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Thinking Styles, Conspiracist Belief, and the Mediating Role of the Dunning-Kruger Effect in Modeling Belief Change

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THINKING STYLES, CONSPIRACIST BELIEF, AND THE MEDIATING ROLE OF THE DUNNING-KRUGER EFFECT IN MODELING BELIEF CHANGE

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ABSTRACT

THINKING STYLES, CONSPIRACIST BELIEF, AND THE MEDIATING ROLE OF THE DUNNING-KRUGER EFFECT IN MODELING BELIEF CHANGE

by Lucas C. Cusano

Why can a person believe something for which there is no evidence and yet also fail to believe something for which there is overwhelming evidence? This study develops a structural model of belief change using the latent constructs of thinking styles and conspiracist belief while accounting for the Dunning-Kruger effect (i.e., overconfidence in one's knowledge the less one knows about a topic) as a mediator. A combined two-hundred and twenty-six participants from both Amazon's Mechanical Turk and the introductory psychology SONA subject pool were given two knowledge measures on topics of genetic modification and vaccination before and after reading refutational texts containing current evidence-based information. Belief change was measured as the difference between overall pre- and post- knowledge assessment scores, while The Dunning-Kruger effect was measured by cross-tabulating high-low median split knowledge measure scores with self-reported confidence ratings. A series of questionnaires functioned as measured indicators of the latent Thinking Styles and Conspiracist Belief constructs. Adequate model fit was achieved with the sample data and all paths of the initial structural model were significant. Thinking Styles predicted Conspiracist Belief, which was then predictive of Belief Change via mediation by the Dunning-Kruger effect. Though large path coefficients were not obtained, the significance of this structural model demonstrates important underlying relationships between individual differences and a person's ability to change incorrect beliefs – something that has become increasingly important in the current era of misinformation and elusive truth.

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Introduction

Individual differences in personality and cognition constitute an large domain of research in the field psychology and often contribute to the ever-growing body of literature, often providing insight as to the how individual difference factors are predictive of general ways of thinking and interpreting reality (Bensley et al., 2014). However, the methodology employed for the investigation of belief change has not managed to establish collectively agreed upon relationships between the various interpretations of belief and its correlates; bearing in mind, research focused on belief change outside of an academic learning environment is relatively new, with most studies being published in the past 10 to 20 years. This paper will explore multiple definitions and prominent perspectives on belief from the fields of philosophy and psychology and investigate factors that may be associated with or possibly predictive of belief change. Given the amount of variability in the concept of belief, it is important that we continue to develop an understanding of individual differences that may be related to or explain an individual's propensity to revise their misconceptions or change their beliefs.

The Nature of Belief and Belief Change

Belief is a complicated and often nuanced subject to approach empirically. This paper will focus on belief described traditionally as "enduring, unquestioned ontological representations of the world [comprising] primary convictions about events, causes, agency, and objects that subjects use and accept as veridical" (Connors & Halligan, 2015, p. 2).

Today, in the age of the internet and social media, there is an ever-increasing exposure to new ideas and viewpoints, and it is important to understand how beliefs are formed with such a large amount of information available. People are generally left to believe whatever they

want to believe. In the past, they might have been told or guided toward what to believe, but since there is now a nearly infinite number of sources from which to gather information, beliefs can range far and wide and can tend to slip away from rational or logical appraisal and revision. It should be noted that acquiring knowledge is subtly distinct from searching for meaning, as searching for meaning relies on pre-existing beliefs or knowledge and is affected by confirmation bias and familiar attributional styles (Kelley & Michela, 1980).

In addition, the ways in which knowledge is gained and information is gathered can also fall victim of selection and confirmation biases, leading to a sort of echo-chamber effect. An echo chamber generally provides desired feedback in terms of information an individual pursues and is considered a form of meta-ignorance, or ignorance of the gaps in one's knowledge (Elzinga, 2018). Uninformed or misinformed individuals, therefore, may tend to think that they know more than they actually do, known as the Dunning-Kruger effect (which will be discussed in further detail later).

One of the first considerations of belief from the philosophical realm addresses the important distinction between the noun *belief* and the verb *believe*. As these two terms are often mixed up, it is important to distinguish between these two for the sake of clarity and future inquiry. The term *believe* is a cognitive process or mental action that occurs during belief formation and maintenance (Seitz & Angel, 2020). On the other hand, *belief* is the embraced veracity of some information or proposition. Belief, or beliefs, can parallel the concept of knowledge in that they are usually held with conviction and regarded as true (Fishbein & Ajzen, 1975). There are, however, multiple slightly different definitions of belief.

Philosophers have long discussed the concept of belief, attempting to define it in various contexts and differentiate categories of belief (Connors & Halligan, 2015). John Locke defined belief through the lens of an intellectualist theory, stating that it is the declaration or reception of any proposition as truth, provided arguments or proofs that are found to persuade a person to receive it as true, without absolute knowledge that it is so (Leicester, 2008; Locke, 1690/1975). A widely accepted interpretation of belief is that it effectively consists of a mental state, an attitude, and a proposition (Seitz & Angel, 2020). The attitude or mental state, then, would be result of appraising such a proposition (Leicester, 2008). According to Schwitzgebel (2021), the propositional attitude has meaning that is expressed with words and involves a mental stance on its validity, essentially defined as the mental acceptance and conviction of the truth or actuality of an idea (circling back to parallel and even overlap with descriptions of belief and knowledge). A general picture of what belief actually is may start to emerge, however esoteric in its philosophical descriptions, yet as a cognitive process it has been difficult to establish a further unified understanding.

By approaching the complexity of belief processing and through the appraisal of a proposition's certainty, it can be understood that belief is not simply accepting or rejecting an idea, but tends to exist on a spectrum of belief acceptance. For example, belief can range from a person not believing something, to suspending disbelief, to entertaining an idea, or to completely believing something. An effective way of understanding these differences employs a Bayesian approach (Howlett & Paulus, 2015), which uses probabilistic updating alongside the gain of new information and knowledge. The more information one gains, the

more the belief gets revised. This also brings into question the subject of what is to be believed and why or how individuals may differ in this.

