrong" was reworded as "I rarely change opinions that are important to me." Thus, seven of the ten new items were reworded. Additionally, six items from Study 2 were included. Three items loaded on the first factor, which was retained, however, the items were excluded because other items loaded higher on Factor 1 and did not cross-load on other factors. The other three items formed Factor 5 (plus one other item) which seemed to assess resistance to change. The items that loaded on Factor 5 were the only recoded items in the data set, thus the

factor was dropped assuming the items were influenced by positive keying. These items were reintroduced based on face validity, however. We also retained only three factors in Study 2 but the parallel analysis suggested four factors. Thus, items may have been excluded in Study 2 when they could have been included for further analyses (see supplemental material Table S11, AOT5-AOT10).

In total, there were 34 items in this study: 14 AOT items, 6 CMT items, 8 PIT items, and 6 PET items. Two items from the AOT scale in Study 3 were excluded from this study because they formed a separate factor: “It is very important to me to hold strong opinions” and “I like to decide that things are really good or really bad.”

Procedure

After providing consent, participants completed the 34 items by rating how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the same demographics items from Study 1.

Results

PCA with orthogonal (Varimax) rotation was conducted to reduce the 34 items. Before running the PCA, the data was analyzed to see if it was appropriate for PCA based on four assumptions stated in Study 1. Based on these tests, the data met the assumptions of PCA and was suitable for the analysis. Seven factors had a Kaiser’s eigenvalue (1960) above 1.0 criterion, as seen in Table 9. The first factor accounts for approximately 25% of the variance and all seven factors explain approximately 58% of the variance. After rotation, the factors still explain approximately 58% of the total variance, with most of the variance spreading across the first three factors (Table 9). A parallel analysis was also done which suggests that four factors should be retained (100 data sets, 95th percentile; see supplementary materials).

Consistent with Studies 3 and 4, the PIT and PET items performed consistently: Based on the PCA, seen in Table 10, all PIT items loaded on the first factor and all but one PET item loaded on the third factor. The PET factor had 6 items so we aimed to have no more than 6 items on the other subscales. Thus, the two lowest loading items from the PIT subscale were removed and the AOT and CMT subscales will be constructed with this in mind. This approach is used to ensure that the subscales are simple and employ the minimum number of items that adequately access analytic thinking styles (Hinkin, 1998).

The PCA also revealed that seven of the fourteen AOT items loaded on the second factor. However, the other seven items loaded on four different factors. The CMT subscale also did not load consistently on one factor: the six items were spread across three factors. Thus, further analyses are required to investigate and potentially bolster those subscales.

Table 9*Total Variance Explained by the Seven Factors With Eigenvalues Above 1.0 in Study 4.*

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.610	25.324	25.324	8.610	25.324	25.324	5.280	15.529	15.529
2	3.642	10.713	36.037	3.642	10.713	36.037	3.572	10.507	26.036
3	2.503	7.363	43.400	2.503	7.363	43.400	3.541	10.415	36.451
4	1.659	4.879	48.279	1.659	4.879	48.279	2.271	6.681	43.132
5	1.257	3.696	51.975	1.257	3.696	51.975	2.204	6.482	49.613
6	1.110	3.263	55.239	1.110	3.263	55.239	1.668	4.906	54.519
7	1.047	3.080	58.318	1.047	3.080	58.318	1.292	3.799	58.318
8	.980	2.881	61.200						

Table 10*Results of a Factor Analysis of the Thinking Styles Items*

Data label	Factor loading						
	1	2	3	4	5	6	7
Factor 1: Preference for Intuitive Thinking							
When I make decisions, I tend to rely on my intuition.	.830	.008	.058	.096	.099	.091	-.004
I like to rely on my intuitive impressions.	.828	.093	.071	-.003	.088	.018	-.076
I believe in trusting my hunches.	.814	.139	-.033	-.069	.127	.118	.009
I often go by my instincts when deciding on a course of action.	.802	.109	.195	-.013	.032	.115	-.022
Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.765	.116	.003	.128	.073	.114	.068
Intuition is the best guide in making decisions.	.749	.183	.064	.038	.223	.043	-.011
I am a very intuitive person.	.673	.102	-.221	.149	-.187	-.152	.154
I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience of life.	.587	.204	.330	.010	-.023	.080	.135
Factor 2: Actively Open-minded Thinking							
It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.198	.759	.087	.049	.152	.212	.134

Data label	Factor loading						
	1	2	3	4	5	6	7
I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.052	.730	.122	.306	.003	.165	-.035
Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.168	.672	.112	.036	.054	.170	.135
It is a noble thing when someone holds the same beliefs as their parents.	.094	.662	.059	.045	.163	.168	.039
It is OK to ignore evidence against your established beliefs.	.149	.590	.140	.325	.177	-.228	.153
Whether something feels true is more important than evidence.	.379	.539	.259	.067	.138	-.206	.018
People should be particularly skeptical of evidence that goes against conclusions they favor.*	.287	.351	.104	.058	.275	-.032	.309
Factor 3: Preference for Intuitive Thinking							
Reasoning things out carefully is not one of my strong points.	.030	.094	.779	.069	-.003	.091	.009
I am not a very analytical thinker.	.060	.036	.758	.108	.091	-.128	.045
I'm not that good at figuring out complicated problems.	.034	.144	.749	.049	.158	.095	-.004
I try to avoid situations that require thinking in depth about something.	-.020	.143	.611	-.081	.513	-.002	.178
When I have a problem I tend to decide before analyzing facts and details.	.323	.191	.541	-.034	.024	.296	-.075
Thinking hard and for a long time about something gives me little satisfaction.	.080	.216	.539	-.026	.418	-.044	.081
Factor 4: Close-minded Thinking							
Of all the different philosophies which exist in the world there is probably only one which is correct.	.005	.155	.035	.787	.021	.001	.027
I think there are many wrong ways, but only one right way, to almost anything.	.025	.268	.193	.693	-.004	.091	-.048
There are two kinds of people in this world: those who are for the truth and those who are against it.	.112	-.016	-.129	.655	.293	.198	.114
Factor 5							
Thinking is not my idea of an enjoyable activity.	.020	.069	.455	-.015	.628	.085	.177
I tend to classify people as either for me or against me.	.249	.159	.060	.276	.454	.194	.001
Knowing the answer without having to understand the reasoning behind it is good enough for me.	.082	.206	.304	.051	.451	.210	-.313

Data label	Factor loading						
	1	2	3	4	5	6	7
It is not very important to me to examine traditionally held beliefs using logic and evidence.	.076	.265	.194	.237	.432	-.142	.066
I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.164	.041	-.158	.258	.409	.307	-.035
It is not very important to me to be skeptical about claims that are not backed up by evidence.*	.100	.353	.186	.052	.387	-.035	-.137
Factor 6							
I rarely change opinions that are important to me.	.171	.297	.117	.067	.049	.688	.181
No one can talk me out of something I know is right.	.234	.178	.070	.291	.077	.529	.407
The sooner we all acquire similar values and ideals the better.	.045	.067	.096	.393	.153	.469	-.292
People should avoid revising their conclusions too quickly in response to new information.	.020	.223	.116	.014	.034	.123	.763

Note. $N = 271$. The extraction method was principal component analysis with an orthogonal (varimax with Kaiser normalization) rotation. Factor loadings above .40 are in bold, except two, as indicated by *.

Study 5

The results of Study 4 again suggest that there are two consistent subscales, PIT and PET, and that there may be one or more AOT-related subscales. In particular, the two subscales, Close-Minded Thinking and Actively Open-minded Thinking, loaded across multiple factors. This study aims to further investigate and bolster the CMT and AOT subscales by including a wider range of items worded specifically to assess the underlying AOT and CMT dimensions. As a result, the development strategy will be content-driven to focus specifically on these constructs.

Method

Participants

American participants ($n = 263$) were recruited from Prolific. Data from 9 participants who did not complete the study were discarded before all analyses. Fourteen participants who reported random responding and 14 who failed the attention check were excluded from further analysis. Data from 27 participants who did not respond “strongly disagree” to “I have been to every country in the world” were excluded from further analyses. For further analyses, 199 participants were retained. The entire study took approximately 15 minutes to complete.

Materials

AOT/CMT. The six CMT items from Study 4 were included in this study. An additional 14 items were created and included in this study. An example of such items is, “The truth does not change.” The items were created to be similar to the CMT items that loaded on Factor 4. The fourteen AOT items from Study 4 were also included in this study. An additional 8 items were created. An example of a new item is, “Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong.” Items can be found in Table 12.