More recently, literature on the subject of belief has grown (Wolfe & Williams, 2018) and placed the study of belief formation, maintenance, and revision into a spotlight of psychological inquiry. In the hopes of a more clear-cut understanding of belief, many researchers have agreed upon two general distinctions. First, belief can be organized into three categories: empirical, relational, and conceptual (Connors & Halligan, 2015; Howlett & Paulus, 2015; Seitz, 2021; Seitz & Angel, 2020). *Empirical beliefs* develop when an individual is exposed to concrete 'objects', and this happens outside of conscious awareness and does not require language. For example, the belief that a person will not float away into the sky when they go outside is developed from sensory information and the perceptual experience of gravity. *Relational beliefs* develop with the assessment of relations in the environment, which also happens below the level of conscious awareness and does not require language. For example, an individual may witness the usefulness of a tool, or some social interaction, and then form a belief about such a tool or the reciprocity of such an interaction. *Conceptual beliefs* develop from abstract processing caused by a sequence of sensory stimuli such as music, or language-based information, and involve neural processes of meaning-making and affective-loading. Conceptual beliefs may include transcendent meanings about the nature of existence, fate, theism, and the world, but they are usually represented linguistically with "I believe in…" (subjective confidence) or "I trust in…" (affective) statements (Seitz & Angel, 2020). These types of beliefs comprise ecological, cultural, social, religious, and political identities and norms, evolve over time, and are

consciously present due to their language-based content (Seitz & Angel, 2020). Conceptual beliefs may also include transcendent meanings about a deity and concepts of destiny (Paloutzian & Park, 2015). However, notions of faith and spirituality with regard to belief are outside of the scope of the current investigation and will not be discussed.

Although research has established three domains in which beliefs can be categorized, an additional commonly supported distinction splits beliefs into two simple categories: testable and non-testable (Howlett & Paulus, 2015). Testable beliefs are empirical, built upon relatively tangible inferences, and can be demonstrated based on sensory experience (Blackburn, 2008). Non-testable beliefs are more ambiguous and vary in their content, tending to be influenced by emotion and abstract inferences (Howlett & Paulus, 2015). One might oversimplify this distinction by saying that one is objective and the other is subjective, but it goes beyond this. Because testable and non-testable beliefs vary in content and are abstract and influenced by affect, or factual and based on concrete inferences, they have been shown to employ different cognitive systems and be processed in different, yet somewhat overlapping, brain regions (Harris et al., 2009). The present study focuses on beliefs that can be considered both testable and conceptual.

Given the power of beliefs to shape cognitive systems of attention, perception, memory, and even determine the way an individual interprets the external world, by experiencing the world in a way that is consistent with a belief or set of beliefs, a person reinforces and maintains their beliefs sometimes in the absence of supporting information (Connors & Halligan, 2015). Howlett and Paulus (2015) found that when individuals are presented with new information or a proposition that is not testable, if it does not conflict with a pre-existing

belief the default response is to accept the proposition; however, if it does conflict with a pre-existing belief, more cognitive control is required to reject such a proposition. Other researchers refer to such gullible acceptance of ideas that are consistent with prior beliefs, and skepticism toward ideas that are not consistent with prior beliefs, as motivated reasoning (Caddick & Feist, 2021; Kunda, 1990). Motivated reasoning accounts for quite a large domain of research, and though conceptually related to belief change, it will not be thoroughly investigated in the current study.

Overall, one of the most prominent inquiries of psychological research of belief has to do with the revision or change of beliefs. The revision of conceptual beliefs is of great interest in psychology and has been the subject of multiple studies, demonstrating a complex relationship with the conceptual change process (Griffin, 2003). Past literature on conceptual change has failed to clearly differentiate the process of acquiring knowledge that conflicts with prior beliefs from revising prior beliefs based on newly acquired knowledge (Griffin, 2003). Revision of beliefs can be a difficult task, yet simply evaluating a belief can also be similarly challenging at the individual level. It is important to note, though the terms ‘revision’ and ‘change’ can be broken down into their subtle differences, they will be used synonymously for the sake of clarity in this paper. Additionally, the terms ‘misconception’ or ‘false/incorrect belief’, as well as ‘conceptual change’ or ‘belief change’, will be used interchangeably.

Predictors of Belief Change

Thinking Styles

Because the way in which people process information, reason, and think is central to who they are, we propose that thinking style will be an important predictor in a person's willingness (or not) to change their mind. Thinking style is often considered to be a single piece of what constitutes an individual's intellectual style (other pieces include learning approaches, adaptation-innovation style, and field dependence/independence; see Fan et al. (2018) for further reading). Yet a thinking style can also be simply defined as the way a person prefers to acquire and process information across situations (Kozhevnikov, 2007; Kozhevnikov et al., 2014).

Inquiry on thinking style as a construct is rooted in the investigation of personality traits, learning approaches, environmental influences, motivation, preference, and intellectual ability/capacity. Thinking style is not just determined by intelligence or personality, rather, is composed of an elaborate interaction between intelligence and personality, as well as a combination of multiple additional factors (Grigorenko & Sternberg, 1995). Psychologists originally proposed thinking style models that were classified into three modes: cognition-centered, personality-centered, and activity-centered (Sternberg, 1988). As theoretical considerations grew, Sternberg developed the theory of mental self-government, which is among the most comprehensive models of thinking style (Sternberg, 1994, 1997). His model identifies 13 thinking styles along five dimensions: functions (legislative, executive, judicial), forms (global, local), levels (liberal, conservative), scopes (hierarchical, monarchic, oligarchic, anarchic), and leanings (internal, external).

To avoid delving into the history and multiple considerations of various thinking style models, in this study we will follow the lead of Newton and colleagues (2021) and argue for four distinct indicators of thinking style: Preference for Intuitive Thinking (PIT), Preference for Effortful Thinking (PET), Actively Open-Minded Thinking (AOT), and Close-Minded Thinking (CMT). We will employ the robust novel measure of thinking style that has been developed from the analysis of more than 250 unique items from 15 commonly used measures over the course of six validation studies: the four-component comprehensive thinking style questionnaire (CTSQ; Newton et al., 2021).

Dual Process Thinking (PIT, PET). Dual-process theory is the view that humans engage in two dichotomous forms of thinking – reflective (rational/analytic) and intuitive (automatic/unconscious) thinking styles (Evans, 2008; Evans & Stanovich, 2013; Kahneman, 2011). The theory evolved from a bipolar approach used in the early development of thinking style theories and models and has its origins in Freud's notion of "primary" versus "secondary" process thinking (Freud, 1895/1950). Dual-process theory poses intuitive and reflective thinking styles as orthogonal constructs: "… an individual can demonstrate a preference to engage in high or low levels of both reflective and intuitive thinking across situations" (Alaybek et al., 2021, p. 2). Others scholars have frequently referred to the two processing styles as System 1 and System 2 (Kahneman, 2011; Stanovich, 2009; Stanovich et al., 2008, 2010). Commonly, System 1 processing occurs rapidly and below the level of conscious awareness in response to encountered situations, often employed by people who score higher on intuitive thinking style measures, while System 2 processing is much slower

and deliberate/conscious, serving to override thoughts or responses resultant of System 1 processing (Stanovich, 2009; Stanovich et al., 2008, 2010).