Procedure

After providing consent, participants completed the 42 items by rating how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the same demographics items from Study 1.

Results

Principal Axis Factoring (PAF) with oblique (Direct Oblimin) rotation was conducted to assess the underlying structure of the 42 items. Unlike PCA, which attempts to represent variance through a small set of components, PAF focuses on the shared variance in the measurements (variables) by looking at a small set of latent variables or factors (Warner, 2012). PAF assumes that unique variance exists and that each variable may have unique measurement

error. Given that we moved from being focused on reducing factors to a strategy that isolates the best items to capture identified factors (and given that the AOT and CMT factors seem to be connected), we used PAF instead of PCA. In any case, both strategies produced similar results.

Two factors were set to be extracted which account for approximately 35% of the total variance after rotation, as seen in Table 11. The two factors very clearly distinguished between AOT and CMT items, as is clear from Table 12. Insofar as there was cross-over, this was for weak items that loaded below .40. Thus, the distinction between Actively Open-minded Thinking and Close-minded Thinking was born out in the data. A parallel analysis was also done which suggests that two factors should be retained (see supplementary materials).

Next, we set out to choose items for future testing. For this, we set a target of six items to match the number of items that were identified for the PIT and PET subscales in the previous studies. This, of course, was an arbitrary cut-off and there were more than six items for both the AOT and CMT subscales that had good factor loadings above .40 (Fabrigar et al., 1999). The items for further testing are noted in bold in Table 12.¹ The factor correlation matrix is presented in Table 13 which shows that the factors are moderately correlated.

Table 11

Total Variance Explained by Three Factors With Eigenvalues Above 1.0

Component	Initial eigenvalues		Extraction sums of squared loadings		Rotation sums of squared loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %

¹ Note that the 6 highest loading items were not chosen. This was due to an error: We originally chose the top 6 items based on data without the inattentive participants removed. Naturally, the chosen items nonetheless loaded similarly to the strict top 6. In any case, we completed a follow-up study using the 6 items that loaded the highest in Table 11 (and contrasting this with the items that were actually selected for future studies). These revised AOT and CMT scales produced largely similar results to the selected scale (see supplementary materials), which is unsurprising given the conceptual overlap in the items.

1	11.798	28.090	28.090	11.203	26.673	26.673	9.707
2	3.918	9.328	37.417	3.350	7.975	34.648	8.210
3	1.795	4.273	41.691				

Table 12

Results of a Factor Analysis of the Thinking Styles Items

Item	Factor loading	
	1	2
Factor 1: Actively Open-minded Thinking		
20. Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs.	.775	-.151
21. Regardless of the topic, what you believe to be true is more important than evidence against your beliefs.	.763	-.132
18. Whether something feels true is more important than evidence.	.760	-.132
22. If something feels really true, it is OK to ignore evidence that says otherwise.	.745	-.023
1. So-called evidence changes all the time, so it is important to remain loyal to my beliefs.	.730	.114
6. Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong.	.725	-.007
17. It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.711	.145
15. There may be evidence that goes against what you believe but that does not mean you have to change them.	.709	-.155
5. It is OK to ignore evidence against your established beliefs.	.689	-.057
3. Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.658	.084
4. It is a noble thing when someone holds the same beliefs as their parents.	.530	.149
CMT20. So-called 'experts' are constantly changing their mind and this is a problem.	.496	.120
11. What you believe to be true is more important than what others say is true.	.455	.133
16. Usually when evidence that goes against my beliefs, it's the evidence that is wrong and not my beliefs.	.454	.319
CMT19. It is not very important to me to be skeptical about claims that are not backed up by evidence.	.439	.118
14. People should be particularly skeptical of evidence that goes against conclusions they favor.	.404	.277
7. People who say they care about "evidence" usually just can't make up their mind about what is true.	.402	.235
10. People should avoid revising their conclusions too quickly in response to new information.	.397	.048
12. I rarely change opinions that are important to me.	.375	.263

Item	Factor loading	
	1	2
CMT17. It is not very important to me to examine traditionally held beliefs using logic and evidence.	.351	-.082
CMT18. No one can talk me out of something I know is right.	.338	.319
CMT8. When I have a problem I tend to decide before analyzing facts and details.	.287	.049
CMT2. Knowing the answer without having to understand the reasoning behind it is good enough for me.	.241	.144
Factor 2: Close-minded Thinking		
11. Either something is true or it is false - there is nothing in-between.	-.236	.812
15. There is no middle ground between what is true and what is false.	-.230	.737
10. I think there are many wrong ways, but only one right way, to almost anything.	.052	.691
7. In my experience, the truth is often black and white.	-.035	.679
3. There is only one correct viewpoint on basically any topic.	-.018	.672
16. The truth does not change.	-.102	.637
1. What has been true in the past remains true today and will be true in the future.	.152	.555
4. Truth is never relative.	-.013	.549
13. There is a right way and a wrong way to do everything.	.045	.507
5. Of all the different philosophies which exist in the world there is probably only one which is correct.	.061	.499
9. What is reasonable to believe as being true does not change over time.	.268	.472
AOT2. I tend to classify people as either for me or against me.	.141	.453
6. I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.088	.434
14. I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.353	.429
12. There are two kinds of people in this world: those who are for the truth and those who are against it.	.055	.425
AOT19. Things people say can be classified as true or false.	.093	.309
AOT13. The sooner we all acquire similar values and ideals the better.	.024	.303
AOT9. People are too confused about what is true and what is false.	.159	.215
AOT8. I don't really 'debate' people - either they accept what is true or they do not.	.122	.202

Note. $N = 263$. The extraction method was principal axis factoring with an oblique (direct oblimin with Kaiser normalization) rotation. Items retained for Study 6 are in bold. Items with just a number before the description are from the set of items that match the factor name under which it

is presented. Items with AOT or CMT and a number loaded on the factor that does not correspond with the item name.

Table 13

Factor Correlation Matrix

Factor	1	2	3
1	-		
2	.394	-	
3	-.293	-.243	-

Study 6

In Study 5 we identified 6 candidate items for the CMT and AOT subscales. The purpose of Study 6 was to confirm the factor structure of the full 4-subscale measure by combining the newly selected CMT and AOT items from Study 5 with the PET and PIT items previously identified in Study 4.

Method

Participants

American participants ($n = 307$) were recruited from Prolific. Data from five participants who did not complete the entire study were discarded before all analyses. Three participants who reported random responding and 11 who failed the attention check were excluded from further analysis. Data from 28 participants who did not respond “strongly disagree” to “I have been to every country in the world” were excluded from further analyses. Two hundred and sixty participants ($N = 260$) were retained for further analyses. The entire study took approximately 10 minutes to complete.

Materials and Procedure

Participants were presented with the 24 items identified in the previous studies as measuring AOT, CMT, PIT, or PET. Participants rated how much they agree or disagree with

each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants then completed the same demographics items from Study 1.

Results

PAF with oblique (Direct Oblimin) rotation was conducted to assess the underlying structure of the 24 items. Four factors were extracted which account for approximately 53% of the total variance after rotation, as seen in Table 14. A parallel analysis was also done which suggests that four factors should be retained (see supplementary materials). The four factors presented in Table 15 loaded as expected. The new AOT and CMT items formed distinct factors in addition to the PET and PIT factors. One CMT item loaded below the threshold for high loadings ($|.40|$); however, since it was above the low cut-off of $|.30|$, it was included in future studies. The factor correlation matrix is presented in Table 16 which shows that the factors are not strongly correlated, with the exception of Factor 1 (PIT) and Factor 4 (AOT) which have a correlation of $-.47$.

Table 14

Total Variance Explained by Four Factors With Eigenvalues Above 1.0.