There can be confusion in dual-process literature that claims System 1 and System 2 processing (or "Type 1" and "Type 2" processing) is readily predicted by an individual's preference for intuitive or analytical thinking because these two styles of thinking are regarded by some as distinct systems while regarded by others as lying on a continuum (e.g., Epstein et al., 1996; Evans, 2008; Evans & Frankish, 2009; Kahneman, 2011; Newstead, 2000; Pacini & Epstein, 1999; Sherman et al., 2014; Evans & Stanovich, 2013; Stanovich, 2009; Stanovich et al., 2008, 2011). In a review of dual-process theories, Evans (2008) lists over 14 different labels that researchers have attached to dual processes in past literature, aligned on the assumption of a general dual-system theory.

Based on the prominence and regard of the dual-systems/processes theory, Newton and colleagues' (2021) Comprehensive Thinking Styles Questionnaire includes factors of Preference for Intuitive Thinking (PIT) and Preference for Effortful Thinking (PET) to account for distinct intuitive-analytic styles and paint a more unified picture of dual-process theory in relation to individual thinking styles. Only by taking into account an individual's preference for intuitive and analytical/reflective thinking is it possible to model individual differences that may be predictive of belief change. There are, however, additional factors that must be considered.

Actively Open-Minded Thinking (AOT). Being open-minded is colloquially regarded as a positive aspect of a person's disposition or outlook. Not to be confused with the trait of openness (to experience) from the popular Five-Factor Model of personality (McCrae &

Costa, 1987), open-mindedness refers to a person's willingness to consider alternative evidence or explanations which may be in opposition to currently held beliefs or perspectives. To expand on this concept, actively open-minded thinking reaches far beyond a personal 'open-minded' disposition; it encompasses the way individuals tend to evaluate new information that contradicts currently held conceptions or beliefs, to give sufficient consideration to such ideas, and to include the opinions of others when forming their own (Baron, 1993; Haran et al., 2013).

Some argue that open-mindedness is one's attitude toward their beliefs, and it is not the actual beliefs themselves that make a person open (or closed) minded (Spiegel, 2012). In this regard, open-mindedness can be defined as recognizing one's fallibility as a knower and maintaining a willingness to engage with information and genuinely consider perspectives and beliefs that contradict those currently held. Stanovich and Toplak (2023) reflect on the original conceptualization of Actively Open-minded Thinking asserted by Stanovich and West (1997) as a "disposition encompassing the cultivation of reflectiveness rather than impulsivity; the desire to act for good reasons; tolerance for ambiguity combined with a willingness to postpone closure; and the seeking and processing of information that disconfirms one's beliefs" (p. 2). Effective open-minded thinking includes tolerance of others beliefs balanced with a conviction of one's own beliefs, a willingness to appraise those beliefs in light of new information, and the ability to accordingly update them. The AOT factor of the CTSQ was adapted from a measure originally developed by Stanovich and West (1997, 2007) to assess aspects of an analytic thinking style. Actively Open-minded Thinking

represents a key aspect of thinking style and should play an important role in classifying individual differences predictive of belief change.

For an up-to-date source of information on the subject of belief change and AOT in particular, see Pennycook and colleagues' (2020) discussion of belief change in accordance with evidence, which addresses implications for a variety of belief domains, as well as Stanovich and Toplak's (2023) insightful review of the 25-year history of studying AOT, which presents noteworthy concerns on the operationalization and measurement of AOT in light of related constructs. These articles represent the most current perspectives in the domain of research regarding open-mindedness and address new and important considerations for its measurement in personality and general psychological research.

Close-Minded Thinking (CMT). Being "hard-headed" and unwilling to consider other's ideas, or avoiding new perspectives altogether, is generally not considered to be a positive aspect of a person's disposition or outlook. Close-minded thinking, however, encompasses more than just a "hard-headed" disposition. Development of the notion of close-mindedness in psychological literature was accredited to Kruglanski et al. (1993) and only later expanded upon as a factor in the Need for Closure (NFC) scale (with other factors including preference for order, preference for predictability, decisiveness, and discomfort with ambiguity) (Kruglanski et al., 1993; Neuberg et al., 1997; Webster & Kruglanski, 1994). There still remains some uncertainty as to whether close-minded thinking is a valid aspect of thinking styles, with the construct of dogmatism, conservative ideology, and right-wing authoritarianism often taking its place in literature on individual differences (Rokeach, 1960; Shearman & Levine, 2006; Sinclair et al., 2020). However, close-minded thinking should be

considered as more than just the opposite of open-minded thinking. The Close-Minded Thinking (CMT) factor of Newton and colleague's (2021) CTSQ was, in part, derived from Stanovich and West's (2007) Actively Open-minded Thinking measure (AOT), which intended to capture seven underlying modes of thinking (i.e., flexible thinking, openness, dogmatism, categorical thinking, constructive thinking, belief identification, and counterfactual thinking). Resultantly, however, AOT maintains consideration as a multidimensional thinking disposition, while CMT does not reach an equivalent degree of regard due to multiple associations with other, often interconnected, assessments of related constructs such as right-wind authoritarianism, conservative ideology, need for closure, and resistance to change.

A close-minded person essentially refuses to acknowledge that their beliefs may be unfounded and will demonstrate this by failing to consider opposing evidence or arguments. Not to be confused with impartiality of evaluations, close-mindedness requires a greater level of bias (Riggs, 2010). Close-Minded Thinking, nevertheless, is a primary underlying factor of Thinking Styles and has been shown to be distinct from AOT (Newton et al., 2021). Interestingly, through the development of the CTSQ, Newton and colleagues found that Close-Minded Thinking was the only significant predictor of vaccine attitudes among U.S. participants, while both Actively Open-minded Thinking and Close-Minded Thinking were stronger unique predictors of belief change (or lack of change, for Close-Minded Thinking) than performance on Fredericks' (2005) Cognitive Reflection Test. Adding to the enigma of Close-Minded Thinking, Newton et al. (2021) also found that Close-Minded Thinking was associated *positively* with religious belief but *negatively* with paranormal belief; further

research is needed to parse factors that could be more strongly associated with Close-Minded Thinking than Actively Open-minded Thinking (p. 81). Ultimately, Close-Minded Thinking is a significant factor of the Thinking Styles construct and its measurement as a part of the CTSQ in our proposed model serves to further identify individual differences predictive of belief change.

Conspiracist Belief

As thinking styles make particular beliefs more or less likely, one form of belief that is of interest as a predictor of belief change is conspiracist belief, otherwise regarded as proposed explanations of an event that are in opposition to a more conventional, well-supported explanation (McCaffrey, 2012, as cited in Bensley et al., 2019). An effectively broad definition of the term conspiracy as it is regarded in the current study comes from Bruder et al. (2013):

> A conspiracy theory is a theory that provides an alternative explanation to the established understanding of a historical or current event. Often, it is claimed that this event is the result of conscious manipulations by individuals or secretive powers. Due to our incomplete knowledge about the world, it can usually not ultimately be decided which explanatory model is true – the established understanding of an event or the respective conspiracy theory. (p. 3)

We include this as a latent construct in our model because we hypothesize that those who demonstrate higher levels of conspiracist belief are resistant or closed to information that does not conform to their beliefs or current understandings and hence will be unwilling to change their mind.

Presently there is a fair amount of conflicting research on the antecedents of conspiracy belief, how to measure those antecedents, and how to define “conspiracy” in general. In a systematic review and meta-analysis, Goreis and Voracek (2019) described two ways in

which psychological literature has approached predictors of belief in unfounded claims concerning conspiracy theories. The first approach focuses on psychopathological antecedents of the endorsement of conspiracy theories, highlighting maladaptive personality traits, paranoid ideation, schizotypy, and facets of narcissism, callousness, and eccentricity. The second approach often taken in psychological research on the predictors of conspiracy belief is through a socio-political lens. The socio-political approach investigates factors of political cynicism, negative attitudes toward authority, individual values, anomia, ethnic status, and religion in relation to belief or endorsement of conspiracy theories. Past research has identified certain positive correlations with agreeableness and openness to belief in conspiracy (Swami et al., 2010), yet additional studies on personality factors from five-factor model have failed to clarify and confirm the exact associations, which are often difficult to explain due to the various types of measurement employed or the generality of beliefs being measured (Goreis & Voracek, 2019).

A prominent theory connecting individual differences to belief in conspiracy comes from an article by Douglas et al. (2017), which claims that belief is driven by three motives: epistemic, existential, and social. Each of these motives serve to achieve basic needs or goals of an individual, and together they provide an effective foundation for understanding how individual differences can be predictive of belief in conspiracy theories. However, research has shown that conspiracy belief often does the opposite of serving these three motivations and can simply be a self-defeating form of motivated social cognition (Douglas et al., 2017). In contrast, Miller et al. (2016) theorizes that belief in conspiracy actually helps people fulfill

psychological and ideological needs, asserting that individual differences stem from ideologically-motivated endorsement of conspiracy.

Nevertheless, reflecting on the definition of conspiracy from Bruder et al. (2013), it is important to note that the "established understanding of an event" parallels currently accepted scientific knowledge and/or evidence-based factual information. False beliefs may be conflated with conspiracy; however, false beliefs can reach beyond simple opposition to conventional understandings and include a wider range of misperceptions. Due to the multiple ways of approaching the topic of belief in conspiracy, research can easily fall down rabbit holes such as the investigation of differences between skepticism and critical thinking, or the relationship between intelligence and rationality. With all the various, sometimes contradictory, research perspectives on belief in conspiracy, it is important that individual differences in thinking style and belief be operationalized and measured properly. The question stands, how and why do individuals choose to endorse such unsubstantiated claims, or make those claims themselves, and does this general tendency play an important role in revising misconceptions or changing beliefs?

Dunning-Kruger Effect

An important factor in our structural model, which will serve to mediate the effects of Thinking Styles and Conspiracist Belief on Belief Change, is the so-called "Dunning-Kruger effect". This effect can be described as a type of cognitive bias in which individuals who lack expertise in a particular domain tend to overestimate their own knowledge or competence (Kruger & Dunning, 1999). As such, those who engage in the Dunning-Kruger mindset

should be resistant to changing their mind, since they think they are correct and are most confident in their knowledge.

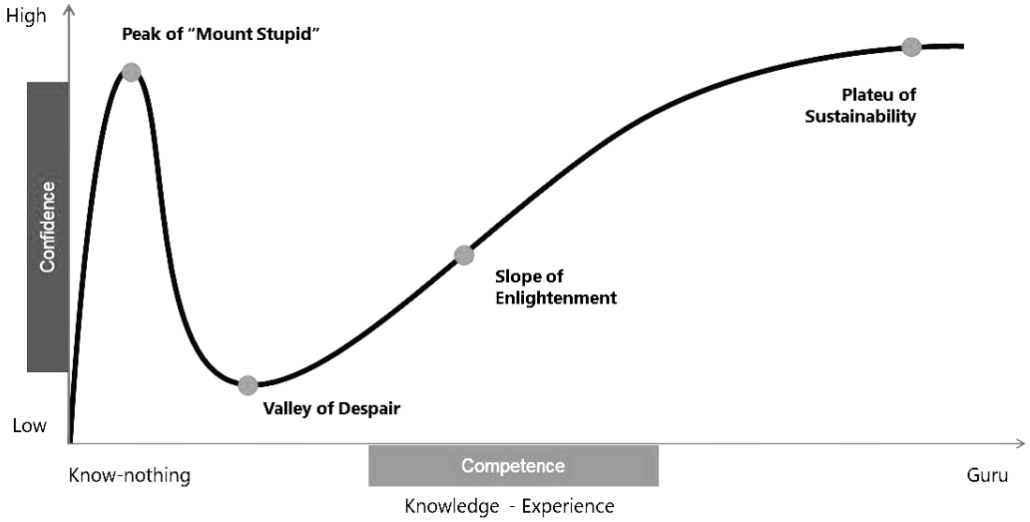
Our model of belief change suggests a basic domain-specific metacognitive deficit in individuals who are overly confident about something they do not know well and are not aware of this lack of knowledge. In other words, people who are incompetent are unaware of their incompetence and innocent of their ignorance, yet their lack of competence (i.e., knowledge) comes with an overestimation of their expertise (i.e., confidence) (Dunning et al., 2003). Another interpretation of this effect is that individuals who perform the worst at a given task tend to overestimate their own ability, while top performers usually make more accurate self-assessments (McIntosh et al., 2019). The Dunning-Kruger effect has received a great deal of attention in recent psychological literature and has even been used to hypothesize individual differences in intuition, decision making, conflict detection, and loosely defined thinking dispositions (Pennycook et al., 2017).