Component	Initial eigenvalues			Extraction sums of squared loadings		Rotation sums of squared loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.529	27.204	27.204	6.136	25.565	25.565	4.988
2	3.277	13.653	40.857	2.799	11.662	37.227	2.673
3	2.742	11.424	52.281	2.265	9.436	46.664	3.102
4	2.041	8.502	60.783	1.616	6.732	53.395	4.767
5	0.979	4.081	64.864				

Table 15
Results of a Factor Analysis of the Thinking Styles Items

Thinking styles item	Factor loading			
	1	2	3	4
Factor 1: Preference for Intuitive Thinking				
7. I often go by my instincts when deciding on a course of action.	.86	-.02	-.05	.03
3. When I make decisions, I tend to rely on my intuition.	.86	-.02	.06	-.03
5. Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.81	.02	.01	.06
1. I like to rely on my intuitive impressions.	.80	.00	.00	-.04
2. I believe in trusting my hunches.	.75	.01	-.04	-.05
6. Intuition is the best guide in making decisions.	.70	.02	.00	-.20
Factor 2: Close-minded Thinking				
17. Either something is true or it is false; there is nothing in-between.	.04	.82	.03	.02
18. There is no middle ground between what is true and what is false.	.01	.81	.05	.08
8. In my experience, the truth is often black and white.	-.02	.70	.13	-.13
15. The truth does not change.	.04	.61	-.06	.06
10. Truth is never relative.	-.05	.54	-.01	.05
2. I think there are many wrong ways, but only one right way, to almost anything.	.00	.33	-.16	-.11
Factor 3: Preference for Effortful Thinking				
3. I try to avoid situations that require thinking in depth about something. (R)	-.16	.05	-.77	-.11
2. Thinking is not my idea of an enjoyable activity. (R)	-.10	.00	-.71	-.13
1. I'm not that good at figuring out complicated problems. (R)	.02	-.03	-.64	.13
4. I am not a very analytical thinker. (R)	.09	-.04	-.62	.03
5. Reasoning things out carefully is not one of my strong points. (R)	.02	-.04	-.62	-.01
6. Thinking hard and for a long time about something gives me little satisfaction. (R)	.12	.08	-.50	-.03
Factor 4: Actively Open-minded Thinking				
1. It is important to be loyal to your beliefs even when evidence is brought to bear against them. (R)	-.04	.02	.00	-.81
20. Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs. (R)	.00	-.04	-.01	-.79
17. Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong. (R)	.02	-.02	.05	-.73
18. There may be evidence that goes against what you believe but that does not mean you have to change them. (R)	.02	.01	-.02	-.72
21. Regardless of the topic, what you believe to be true is more important than evidence against your beliefs. (R)	.08	.03	-.08	-.71
6. Whether something feels true is more important than evidence. (R)	.16	-.05	-.03	-.61

Note. $N = 260$. The extraction method was principal axis factoring with an oblique (direct oblimin with Kaiser normalization) rotation. Factor loadings above $|\text{.40}|$ are in bold, except one, as indicated by *. Reverse-scored items are denoted with (R).

Table 16*Factor Correlation Matrix*

Factor	1	2	3	4
1	-			
2	.013	-		
3	-.163	-.128	-	
4	-.465	-.103	.280	-

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Supplementary File 1 – Additional analyses for main text

Study 1

Table S1. *Confirmatory factor analysis results*

Model	χ^2_m	df _m	BIC	RMSEA [90% CI]	CFI	TLI	SRMR
1-Factor	3139.20	252	29952.875	.167 [.161 - .172]	.446	.393	.156
4-Factor (Orthogonal)	747.03	252	27560.709	.069 [.063 - .075]	.905	.896	.161
4-Factor (Oblique)	568.90	246	27418.718	.056 [.050 - .062]	.938	.930	.057

Note. This table presents model fit statistics from Confirmatory Factor Analyses conducted in mPlus 8.60 (Muthén & Muthén, 2021). χ^2_m refers to the chi-square model fit and df_m refers to the model's degrees of freedom. The next columns are, in order, Bayesian information criterion (BIC; Raftery, 1995), the Root Mean Square Error of Approximation (RMSEA; Steiger, 2000), Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis index (TLI; Bentler, 1990) and Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1998) fit indices for each CFA model. To compare model fit of unnested models, we used a BIC difference of > 10 to indicate superior fit for the model with a lower BIC value (see Raftery, 1995).

Table S2. *Standardized loadings for 4-factor oblique model*

Item	AOT	CMT	PIT	PET
AOT1	.820			
AOT2	.767			
AOT3	.693			
AOT4	.717			
AOT5	.745			
AOT6	.773			
CMT1		.577		
CMT2		.725		
CMT3		.532		
CMT4		.568		
CMT5		.807		
CMT6		.783		
PIT1			.872	
PIT2			.798	
PIT3			.855	
PIT4			.739	
PIT5			.767	
PIT6			.800	
PET1				.728
PET2				.821
PET3				.867
PET4				.691
PET5				.682
PET6				.630

Table S3. *Factor correlation matrix for principal axis factoring with direct oblimin rotation and Kaiser normalization*

Factor	AOT	CMT	PIT	PET
AOT	-			
CMT	-.23***	-		
PIT	-.50***	.18**	-	
PET	.37***	-.27***	-.26***	-

Study 2

Table S4. *Confirmatory factor analysis results*

Model	χ^2_m	df _m	BIC	RMSEA [90% CI]	CFI	TLI	SRMR
1-Factor	2598.39	252	27274.771	.158 [.152 - .163]	.481	.431	.149
4-Factor (Orthogonal)	683.49	252	25359.869	.068 [.062 - .074]	.905	.895	.160
4-Factor (Oblique)	511.00	246	25222.946	.054 [.047 - .060]	.941	.934	.052

Note. This table presents model fit statistics from Confirmatory Factor Analyses conducted in mPlus 8.60 (Muthén & Muthén, 2021). χ^2_m refers to the chi-square model fit and df_m refers to the model's degrees of freedom. The next columns are, in order, Bayesian information criterion (BIC; Raftery, 1995), the Root Mean Square Error of Approximation (RMSEA; Steiger, 2000), Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis index (TLI; Bentler, 1990) and Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1998) fit indices for each CFA model. To compare model fit of unnested models, we used a BIC difference of > 10 to indicate superior fit for the model with a lower BIC value (see Raftery, 1995).

Table S29. *Standardized loadings for 4-factor oblique model*

Item	AOT	CMT	PIT	PET
AOT1	.790			
AOT2	.718			
AOT3	.711			
AOT4	.714			
AOT5	.792			
AOT6	.736			
CMT1		.476		
CMT2		.686		
CMT3		.493		
CMT4		.595		
CMT5		.865		
CMT6		.847		
PIT1			.822	
PIT2			.767	
PIT3			.800	
PIT4			.642	
PIT5			.616	
PIT6			.704	
PET1				.612

PET2	.794
PET3	.800
PET4	.642
PET5	.616
PET6	.704

Table S5. Factor correlation matrix principal axis factoring with direct oblimin rotation and Kaiser normalization

Factor	AOT	CMT	PIT	PET
AOT	-			
CMT	-.28***	-		
PIT	-.55***	.19**	-	
PET	.36***	-.17**	-.26***	-

Table S6. Fisher's *r*-to-*z* test for the Canadian sample comparing correlations of the CRT and subscales of the CTSQ with COVID-19 vaccination attitudes, COVID-19 vaccination behaviors, misperceptions about COVID-19, and news discernment. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

Variable	Attitudes <i>z</i> (<i>p</i>)	Behaviour <i>z</i> (<i>p</i>)	Misperceptions <i>z</i> (<i>p</i>)	Discernment <i>z</i> (<i>p</i>)
AOT	(-3.673) <.001	(-2.142) .016	(7.946) <.001	(-5.359) <.001
CMT	(5.723) <.001	(3.632) <.001	(-13.193) <.001	(9.648) <.001
PIT	(7.818) <.001	(4.749) <.001	(-11.581) <.001	(10.938) <.001
PET	(0.370) .356	(0.890) .187	(4.349) <.001	(-2.569) .005

Table S7. Fisher's *r*-to-*z* test for the American sample comparing correlations of the CRT and subscales of the CTSQ with COVID-19 vaccination attitudes, COVID-19 vaccination behaviors, misperceptions about COVID-19, and news discernment. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

Variable	Attitudes <i>z</i> (<i>p</i>)	Behaviour <i>z</i> (<i>p</i>)	Misperceptions <i>z</i> (<i>p</i>)	Discernment <i>z</i> (<i>p</i>)
AOT	(-1.369) .085	(-0.634) .263	(9.541) <.001	(-3.521) <.001
CMT	(6.742) <.001	(5.923) <.001	(-15.128) <.001	(13.38) <.001
PIT	(7.682) <.001	(6.166) <.001	(14.701) <.001	(13.347) <.001
PET	(0.598) .275	(1.721) .043	(-20.57) <.001	(-1.266) .103

Study 3 - Supplemental Study

The results of Study 1 supported our four factor model for the 24-item Comprehensive Thinking Style Questionnaire and show that the subscales have good predictive validity for various psychological measures. The purpose of this study is to test whether the four subscales predict performance on three behavioral measures that are thought to require the engagement of analytic (Type 2) processing and also to investigate whether the subscales differ in their association with behavioral tasks of this nature.