Though the Dunning-Kruger effect can be simply described as a metacognitive deficit (Wolfe & Williams, 2018), Kruger and Dunning (1999) establish that the "mediational role of metacognitive skills" (p. 1130) is revealed in the observed link between low objective performance and an inflated self-assessment of ability. If the Dunning-Kruger effect can be used to model a general understanding of how and why individuals overestimate their own abilities, then it should also be useful in modeling a framework of why individuals may be resistant to changing, revising, or even appraising their own beliefs or misconceptions. Traditionally the Dunning-Kruger effect has been used to graph individual ability (i.e., competence) against confidence (Gignac & Zajenkowski, 2020).

Employing a popular visualization, notwithstanding some pseudo-scientific terminology (see Figure 1), an individual with low competence and high confidence would be placed at the peak of "Mount Stupid". To gain competence, they would have to descend into the "Valley of Despair" before regaining confidence and achieving competence.

Figure 1

Dunning-Kruger Effect Curve



Movement, or rather a lack of movement, from the peak of "Mount Stupid" toward the "Plateau of Sustainability" can be reasonably understood in light of the theory of cognitive dissonance, a term developed by Leon Festinger (1957). This theory states that when a person has two cognitions that are psychologically inconsistent, they experience a state of dissonance or discomfort and will strive to reduce it either by changing their behavior or by changing their attitude and/or beliefs (for a review of Festinger's theory, see Aronson, 1997). Individuals may avoid dissonance altogether by maintaining high confidence and low appraisal, or competence, of particular beliefs, thus remaining at the peak of "Mount Stupid". Research has shown that individuals selectively expose themselves to consonant information

(Frey, 1982), which is in line with concept of motivated reasoning but will not be discussed in detail in this paper. Perhaps, once the process of gaining new information that challenges prior beliefs is begun, an individual experiences cognitive dissonance and may subconsciously choose to reduce or stop it by remaining confident and incompetent. The theory of cognitive dissonance should be helpful in conceptualizing the process of belief change and might frame a better understanding of the factors related to appraising and revising one's beliefs and (mis)conceptions.

Hypothesized Structural Model

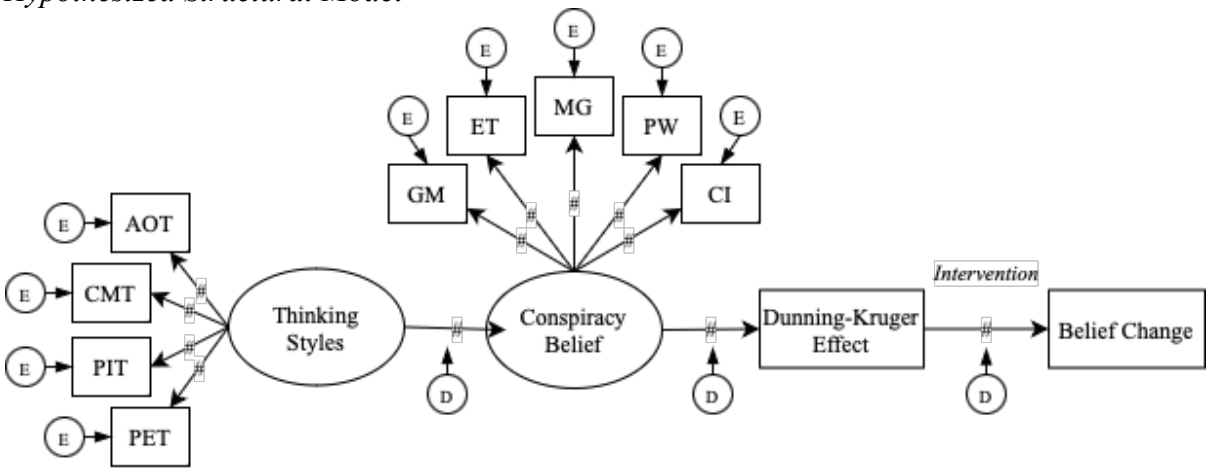
The structural model (Figure 2) proposes that Thinking Styles predict Conspiracist Belief, and then the measured Dunning-Kruger effect acts as mediator between Conspiracy Belief and the outcome of Belief Change. A mediator is part of the causal path of an effect and can reveal how or why a particular relationship exists. In other words, Thinking Style is predictive of Conspiracist Belief, and Conspiracist Belief is predictive of an individual's ability to change their beliefs only when accounting for the measured Dunning-Kruger effect. Each measured variable will be assessed for normality of the distribution and the presence of erroneous data and/or outliers. Data will also be assessed for multicollinearity, multivariate normality, unidimensional constructs, and a linear relationship between measured variables and latent constructs.

In a structural model, rectangles represent observed variables (i.e., measured indicators), while ovals represent latent factors/variables/constructs. Each path represents a hypothesis, with one-headed arrows denoting an expected directional relationship between two variables. The solid paths signify that the relationships are freely estimated parameters. The numbers on

each path denote loadings of an indicator to its respective latent construct, or loadings between variables. Arrows point from latent variables to measured variables because they indicate the influence of a latent variable on its indicators, since the indicators are intended to reflect the underlying latent variable if the model is supported. In the hypothesized model represented in Figure 2, E indicates error variance of measured variables and D indicates disturbances, which are essentially error terms of estimated path coefficients. Although not depicted in the diagram, the variances of the errors and the disturbance are all free parameters.

Figure 2

Hypothesized Structural Model



Note.
Thinking Styles:
AOT = Actively Open-minded Thinking
CMT = Closed-Minded Thinking
PIT = Preference for Intuitive Thinking
PET = Preference for Effortful thinking

Conspiracy Belief:
GM = Government Malfeasance
ET = Extraterrestrial Cover-up
MG = Malevolent Global Conspiracies
PW = Personal Well-being
CI = Control of Information

Intervention = Refutation texts on topics of GMF and VAX
Dunning-Kruger Effect = quadrants of high/low competence and confidence
Belief Change = difference scores of pre- and post-knowledge assessments

Method

A generally accepted rule of thumb for adequate sample size in a structural equation model is that it is best to have at least ten times as many participants as measured variables (Nunnally, 1967; as cited in Westland, 2010, Wolf et al., 2013). The present structural model has 11 measured variables, which suggests a minimum sample size of 110. Out of caution, a minimum sample size of 200 participants, which is considered sufficient for the evaluation of structural models (Hoelter, 1983; Kyriazos, 2018), was sought for this study.

Participants

Data for this study were obtained from California State University undergraduate students in the Psychology-1 SONA subject pool, as well as United States adults from Amazon's Mechanical Turk (MTurk) system. All data were collected anonymously and confidentially; participants were informed at the beginning of the survey that their answers will be used for research and asked to confirm that their answers were accurate and suitable for research upon completion.

A total of 157 SONA student participants, at least 18 years of age with proficiency in English, signed up and took part in this study online by selecting from a list of available research studies to join. Undergraduate student participants (referred to as SONA participants moving forward) satisfied degree requirements and were granted up to 1 hour of course credit upon completion of the study; they were also given the option to complete an alternative writing assignment in lieu of participation. Those who demonstrated a genuine lack of attention, effort, or time-spent by failing more than one attention check, spending less than 20 minutes overall to complete the study, or spending less than 20 seconds engaging with

each of the intervention materials were excluded from analysis ($N = 23$). Additionally, SONA participants who failed to submit the study within one weeks of providing informed consent (indicating the start of the study), or by the study closure date at the end of the academic semester, were excluded ($N = 17$), along with all duplicate responses ($N = 9$). A number of participants ($N = 25$) were identified as bordering one or more of the attention/effort/time-spent cutoff criteria and were docked course credit but not excluded from analysis. Overall, one hundred and eight ($N = 108$) SONA participants remained and were included for the analysis.

A total of 177 MTurk Workers, at least 18 years of age with proficiency in English, took part in this study by selecting from a list of various Human Intelligence Tasks (HIT's) on Amazon's MTurk online system. These participants were located in the United States, which was verified by IP address metadata, and were required to meet specific criteria in order to sign up and take part in this study. Criteria included: (1) having been granted the "Masters Qualification", which is only assigned to MTurk Workers who have consistently demonstrated a high degree of success in performing a wide range of HIT's, (2) a HIT approval rating greater than or equal to 97%, (3) having previously completed a minimum of 1000 HIT's, which is a qualification assigned by MTurk, and (4) having not already completed the current study. MTurk participants who met all criteria were compensated $5.00 for their participation upon review and acceptance of their submitted HIT. Even with such criteria applied to screen out potential low-quality respondents, there were still difficulties in collecting valid responses (see Design and Procedure section for further detail regarding safeguards against bots and invalid/fraudulent responses).

MTurk participants who demonstrated a genuine lack of attention, effort, and/or time-spent by failing more than one attention check, spending less than 20 minutes to complete the survey overall, spending less than 20 seconds engaging with each of the intervention materials, straight lining responses on scale measures, or otherwise demonstrating clearly unreasonable or fraudulent response patterns ($N = 27$) were excluded from analysis and their HIT rejected. Additionally, participants who failed to submit their HIT within one week of providing informed consent (indicating the start of the study), or by the rolling survey-batch closure date, ($N = 32$) were excluded from analysis. In total, one hundred and eighteen ($N = 118$) MTurk participants remained and were included for analysis.

Overall, a total of 226 participants ranging from 18 to 71 years of age ($M_{age} = 31.06$, $SD_{age} = 13.42$) across both the SONA and MTurk samples were included for data analysis. Unfortunately, due to a technical error in setting up each survey platform, gender data was not collected for 21 SONA participants and 12 MTurk participants. Of the 193 participants with a recorded gender response, 87 identified as male (45.08%), 103 as female (53.37%), 2 as non-binary/non-conforming (1.03%), and 1 preferred not to say (0.52%). The self-reported ethnic/racial identity of all 226 participants was 52.66% White/Caucasian, 18.14% Hispanic/Latino, 4.42% Black/African American, 0.89% Middle Eastern, 16.81% Asian, 0.44% Native American, 5.75% Multi-ethnic or Mixed-race, and 0.89% preferred not to say. Descriptive statistics for all sociodemographic variables, including age, gender, ethnicity/race, education level, political preference, political party, religious preference, and religious importance, are listed in Table 1.

Table 1

Sociodemographic Characteristics Overall and Per Sample

	Combined Samples (*n* = 226)		MTurk (*n* = 118)		SONA (*n* = 108)	
Gender	*n*	*%*	*n*	*%*	*n*	*%*
Male	87	45.1	62	58.5	25	28.7
Female	103	53.4	42	39.6	61	70.1
Transgender	0	0.0	0	0.0	0	0.0
Non-binary/non-conforming	2	1.0	1	0.9	1	1.1
Other	0	0.0	0	0.0	0	0.0
Prefer not to say	1	0.5	1	0.9	0	0.0
Missing	33	NA	12	NA	21	NA
Ethnicity/Race						
White/Caucasian	119	52.7	99	83.9	20	18.5
Hispanic/Latino	41	18.1	3	2.5	38	35.2
Black/African American	10	4.4	6	5.1	4	3.7
Middle Eastern	2	0.9	1	0.8	1	0.9
Asian	38	16.8	3	2.5	35	32.4
Pacific Islander	0	0.0	0	0.0	0	0.0
Native American	1	0.4	1	0.8	0	0.0
Multi-ethnic or Mixed race	0	0.0	4	3.4	9	8.3
Other	13	5.8	0	0.0	0	0.0
Prefer not to say	2	0.9	1	0.8	1	0.9
Education						
Less than high school degree	0	0.0	0	0.0	0	0.0
High school graduate	71	31.4	22	18.6	49	45.4
Some college but no degree	62	27.4	14	11.9	48	44.4
Associate degree in college	27	11.9	19	16.1	8	7.4
Bachelor's degree in college	60	26.5	57	48.3	3	2.8
Master's degree	4	1.8	4	3.4	0	0.0
Doctoral degree	1	0.4	1	0.8	0	0.0
Professional degree (JD, MD)	1	0.4	1	0.8	0	0.0