For this, we administered a battery of 15 questions (via Toplak et al., 2011) that are derived from the seminal work heuristics and biases research program (Kahneman, 2011; Kahneman et al., 1982). A measure of intuitive-analytic thinking disposition should be strongly associated with performance on the heuristics and biases battery as it consists of problems that cue an incorrect intuitive response and that therefore requires effortful thought. We also included the Alice-Heim group ability test (Heim, 1970), which is a short measure of cognitive ability (focusing on verbal and mathematical reasoning. People who have a more analytic thinking disposition (and particularly those who have a preference for effortful thought, PET) should performance better on a cognitive ability test. Finally, we also included the Cognitive Reflection Test, which is very likely to correlate strongly with the CTSQ since it was used to help build the measure in Study 1. We nonetheless include it here to confirm this association for the individual subscales that we developed.

Participants

American participants ($n = 525$) were recruited from Prolific for the behavioral measures. Data for 20 participants who did not complete the study was removed. Fifty-nine participants who reported random responding and 11 who failed the attention check were excluded from further analysis. Data from 65 participants who did not respond “strongly disagree” to “I have

been to every country in the world” were excluded from further analyses. Thus, data from 375 participants were retained for further analyses. The entire study took approximately 15 minutes to complete.

Table S8. *Participant demographic characteristics for Study 9*

Variable	Study 9
Number of participants, <i>n</i>	375
Age in years	
<i>Mean</i>	32.19
<i>Mi. - Max.</i>	18 - 85
Gender, <i>n</i>	
Male	188
Female	175
Transgender Female	1
Transgender Male	2
Trans/Non-Binary	8
Not listed	1
Prefer not to answer	0
Highest education level, <i>n</i>	
Less than high school degree	0
High school graduate	42
Some college but no degree	91
Associate degree in college (2-year)	33
Bachelor's degree in college (4-year)	139
Master's degree	54
Doctoral degree	7
Professional degree (JD, MD)	9
Ethnicity, <i>n</i>	

White/Caucasian	294
Black or African American	33
American Indian or Alaska Native	8
Asian	45
Native Hawaiian or Pacific Islander	1
Middle Eastern	0
Not listed	18

Materials

Comprehensive Thinking Styles Questionnaire. We used the 24-item CTSQ as specified in Study 6. The scale has four subscales created by using average scores: AOT ($\alpha = .88$, $M = 4.24$, $SD = .97$), CMT ($\alpha = .82$, $M = 2.92$, $SD = .98$), PIT ($\alpha = .92$, $M = 3.64$, $SD = .96$), and PET ($\alpha = .85$, $M = 4.55$, $SD = .90$). AOT and PET were recoded prior to running the analyses so that a higher score represented higher actively open-minded thinking and a greater preference for effortful thinking (respectively).

Behavioral Measures

Alice Heim Group Ability Test (Heim, 1970). Participants completed the 65-item Alice Helm 4, part I (AH 4), which consists of 32 verbal and 33 mathematical reasoning items of increasing difficulty. Participants were given 5 minutes to complete as many questions as possible. The verbal items included 11 verbal opposites, 10 verbal synonyms, and 11 verbal analogies. One example is, “*Fact* is to *fiction* as *historian* is to...” (Response options: history, book, novelist, teacher, story). Of the numerical items, 10 were reasoning items, 11 arithmetic items, and 12 series completion items. An example is “Here are three figures: 2 3 4. Divide the biggest figure by the smallest and add the result to the figure printed immediately after the

smallest figure.” Items are scored by summing up the correct responses with higher scores indicating higher cognitive ability.

Cognitive Reflective Test (CRT; Frederick, 2005). Participants completed the same 7-item version of the CRT that was used in Study 1. The measure had acceptable reliability ($\alpha = .69$, $M = .66$, $SD = .29$).

Heuristics and Biases Battery (Toplak et al., 2011). Participants completed the 15-item “heuristics and biases” battery which assess various domains of rational thinking: hypothetical thought, probabilistic reasoning, scientific reasoning, statistical thinking, and theory justification. Items are designed to cue an incorrect intuitive response as a result of bias or a common heuristic. Problems include the causal base-rate, framing, sample size, methodological reasoning, gambler’s fallacy, and sunk cost for example. An example of an item is “You are staying in a hotel on vacation. You paid \$6.95 to see a movie on pay T.V. After 5 minutes, you are pretty bored with the film. Would you watch the movie or not?” Items are scored by summing up the correct responses with higher scores indicating greater rational thinking and less intuitive thinking. The items were generated from the heuristics and biases tradition in judgment and decision making (Kahneman et al., 1982). The measure had relatively weak reliability, however ($\alpha = .65$, $M = .50$, $SD = .18$).

Procedure

Participants provided consent then responded to 24 items by rating how much they agree or disagree with each item on a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Participants also completed three tasks: Alice Heim Group Ability Test, CRT, and heuristics and biases. Participants then completed the same demographics items from Study 1.

Results

We again ran a confirmatory factor analysis on the CTSQ using our correlated 4-factor model and found evidence of good fit: $\chi^2 = 511.00$, $df = 246$; RMSEA = .05, SRMR = .05; CFI = .94, TLI = .93. Factor loadings were very similar to Studies 6 and 7 (see supplementary materials).

As stated in our preregistration (available on [OSF](#)), we calculated bivariate Pearson (r) correlations between the four subscales and three behavioral measures (Table S9). The four subscales were all significantly correlated with all three of the behavioral measures. Furthermore, the correlations were largely similar in size.

To investigate further, we completed three multiple regression analyses with the behavioral measures as the dependent variables and the 4 subscales as predictors (this analysis was not preregistered). A summary of the results can be seen in Table S10.

Table S9. *Pearson correlations the four subscales with behavioral measures.* CRT = Cognitive Reflection Test, AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking

Variable	1	2	3	4	5	6	7
CRT	-						
AOT	.282**	-					
CMT	-.127*	-.256**	-				
PIT	-.282**	-.496**	.164**	-			
PET	.225**	.301**	-.160**	-.239**	-		
Alice Heim Test	.386**	.246**	-.224**	-.185**	.213**	-	
Heuristics and Biases	.440**	.300**	-.188**	-.377**	.258**	.383**	-

Note. * $p < .05$. ** $p < .01$ $N = 375$ Cases excluded listwise.

Table S10. Regression coefficients (β) correlating the four subscales with behavioral measures. Each dependent variable was included in a separate regression analysis with the four subscales as predictors. The coefficient therefore represents the unique predictive validity for each subscale while controlling for the other subscales. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking

Variable	AOT	CMT	PIT	PET
Alice Heim Test	0.136*	-0.158**	-0.060	0.132*
Cognitive Reflection Test	0.146*	-0.040	-0.171**	0.134**
Heuristics and Biases Task	0.092	-0.095	-0.280**	0.148**

Note. * $p < .05$. ** $p < .01$

The regression results indicate that PIT was uniquely predictive of performance on the CRT and the heuristics and biases battery (both that contain intuitive but incorrect answers), but not the Alice Heim Test of cognitive ability. PET was uniquely predictive of all three behavioral measures, as might be expected given that all three tasks require effortful thought. AOT was predictive of performance on the CRT and Alice Heim Test, but not the heuristics and biases battery. Finally, similar to the belief measures, CMT was the weakest predictor of the behavioral measures and was only uniquely predictive of performance on the Alice Heim Test.

Table S11. Confirmatory factor analysis results

Model	χ^2_m	df _m	BIC	RMSEA [90% CI]	CFI	TLI	SR MR
1-Factor	10339.53	252	170952.240	.138 [.136 - .141]	.546	.503	.124
4-Factor (Orthogonal)	2827.98	252	163440.685	.070 [.068 - .072]	.884	.873	.185
4-Factor (Oblique)	1401.26	246	162059.837	.047 [.045 - .050]	.948	.942	.050

Note. This table presents model fit statistics from Confirmatory Factory Analyses conducted in mPlus 8.60 (Muthén & Muthén, 2021). χ^2_m refers to the chi-square model fit and df_m refers to the model's degrees of freedom. The next columns are, in order, Bayesian information criterion (BIC; Raftery, 1995), the Root Mean Square Error of Approximation (RMSEA; Steiger, 2000), Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis index (TLI; Bentler, 1990) and

Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1998) fit indices for each CFA model. To compare model fit of unnested models, we used a BIC difference of > 10 to indicate superior fit for the model with a lower BIC value (see Raftery, 1995).

Table S12. *Standardized loadings for 4-factor oblique model*

Item	AOT	CMT	PIT	PET
AOT1	.798			
AOT2	.748			
AOT3	.726			
AOT4	.702			
AOT5	.755			
AOT6	.794			
CMT1		.615		
CMT2		.697		
CMT3		.366		
CMT4		.527		
CMT5		.777		
CMT6		.732		
PIT1			.755	
PIT2			.730	
PIT3			.799	
PIT4			.768	
PIT5			.738	
PIT6			.775	
PET1				.688
PET2				.780
PET3				.795
PET4				.713
PET5				.714
PET6				.584

Table S13. *Factor correlation matrix principal axis factoring with direct oblimin rotation and Kaiser normalization*

Factor	AOT	CMT	PIT	PET
AOT	-			
CMT	-.37***	-		
PIT	-.52***	.26**	-	
PET	.60***	-.32**	-.25***	-

Supplemental File 2 – Additional analyses for Appendix B

Study 2

Table S1. *Parallel analysis and random data eigenvalues for Study 2. The root for the number in bold corresponds with the number of factors to extract.*

Root	Means	Percentile
1.000000	2.113848	2.218582
2.000000	1.998109	2.064111
3.000000	1.903013	1.982006
4.000000	1.831294	1.910436
5.000000	1.764404	1.842547
6.000000	1.703473	1.770458
7.000000	1.646644	1.697246
8.000000	1.587888	1.636679
9.000000	1.544349	1.586588
10.000000	1.496028	1.537451
11.000000	1.449776	1.486302
12.000000	1.407683	1.445518
13.000000	1.362453	1.399490
14.000000	1.320894	1.360286
15.000000	1.277423	1.314002
16.000000	1.241180	1.268363
17.000000	1.203293	1.239444
18.000000	1.168111	1.200099
19.000000	1.133469	1.169982
20.000000	1.098717	1.127596
21.000000	1.062857	1.092068
22.000000	1.028565	1.056212
23.000000	.998605	1.025027
24.000000	.965288	.989566
25.000000	.933912	.967095
26.000000	.904256	.938969
27.000000	.876383	.906650
28.000000	.848253	.875401
29.000000	.820394	.848185
30.000000	.793364	.827168
31.000000	.766635	.793673
32.000000	.738415	.764769
33.000000	.711630	.737147
34.000000	.686955	.716253
35.000000	.658341	.682926
36.000000	.635679	.659414

37.000000	.611116	.634078
38.000000	.586609	.613335
39.000000	.561432	.586927
40.000000	.538680	.566883
41.000000	.514421	.542750
42.000000	.489597	.512988
43.000000	.465715	.486678
44.000000	.440355	.464998
45.000000	.417528	.440857
46.000000	.392305	.416462
47.000000	.368690	.394178
48.000000	.340154	.364708
49.000000	.313684	.340510
50.000000	.278134	.306171

Note. Specifications for this run: 204 cases, 50 variables, 100 data sets, 95th percentile.

Table S2. *Total variance explained by the seven factors with eigenvalues above 1.0 for Study 2.*

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	23.441	46.883	46.883	23.118	46.236	46.236
2	3.242	6.483	53.366	2.940	5.880	52.117
3	2.407	4.814	58.180	1.952	3.905	56.021
4	1.914	3.828	62.008	1.496	2.993	59.014
5	1.434	2.868	64.876	1.009	2.019	61.033
6	1.265	2.529	67.405	.892	1.784	62.817
7	1.062	2.125	69.530	.666	1.333	64.150
8	.945	1.890	71.419			

Table S3. *Pattern matrix using principal axis factoring with direct oblimin rotation and factor loadings above |.30| which shows the four-factor solution.*

Subscale	Data labels	Factor loadings						
		1	2	3	4	5	6	7
AOT8	I think there are many wrong ways, but only one right way, to almost anything.	.558	.002	.122	-.035	-.171	.132	.080
NE15	I like to decide that things are really good or really bad.	.524	-.105	.308	.085	-.035	.029	.035

IAS15	The sooner we all acquire similar values and ideals the better.	.516	-.156	.046	.046	-.285	-.018	.027
AOT24	Of all the different philosophies which exist in the world there is probably only one which is correct.	.504	-.128	-.035	.000	-.244	.154	.109
AOT19	Certain beliefs are just too important to abandon no matter how good a case can be made against them.	.499	-.244	.009	-.089	-.146	.135	.012
AOT23	I believe that loyalty to one's ideals and principles is more important than "open-mindedness."	.407	-.198	.039	-.046	-.254	.245	.093
NE1	It is very important to me to hold strong opinions.	.402	-.071	.269	.054	.096	.050	.277
AOT21	It is a noble thing when someone holds the same beliefs as their parents.	.380	-.209	.141	-.047	-.223	.203	-.130
AOT38	I think that if people don't know what they believe in by the time they're 25, there's something wrong with them.	.376	.070	.175	-.086	-.219	.275	.094
AOT	It is OK to ignore evidence against your established beliefs.	.375	-.202	.054	-.154	-.209	.280	-.110
AOT15	It is important to be loyal to your beliefs even when evidence is brought to bear against them.	.326	-.168	.097	-.230	-.090	.322	.087
AOT9	It makes me happy and proud when someone famous holds the same beliefs that I do.	.302	-.302	.170	.077	-.134	.060	-.069
REI7	I like to rely on my intuitive impressions.	-.016	-.866	.134	-.006	.008	-.006	-.062
REI3	I believe in trusting my hunches.	-.026	-.848	-.031	.092	-.124	.017	.070
GDMS	When I make decisions, I tend to rely on my intuition.	.080	-.824	-.046	-.026	-.058	.015	.015
PID17	I am a very intuitive person.	.002	-.817	-.117	.063	.155	.129	.168
REI34	Using my "gut-feelings" usually works well for me in figuring out problems in my life.	.039	-.713	.109	-.001	-.004	.061	-.032
REI24	I often go by my instincts when deciding on a course of action.	.046	-.691	.103	-.109	-.057	-.005	.017
AOT40	Intuition is the best guide in making decisions.	.144	-.690	.103	-.101	.002	.087	.031
PID8	I prefer drawing conclusions based on my feelings, my knowledge of human nature and my experience...	.085	-.537	-.046	.029	-.192	-.019	.171

GDMS3	When I make a decision, it is more important for me to feel the decision is right than to have a...	.250	-.474	.105	-.133	-.168	.043	-.061
PID4	With most decisions it makes sense to completely rely on your feelings.	.273	-.371	.173	-.085	-.173	.179	-.010
AOT31	My blood boils over whenever a person stubbornly refuses to admit he's wrong.	-.067	.068	.680	.164	.070	-.020	.265
CIHS16	When someone disagrees with ideas that are important to me, it feels as though I'm being attacked.	.111	-.019	.634	-.094	-.175	-.010	-.013
AOT5	There are two kinds of people in this world: those who are for the truth and those who are against it.	.364	-.017	.448	-.027	-.008	.161	.071
AOT3	I tend to classify people as either for me or against me.	.253	-.045	.436	-.120	-.031	.234	.116
RTC12	When someone pressures me to change something, I tend to resist it even if I think the change may...	.072	-.175	.397	-.160	-.184	.135	-.059
GDMS15	I often make impulsive decisions.	-.179	-.270	.349	-.016	-.304	.240	-.090
CIHS6	I have at times changed opinions that were important to me, when someone showed me I was wrong.	.028	-.162	.013	.665	.038	-.031	-.014
AOT Baron4	People should revise their conclusions in response to relevant new information.	.063	-.087	.064	.662	.122	-.057	-.080
AOT Baron2	People should take into consideration evidence that goes against conclusions they favor.	-.175	.111	-.075	.566	-.116	.037	-.023
NE3	I trust the facts, not my instincts, to tell me what is true.	.116	.337	.026	.446	-.108	.097	.099
REI25	I'm not that good at figuring out complicated problems.	-.015	.028	.051	.065	-.865	.045	-.059
REI16	Thinking is not my idea of an enjoyable activity.	.124	.032	-.035	-.062	-.844	-.123	.146
REI6	I try to avoid situations that require thinking in depth about something.	.056	.004	.119	-.071	-.779	-.060	.034
REI4	I am not a very analytical thinker.	.019	-.055	-.048	.027	-.761	.164	.000
REI27	Reasoning things out carefully is not one of my strong points.	-.041	-.083	.121	-.062	-.644	.218	-.012
REI10	Thinking hard and for a long time about something gives me little satisfaction.	.229	-.054	.021	-.057	-.642	-.101	.135