	Combined Samples (*n* = 226)		MTurk (*n* = 118)		SONA (*n* = 108)	
Political Preference	*n*	*%*	*n*	*%*	*n*	*%*
Extremely liberal	20	8.8	18	15.3	2	1.9
Liberal	65	28.8	31	26.3	34	31.5
Moderately liberal	54	23.9	25	21.2	29	26.9
Moderate - middle of the road	32	14.2	15	12.7	17	15.7
Moderately conservative	14	6.2	10	8.5	4	3.7
Conservative	12	5.3	11	9.3	1	0.9
Extremely conservative	8	3.5	7	5.9	1	0.9
Other	3	1.3	1	0.8	2	1.9
Don’t know	18	8.0	0	0.0	18	16.7
Political Party						
Democrat	123	54.4	64	54.2	59	54.6
Republican	27	11.9	22	18.6	5	4.6
Independent (unaffiliated)	54	23.9	30	25.4	24	22.2
Other	3	1.3	2	1.7	1	0.9
Don’t know	19	8.4	0	0.0	19	17.6
Religious Preference						
Buddhism	6	2.7	2	1.7	4	3.7
Christianity	88	38.9	46	39.0	42	38.9
Hinduism	3	1.3	0	0.0	3	2.8
Islam	4	1.8	0	0.0	4	3.7
Judaism	1	0.4	1	0.8	0	0.0
Paganism	1	0.4	1	0.8	0	0.0
Agnostic/uncertain	41	18.1	28	23.7	13	12.0
None/atheism	59	26.1	38	32.2	21	19.4
Other	23	10.2	2	1.7	21	19.4
Religion Importance						
Not at all important	92	40.7	67	56.8	25	23.1
Slightly important	49	21.7	18	15.3	31	28.7
Moderately important	44	19.5	13	11.0	31	28.7
Very important	24	10.6	8	6.8	16	14.8
Extremely important	17	7.5	12	10.2	5	4.6

Measures

Both the Thinking Styles and Conspiracist Belief latent constricts in the structural model were assessed using multiple measured indicators. The Dunning-Kruger effect and Belief Change were directly measured as observed variables. In order to assess belief change, we employed a refutation texts procedure (Thacker et al., 2020) that consisted of factual evidence-based information being given to participants as an intervention task. The idea was to see how much of this factual information changed their beliefs. In addition, participants responded to a variety of sociodemographic questions regarding age, gender, ethnicity/race, education level, religiosity, and political orientation. Before completing the following questionnaires, participants were presented with a commitment request – "Do you commit to providing thoughtful answers to the questions in this survey?" – which has been shown to effectively decrease the rate of quality issues in survey responses more than other, more traditional types of attention checks (Geisen, 2022).

Thinking Styles

To measure the latent construct of individuals' thinking styles, the four factor Comprehensive Thinking Styles Questionnaire was used (CTSQ; Newton & Pennycook, 2020; Newton et al., 2021, 2023; see Appendix A). The four factors of this questionnaire include Actively Open-minded Thinking (AOT; $\alpha = .89$), Closed-Minded Thinking (CMT; $\alpha = .79$), Preference for Intuitive Thinking (PIT; $\alpha = 0.92$), and Preference for Effortful Thinking (PET; $\alpha = 0.86$). Participants were instructed to rate their agreement with each of the 24 statement (six per factor) using a 5-point Likert scale with values ranging from 1 = *strongly disagree* to 5 = *strongly agree*. All scale items are worded in the same direction to

maintain reliability of subscales, and all AOT and PET items were reverse coded so that greater average scores correspond to a greater tendency toward each reflective/analytic thinking style. The reliability coefficient of the overall CTSQ was fairly high (α = 0.90), demonstrating good internal consistency. It is important to note, however, that AOT and CMT, or PIT and PET, are not parallel scales operating on a continuum; despite being moderately intercorrelated, each subscale represents distinct types of thinking styles (see Newton et al., 2023). In the current study, subscale scores were summed instead of averaged in order to potentially capture additional variability. Barry (2017) presents a valid argument in favor of using sums over averages for such Likert scale data, claiming that it is not only mathematically wrong and potentially misleading to use averages, but the use of average Likert scale scores is unable to account for and explain important additional variability.

Conspiracist Belief

To assess conspiracist ideation and the general disposition to engage in or endorse conspiracy theories, we used the Generic Conspiracist Beliefs Scale (GCBS; Brotherton et al., 2013; see Appendix B). This scale is composed of five subscales with three items each: Government Malfeasance (GM: reflected allegations of routine criminal conspiracy within governments, α = 0.90): Extraterrestrial Cover-Up (ET: concerns about deception of the public regarding the existence of aliens, α = 0.94); Malevolent Global Conspiracies (MG, concerns about allegations that small, secret groups exert total control over global events, α = 0.88); Personal Well-Being (PW, conspiracist concerns over personal health and liberty such as the spread of diseases and the use of mind-control technology, α = 0.85); and finally, Control of Information (CI, beliefs relating to unethical control and suppression of

information by organizations including the government, the media, scientists, and corporations, α = 0.79). Each of the 15 items are rated on a 5-point Likert-type scale indicating the degree to which respondents believe each statement is likely to be true, ranging from 1 = *definitely not true* to 5 = *definitely true*. Higher scores on each of the subscales indicate a greater disposition to engage in conspiracist ideation. The overall internal reliability of the GCBS was very high (α = 0.95), and it demonstrated good test-retest reliability, criterion-related validity, and discriminant validity (Brotherton et al., 2013; Drinkwater et al., 2020). An attention check – "Please select the opposite of *definitely true* for this question." – was included at the end of this scale to assess whether participants were fully reading each item and providing valid responses for analysis.

Dunning-Kruger Effect

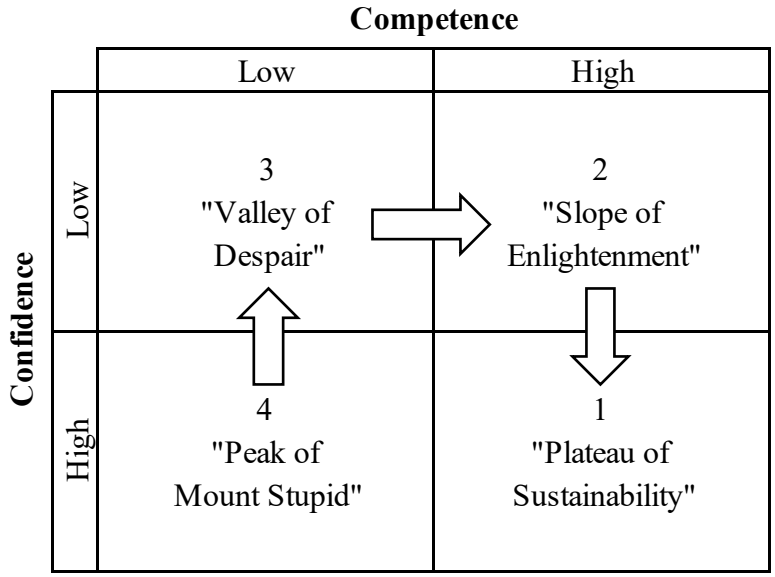
Recall that the Dunning-Kruger effect occurs when people with less knowledge (i.e., those less competent) are the most likely to be overconfident in said knowledge. In order to assess the mediational role of this competence – confidence interaction, we measured objective knowledge on given topics along with participant's confidence in the accuracy of that knowledge. Both confidence and competence scores were standardized, summed across topics, then high-low median split and participants were placed respectively into four quadrants (see Figure 3) and assigned indicator values denoting stages of the Dunning-Kruger effect represented earlier in Figure 1.