NE12	I am pretty much indifferent to many important issues.	-.243	-.238	.112	.060	-.462	.393	.015
REI33	Knowing the answer without having to understand the reasoning behind it is good enough for me.	.321	-.124	.179	-.070	-.427	-.029	.037
NE7	I often prefer to remain neutral about complex issues.	.012	-.098	.050	-.052	-.351	.322	-.127
NFC17	I usually make important decisions quickly and confidently.	.228	-.178	-.062	-.064	.144	.520	.234
AOT6	Changing your mind is a sign of weakness.	.093	-.017	.249	-.091	-.261	.509	.032
AOT22	Coming to decisions quickly is a sign of wisdom.	.238	-.134	.054	-.028	-.095	.494	.119
IAS4	People who fit their lives to a schedule probably miss most of the joy of living.	.140	-.162	.180	.011	.002	.452	.039
AOT Baron3	Being undecided or unsure is the result of muddled thinking.	.073	-.087	.142	-.075	-.135	.404	.325
IAS1	An expert who doesn't come up with a definite answer probably doesn't know too much.	.121	-.014	.165	-.062	-.261	.366	.179
NFC33	It's annoying to listen to someone who cannot seem to make up his or her mind.	-.094	-.024	.067	-.067	-.035	.077	.696
IAS5	A good job is one where what is to be done and how it is to be done are always clear.	.055	-.226	.260	.058	-.115	-.307	.416
AOT13	No one can talk me out of something I know is right.	.218	-.229	.040	-.144	-.070	.095	.366

Table S5. Factor correlation matrix for principal axis factoring with direct oblimin rotation and Kaiser normalization

Factor	1	2	3	4	5	6	7
1	-						
2	-.438	-					
3	.440	-.390	-				
4	-.153	.239	-.031	-			
5	-.422	.360	-.465	.157	-		
6	.380	-.393	.332	-.172	-.446	-	
7	.327	-.240	.387	.010	-.183	.151	-

Table S5. *Exploratory factor analysis with maximum likelihood estimation and geomin (oblique) rotation.*

Iteration	Factor			
	1	2	3	4
I1	0.122	-0.416*	0.086	0.299*
I2	0.731*	0.074	-0.209*	-0.002
I3	0.352*	0.037	-0.086	0.333*
I4	0.709*	0.012	-0.218*	0.343*
I5	0.332*	0.038	0.349*	-0.205*
I6	0.210	0.171*	0.461*	-0.099
I7	0.681*	0.035	-0.056	0.271*
I8	0.772*	-0.034	0.030	0.129*
I9	0.710*	-0.043	0.017	0.282*
I10	0.740*	-0.072	0.254*	-0.066
I11	0.746*	-0.075	0.085	0.141*
I12	0.464*	0.204*	0.025	0.083
I13	0.568*	0.194*	-0.107	0.156*
I14	0.706*	0.089	0.021	-0.079
I15	0.681*	0.075	0.096	-0.031
I16	0.724*	0.028	0.058	0.007
I17	0.811*	0.071	0.037	-0.055
I18	0.735*	-0.004	0.077	0.076
I19	0.269*	-0.030	-0.003	0.584*
I20	0.813*	-0.196*	0.150*	0.025
I21	0.316*	0.667*	-0.031	-0.072
I22	-0.467*	-0.059	0.174	0.262*
I23	0.770*	-0.033	0.005	0.069
I24	-0.419*	0.081	0.035	0.393*
I25	0.751*	0.086	0.112	-0.230*

I26	0.889*	0.041	-0.059	-0.160*
I27	0.511*	0.114	0.162*	0.012
I28	-0.087	0.882*	0.082	0.038
I29	0.162	-0.006	0.733*	-0.081
I30	0.049	0.061	0.779*	0.056
I31	-0.006	0.884*	0.002	0.036
I32	0.177	0.037	0.582*	0.114
I33	0.029	-0.009	0.787*	0.108
I34	0.067	0.750*	0.079	-0.026
I35	-0.034	-0.026	0.878*	0.079
I36	0.308*	0.040	0.601*	-0.099
I37	0.342*	0.137*	0.408*	0.113
I38	0.078	0.752*	0.015	0.015
I39	0.041	0.846*	0.031	-0.015
I40	0.416*	0.406*	0.102	-0.087
I41	0.197	0.228*	0.360*	0.039
I42	0.689*	-0.035	0.134	0.018
I43	0.471*	0.164*	0.042	0.094
I44	0.030	0.296*	0.041	0.539*
I45	0.515*	0.080	0.153*	0.194*
I46	-0.355*	0.122	0.031	0.410*
I47	0.367*	0.053	0.283*	0.283*
I48	0.515*	0.343*	0.122*	0.000
I49	0.077	0.544*	0.125	0.094
I50	0.075	0.800*	-0.224*	0.039

Note. This is the mPlus default.

Study 3

Table S6. *Parallel analysis and random data eigenvalues for Study 3. The root for the number in bold corresponds with the number of factors to extract.*

Root	Means	Percentile
1.000000	1.633070	1.728803
2.000000	1.531943	1.596225
3.000000	1.456907	1.514404
4.000000	1.392109	1.444782
5.000000	1.332669	1.375351
6.000000	1.277030	1.311612
7.000000	1.232594	1.273381
8.000000	1.190768	1.224574
9.000000	1.146866	1.181362
10.000000	1.106516	1.136925
11.000000	1.068362	1.103652
12.000000	1.029330	1.067362
13.000000	.991145	1.022830
14.000000	.953757	.993854
15.000000	.917232	.950696
16.000000	.881057	.909842
17.000000	.845222	.875316
18.000000	.811222	.841524
19.000000	.776743	.807787
20.000000	.742420	.771019
21.000000	.707423	.738887
22.000000	.672090	.701014
23.000000	.635441	.671089
24.000000	.595391	.624453
25.000000	.561914	.594780
26.000000	.510776	.551191

Note. Specifications for this run: 262 cases, 26 variables, 100 data sets, 95th percentile

Table S7. *Total variance explained by the five factors with eigenvalues above 1.0 for Study 3.*

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.635	25.520	25.520	6.635	25.520	25.520	5.146	19.791	19.791
2	3.938	15.147	40.668	3.938	15.147	40.668	3.269	12.572	32.363
3	2.224	8.556	49.223	2.224	8.556	49.223	2.873	11.051	43.415
4	1.370	5.271	54.494	1.370	5.271	54.494	2.545	9.790	53.204
5	1.045	4.020	58.513	1.045	4.020	58.513	1.380	5.309	58.513
6	.986	3.792	62.305						

Table S8. *Pattern matrix using principal axis factoring with direct oblimin rotation and factor loadings above |.40| which shows the three-factor solution.*

Subscale	Factor loading				
	1	2	3	4	5
PIT5	0.872	-0.052	0.039	0.106	0.011
PIT1	0.850	0.009	0.092	0.042	0.005
PIT2	0.824	0.065	-0.003	0.035	0.168
PIT7	0.809	0.090	0.030	0.093	0.018
PIT3	0.801	0.068	0.085	0.159	0.095
PIT6	0.747	0.138	0.081	0.171	0.007
PIT4	0.723	-0.222	0.085	-0.004	0.164
PIT8	0.600	0.157	0.003	0.208	-0.143
PET3	-0.038	0.771	0.115	0.162	0.144
PET2	-0.140	0.767	0.106	0.166	0.228
PET1	0.061	0.711	0.253	0.019	-0.180
PET6	0.114	0.667	0.043	0.048	0.373
PET5	0.139	0.652	0.140	0.135	-0.125
PET4	0.085	0.561	-0.041	0.004	-0.342
AOT1	0.032	0.119	0.721	0.181	0.082
AOT5	0.096	0.195	0.705	-0.006	0.092
AOT3	0.024	0.088	0.646	0.323	-0.018
AOT6	0.091	0.006	0.644	0.043	0.155
AOT9	0.004	0.038	0.606	0.145	-0.012
AOT12	0.108	0.277	0.389	0.197	0.285
AOT11	0.182	0.089	0.190	0.810	0.111
AOT4	0.205	0.088	0.186	0.716	0.060
AOT10	0.174	0.224	0.103	0.705	-0.094
AOT8	0.083	0.068	0.322	0.647	0.263
AOT7	0.194	-0.057	0.216	0.099	0.742
AOT2	0.022	0.265	0.359	0.241	0.391

Table S9. *Factor correlation matrix for principal axis factoring with direct oblimin rotation and Kaiser normalization*

Factor	1	2	3	4	5
1	-				
2	.085	-			
3	.044	.416	-		
4	-.331	-.354	-.116	-	
5	.188	.340	-.015	-.472	-

Study 4

Table S10. *Items dropped in Study 1 that were below the cut off of +/- .21 but above +/- .20.*

Original item label	Data label	Correlation (r) with CRT	New item label	Reworded data label
IR1	It is important to me personally to be skeptical about claims that are not backed up by evidence.	.208	AOT11	It is not very important to me to be skeptical about claims that are not backed up by evidence.
PID13	When I have a problem I first analyse the facts and details before I decide.	.203	AOT12	When I have a problem I tend to decide before analyzing facts and details.
NE1	Evidence is more important than whether something feels true.	.202	AOT13	Whether something feels true is more important than evidence.
IR3	It is important to me personally to examine traditionally held beliefs using logic and evidence.	.202	AOT14	It is not very important to me to examine traditionally held beliefs using logic and evidence.

Table S11. *Items dropped in Study 2 that were reintroduced in Study 4.*

Data label	Original item label	New item label	Factor loading			
			1	2	3	4
It is a noble thing when someone holds the same beliefs as their parents.	AOT21	AOT10	0.564	0.367	0.400	
Knowing the answer without having to understand the reasoning behind it is good enough for me.	REI33	AOT9	0.534		0.533	
I have at times changed opinions that were important to me, when someone showed me I was wrong.	CIHS6	AOT5				0.760
People should revise their conclusions in response to relevant new information.	AOTBaron4	AOT6				0.745
People should take into consideration evidence that goes against conclusions they favor.	AOTBaron2	AOT7				0.662
No one can talk me out of something I know is right.	AOT13	AOT8	0.432	0.356		

Table S12. *Parallel analysis and random data eigenvalues for Study 4. The root for the number in bold corresponds with the number of factors to extract.*

Random Data Eigenvalues		
Root	Means	Percentile
1.000000	1.734649	1.807824
2.000000	1.640825	1.711923
3.000000	1.567271	1.615567
4.000000	1.507675	1.554454
5.000000	1.453902	1.492105
6.000000	1.404108	1.438571
7.000000	1.350968	1.389089
8.000000	1.308172	1.351554
9.000000	1.267436	1.318361
10.000000	1.224492	1.259637
11.000000	1.185627	1.218532
12.000000	1.148342	1.182706
13.000000	1.111502	1.143966
14.000000	1.076046	1.106736
15.000000	1.041667	1.067911
16.000000	1.009093	1.037259
17.000000	.976756	1.005522
18.000000	.944787	.971746
19.000000	.913877	.941025
20.000000	.883825	.908484
21.000000	.854949	.884360
22.000000	.822685	.848537
23.000000	.792243	.821807
24.000000	.763960	.797559
25.000000	.736513	.764900
26.000000	.705497	.733593
27.000000	.674774	.702530
28.000000	.648016	.677345
29.000000	.620603	.644982
30.000000	.590668	.617986
31.000000	.562883	.596755
32.000000	.530483	.562213
33.000000	.495401	.532481
34.000000	.450306	.490292

Note. Specifications for this Run: 271 cases, 34 variables, 100 data sets, 95th percentile

Table S13. Total variance explained by the seven factors with eigenvalues above 1.0 in Study 4.

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.610	25.324	25.324	8.128	23.905	23.905
2	3.642	10.713	36.037	3.219	9.466	33.372
3	2.503	7.363	43.400	2.012	5.918	39.290
4	1.659	4.879	48.279	1.099	3.232	42.521
5	1.257	3.696	51.975	.749	2.204	44.726
6	1.110	3.263	55.239	.592	1.741	46.467
7	1.047	3.080	58.318	.487	1.432	47.899
8	.980	2.881	61.200			

Table S14. Pattern matrix using principal axis factoring with direct oblimin rotation and factor loadings above |.40.

Subscale	Factor						
	1	2	3	4	5	6	7
PEt2	0.747	0.033	-0.012	0.015	-0.093	0.066	0.053
PET3	0.653	0.079	-0.099	-0.050	-0.065	0.273	-0.015
PET6	0.457	-0.031	-0.035	-0.052	0.011	0.264	-0.107
AOT9	0.338	-0.060	0.114	0.188	0.116	0.126	-0.139
CMT6	0.274	-0.184	0.267	0.045	-0.092	-0.047	-0.047
AOT14	0.244	-0.027	0.198	-0.105	-0.003	0.096	-0.145
AOT11	0.213	-0.062	0.087	-0.030	0.021	0.105	-0.201
PIT1	0.013	-0.839	-0.031	0.027	0.104	0.036	-0.010
PIT3	0.005	-0.832	0.078	0.035	-0.010	0.044	0.124
PIT2	0.066	-0.809	-0.113	0.082	-0.023	-0.111	-0.060
PIT7	-0.035	-0.788	-0.065	0.086	0.021	0.169	-0.028
PIT6	0.142	-0.725	0.015	0.012	0.060	-0.040	-0.091
PIT5	0.005	-0.721	0.083	-0.013	-0.104	-0.037	0.022
PIT4	-0.222	-0.636	0.063	-0.222	-0.076	-0.144	0.000
PIT8	-0.058	-0.503	-0.052	-0.050	-0.161	0.302	-0.059
CMT2	-0.073	0.055	0.680	-0.097	0.004	0.040	-0.058
CMT4	0.091	-0.051	0.609	0.027	-0.156	-0.127	0.116
CMT1	-0.073	0.048	0.577	-0.010	0.019	0.161	-0.178
CMT3	0.037	-0.012	0.377	0.278	-0.008	0.063	-0.041
CMT5	0.133	-0.132	0.261	0.172	-0.016	-0.138	-0.061
CMT8	-0.015	-0.080	0.226	0.131	-0.727	0.049	0.073
CMT6	0.071	0.064	-0.074	-0.102	-0.380	0.024	-0.163
CMT5	-0.031	-0.061	0.031	0.367	-0.375	0.068	-0.251
PET5	0.068	0.029	0.021	0.041	-0.048	0.675	0.006

PET4	0.151	-0.014	0.067	-0.140	-0.015	0.649	0.114
PET1	0.209	0.023	0.018	0.071	0.005	0.589	-0.056
AOT12	0.017	-0.253	-0.052	0.186	-0.062	0.448	-0.118
AOT2	-0.141	0.065	0.226	0.044	0.020	0.084	-0.728
AOT4	0.080	-0.060	-0.054	0.005	-0.184	-0.075	-0.718
AOT10	0.089	-0.016	0.008	0.073	-0.011	-0.057	-0.607
AOT1	0.021	-0.061	-0.021	-0.047	-0.195	0.022	-0.524
AOT3	0.109	-0.053	0.245	-0.351	-0.079	0.039	-0.381
AOT13	0.105	-0.305	0.011	-0.260	0.040	0.145	-0.371
AOT7	0.174	-0.207	0.017	-0.116	-0.124	0.006	-0.232

Table S15. *Factor correlation matrix for principal axis factoring with direct oblimin rotation and Kaiser normalization*

Factor	1	2	3	4	5	6	7
1	-						
2	-0.189	-					
3	0.217	-0.187	-				
4	0.077	-0.047	0.145	-			
5	-0.183	0.282	-0.214	-0.029	-		
6	0.474	-0.128	0.061	0.001	-0.112	-	
7	-0.372	0.326	-0.345	0.047	0.385	-0.306	-

Study 5

Table S16. *Parallel analysis and random data eigenvalues for Study 5. The root for the number in bold corresponds with the number of factors to extract.*

Root	Means	Percentile
1.000000	2.008933	2.109917
2.000000	1.899162	1.978025
3.000000	1.802226	1.886239
4.000000	1.725418	1.789938
5.000000	1.660036	1.718722
6.000000	1.601623	1.649841
7.000000	1.541182	1.588431
8.000000	1.486514	1.537643
9.000000	1.434963	1.483576
10.000000	1.383722	1.434891
11.000000	1.334685	1.373591
12.000000	1.290130	1.327272
13.000000	1.244573	1.286578
14.000000	1.205552	1.235526
15.000000	1.165974	1.201844
16.000000	1.124831	1.157771
17.000000	1.087171	1.120433
18.000000	1.052630	1.093366
19.000000	1.017124	1.054714
20.000000	.979017	1.009386
21.000000	.945782	.977561
22.000000	.916099	.946943
23.000000	.883001	.916697
24.000000	.852256	.885609
25.000000	.821345	.844255
26.000000	.791230	.817556
27.000000	.760955	.793579
28.000000	.732080	.763124
29.000000	.702815	.734821
30.000000	.674000	.700588
31.000000	.644365	.669315
32.000000	.617221	.643426
33.000000	.589824	.624428
34.000000	.563185	.590750
35.000000	.531732	.556154
36.000000	.503661	.529292
37.000000	.478803	.503031
38.000000	.450165	.477017
39.000000	.421637	.446997
40.000000	.392700	.419698
41.000000	.360562	.387262

42.000000 .321115 .352160

Note. Specifications for this Run: 199 cases, 42 variables, 100 data sets, 95th percentile

Follow up Studies

Table S17. *Pattern matrix using principal axis factoring with direct oblimin rotation and factor loadings above |.30| which shows the four-factor solution for the current version of the CTSQ. PIT = Preference for Intuitive Thinking, CMT = Close-minded Thinking, PET = Preference for Effortful Thinking, AOT = Actively Open-minded Thinking*

Subscale	Factor			
	1	2	3	4
AOT17	0.816	-0.056	-0.021	0.052
AOT18	0.809	-0.067	-0.015	-0.085
AOT20	0.729	0.101	-0.020	0.068
AOT21	0.718	0.054	-0.007	0.111
AOT1	0.685	0.053	0.147	0.062
AOT6	0.406	0.285	0.055	0.183
PET3	0.049	0.810	0.054	-0.035
PET2	0.011	0.770	0.050	-0.081
PET1	0.054	0.705	0.000	-0.086
PET5	0.053	0.683	-0.037	0.019
PET4	-0.050	0.619	-0.047	0.018
PET6	-0.047	0.519	0.039	0.198
CMT18	-0.041	-0.136	0.893	0.111
CMT17	-0.038	-0.011	0.838	-0.011
CMT15	0.011	-0.079	0.760	0.042
CMT8	-0.042	0.119	0.719	0.118
CMT10	0.054	0.082	0.492	-0.167
CMT2	0.220	0.129	0.443	0.045
PIT3	-0.015	0.040	0.025	0.885
PIT7	-0.099	0.048	0.039	0.867
PIT5	0.024	-0.034	0.016	0.787
PIT1	0.138	0.016	-0.008	0.779
PIT2	0.080	-0.056	-0.052	0.755
s	0.136	0.026	0.073	0.698

Table S18. *Pattern matrix using principal axis factoring with direct oblimin rotation and factor loadings above |.30| which shows the four-factor solution if the 6 highest loading items from study 5 were used. PIT = Preference for Intuitive Thinking, CMT = Close-minded Thinking, PET = Preference for Effortful Thinking, AOT = Actively Open-minded Thinking*

Subscale	Factor			
	1	2	3	4
PET1	0.808	-0.107	0.004	0.016
PET3	0.780	-0.010	-0.062	-0.092
PET2	0.735	-0.028	-0.078	-0.095
PET4	0.698	0.096	0.023	0.051
PET5	0.596	0.079	-0.077	-0.105
PET6	0.404	0.101	-0.035	-0.175
PIT1	0.030	0.785	-0.040	0.084
PIT3	0.095	0.769	0.061	-0.079
PIT6	0.172	0.768	-0.050	0.115
PIT4	-0.184	0.745	-0.014	-0.059
PIT5	0.048	0.718	-0.025	-0.095
PIT2	-0.109	0.686	-0.020	-0.191
CMT17	-0.120	-0.019	-0.916	-0.017
CMT6	0.060	0.112	-0.789	0.109
CMT8	0.013	-0.033	-0.612	-0.203
CMT15	0.071	-0.004	-0.565	0.049
CMT2	0.044	0.078	-0.540	-0.198
CMT11	0.206	-0.054	-0.467	-0.290
AOT21	0.106	0.070	0.061	-0.782
AOT6	0.144	0.089	0.050	-0.743
AOT15	0.150	-0.017	-0.020	-0.707
AOT20	-0.031	0.015	-0.037	-0.685
AOT22	-0.011	0.127	-0.134	-0.606
AOT17	-0.022	0.000	-0.115	-0.537

Table S19. Pearson correlations between the subscales and belief measures for the current version of the CTSQ. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

Variable	1	2	3	4	5	6	7	8	9
1. AOT	-								
2. CMT	-.363**	-							
3. PIT	-.516**	.273**	-						
4. PET	.417**	-.286**	-.225**	-					
5. Religious Belief	-.435**	.343**	.326**	-.185*	-				
6. Bullshit Receptivity	-.372**	.290**	.315**	-.231**	.510**	-			
7. Moral Judgment	-.207**	.223**	.280**	-.009	.507**	.353**	-		
8. Disgust	-.065	.098	.154*	-.004	.394**	.238**	.769**	-	
9. Misperceptions	-.589**	.269**	.292**	-.404**	.429**	.364**	.282**	.177*	-

Note. * $p < .05$. ** $p < .01$. $N = 175$. Cases excluded listwise.

Table S20. Pearson correlations between the subscales and belief measures for the alternate version of the CTSQ with changes to the AOT and CMT subscales. AOT = Actively Open-minded Thinking, CMT = Close-minded Thinking, PIT = Preference for Intuitive Thinking, PET = Preference for Effortful Thinking.

Variable	1	2	3	4	5	6	7	8	9
1. AOT	-								
2. CMT	-.619**	-							
3. PIT	-.520**	.385**	-						
4. PET	.588**	-.517**	-.321**	-					
5. Religious Belief	-.432**	.369**	.242**	-.276**	-				
6. Bullshit Receptivity	-.446**	.350**	.409**	-.179*	.253**	-			
7. Moral Judgment	-.217**	.195**	.204**	-.124	.334**	.233**	-		
8. Disgust	-.053	.045	.208**	-.013	.259**	.094	.711**	-	
9. Misperceptions	-.540**	.525**	.292**	-.412**	.371**	.327**	.131	.010	-

Note. * $p < .05$. ** $p < .01$. $N = 180$. Cases excluded listwise.

Study 6

Table S21. *Parallel analysis and random data eigenvalues for Study 6. The root for the number in bold corresponds with the number of factors to extract.*

Root	Means	Percentile
1.000000	1.599030	1.682463
2.000000	1.495639	1.571884
3.000000	1.420563	1.474520
4.000000	1.359117	1.404154
5.000000	1.303443	1.353869
6.000000	1.251577	1.294161
7.000000	1.203761	1.240785
8.000000	1.154644	1.192488
9.000000	1.112406	1.149192
10.000000	1.071597	1.106977
11.000000	1.032080	1.064916
12.000000	.988957	1.026441
13.000000	.954049	.990224
14.000000	.915946	.951740
15.000000	.879291	.915303
16.000000	.842168	.870950
17.000000	.804527	.832006
18.000000	.770665	.800153
19.000000	.737001	.768777
20.000000	.701319	.737419
21.000000	.666948	.705878
22.000000	.623442	.653023
23.000000	.582345	.616914
24.000000	.529485	.576970

Note. Specifications for this Run: 260 cases, 24 variables, 100 data sets, 95th percentile

Table S22. *Confirmatory factor analysis*

Model	χ^2_m	df _m	BIC	RMSEA [90% CI]	CFI	TLI	SRMR
1-Factor	1850.71	252	19062.656	.156 [.150 - .163]	.472	.422	.151
4-Factor (Orthogonal)	573.97	252	17785.908	.070 [.063 - .078]	.894	.884	.143
4-Factor (Oblique)	477.79	246	17723.096	.060 [.052 - .068]	.923	.914	.059

Note. This table presents model fit statistics from Confirmatory Factor Analyses conducted in mPlus 8.60 (Muthén & Muthén, 2021). χ^2_m refers to the chi-square model fit and df_m refers to the model's degrees of freedom. The next columns are, in order, Bayesian information criterion (BIC; Raftery, 1995), the Root Mean Square Error of Approximation (RMSEA; Steiger, 2000), Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis index (TLI; Bentler, 1990) and Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1998) fit indices for each CFA model. To compare model fit of unnested models, we used a BIC difference of > 10 to indicate superior fit for the model with a lower BIC value (see Raftery, 1995).

Table S23. *Standardized loadings for 4-factor oblique model*

Item	AOT	CMT	PIT	PET
AOT1	.788			
AOT2	.699			
AOT3	.727			
AOT4	.741			
AOT5	.798			
AOT6	.780			
CMT1		.370		
CMT2		.697		
CMT3		.468		
CMT4		.577		
CMT5		.853		
CMT6		.825		
PIT1			.835	
PIT2			.770	
PIT3			.861	
PIT4			.750	
PIT5			.807	
PIT6			.859	
PET1				.572
PET2				.755
PET3				.799
PET4				.586
PET5				.608
PET6				.548

Table S24. *Factor correlation matrix for principal axis factoring with direct oblimin rotation and Kaiser normalization*

Factor	AOT	CMT	PIT	PET
AOT	-			
CMT	-.04	-		
PIT	-.53***	.00	-	
PET	.36***	-.07	-.16*	-