In other words, depending on the actual number of correct responses on the knowledge measure in relation to the self-assessed number of correct responses, participants were categorized as (4) high confidence/low competence, (3) low confidence/low competence, (2)

low confidence/high competence, and (1) high confidence/high competence. The higher the score, the more a person engaged in Dunning-Kruger thinking.

Figure 3

Quadrants and Indicator Values of the Measured Dunning Kruger Effect



Note. Arrows represent the path along the Dunning-Kruger effect curve depicted in Figure 1.

Knowledge (i.e., competence) and confidence were measured on the topics of genetically modified foods (GMF) and vaccination/vaccines (VAX), since they are popularly employed in research concerning common misconceptions, false beliefs, and belief revision (Bird, 2021; Dobson, 2022; Ecker et al., 2022; Light et al., 2022; van Stekelenburg et al., 2021). Looking back at the common categorizations of belief discussed earlier, these two topics are composed of beliefs that are conceptual and testable. Researchers have reported that individuals who have informed prior beliefs are relatively unaffected by all types of new information (Huffman et al., 2007), so we asked participants to rate how well informed they believe themselves to be on each of these topics (on a scale of 1 = not informed at all, 2 = not

very informed, 3 = somewhat informed, 4 = well informed, 5 = extremely well informed). This served as an initial subjective measure of informed prior beliefs and is intended to reveal whether such informed prior beliefs can influence susceptibility to new information or play a role in predicting the belief change process. This rating was also used to run post-hoc correlations and potentially shed light on various subtleties that could contribute to further understanding of individual variability in belief change.

The objective knowledge measures were administered as the first step in assessing the Dunning-Kruger effect, that is, measuring the knowledge/competence part of the Dunning-Kruger equation. The 10-item multiple-choice GMF knowledge measure (Heddy et al., 2017; see Appendix C), which was co-designed and reviewed by an expert on GMFs (Broughton et al., 2012), was used to assess content knowledge and conceptions related to GMFs. Of the four response options provided for each item, three choices represented a misconception or incorrect belief and are scored as a 0, while the correct choice reflected knowledge that is consistent with the scientifically accepted perspective and is scored as a 1. Therefore, a higher total score indicated that a participant holds correct beliefs regarding GMFs which are congruent with scientifically accepted knowledge, while a lower total score indicated that a participant has misconceptions or incorrect beliefs regarding GMFs. Heddy et al. (2017) asserts that this measure has been shown to be appropriately valid and reliable in other research (see Trevors et al., 2016).

In addition to the GMF measure, participants were given a 13 item True/False VAX knowledge questionnaire that was developed using information from the National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases (Centers for

Disease Control and Prevention, 2022; see Appendix D), and modified to contain both correct and incorrect statements. This measure was developed and modified for the current study to avoid explicitly focusing on childhood vaccination and instead lean toward current knowledge and conceptions regarding COVID-19 vaccines and vaccination in general. Correct responses are scored as a 1, and incorrect responses are scored as a 0; therefore, a higher total score indicates that a participant holds correct beliefs regarding VAX which are congruent with the current scientifically accepted knowledge, while a lower total score indicates that a participant holds misconceptions or false beliefs regarding VAX.

Though ceiling and/or floor effects may infrequently be observed when using these methods to measure GMF and VAX knowledge, the current study was not designed around the possible scarcity of such cases given the fact that the participants were not considered to be overly educated on subjects including biological, cellular, molecular, or genetic engineering, biochemistry, or principles of epidemiology.

In order to obtain the second part of the Dunning-Kruger effect, participants were asked to rate their confidence in their knowledge, or how they think they performed on each knowledge measure: “Of the 10 GMF items [13 VAX items], how many do you think you answered correctly?”. This was intended to assess accuracy of knowledge (meta-knowledge) and it served as the confidence aspect of the Dunning-Kruger effect.

Participants’ total standardized scores on each initial knowledge measure were summed to create an overall competence score. Likewise, the standardized confidence ratings for each initial measure were summed to create an overall confidence score. These confidence and competence scores were then split at their respective medians and cross tabulated to create a

Dunning-Kruger indicator value (α = .82) specifying membership in one of the four quadrants represented in Figure 3. This indicator value represents the Dunning-Kruger effect because it reveals the extent to which people who have little actual knowledge (a proxy for competence) believe that they know a lot (confidence). For example, a person with a low objective knowledge score (competence) and a high confidence score is placed in the lower left quadrant of Figure 3 (aka "Peak of Mount Stupid" in Figure 1). As they realize their ignorance and their confidence decreases, they move to the upper left quadrant ("Valley of Despair" in Figure 1). As they gain knowledge but have relatively little confidence in that knowledge, they move to the upper right quadrant in Figure 3 and are now in the "Slope of Enlightenment". Finally, as their knowledge grows even further and they gain confidence, they reach the lower right quadrant and have entered the "Plateau of Sustainability".

Belief Change

The major outcome variable that is being predicted in our model is the extent to which people are willing to change their misconceptions and incorrect beliefs upon engaging with factual evidence-based information (i.e., refutation evidence). We measured belief change two different ways. First, with a self-report measure and then more directly with a information intervention (refutation) technique.

First, we assessed a more general, trait-like resistance to belief change by administering the Resistance to Change Beliefs (RC-B) scale, which was designed to capture an individual's preference for tradition and preference for gradual change (White et al., 2020; see Appendix E). With an internal reliability of α = .85, the RC-B consists of 10 items and for the current study was adjusted to a 5-point Likert scale ranging from 1 = *strongly*

disagree to 5 = *strongly agree*. Subscales include preference for tradition (α = .84) and preference for gradual change (α = .71), with higher scores on the entire RC-B scale indicating a greater resistance to change. Research has shown that individuals who self-identify as socially and economically conservative tend to score higher on the RC-B scale (White et al., 2020), which raises the question of whether this scale is better suited as a measure of conservative ideology than belief change. However, items in the RC-B scale do not refer to political issues and focus on beliefs rather than predispositions, measuring only the resistance to change construct, whereas other measures of resistance to change, such as Oreg's RTC scale (2003), measure an individual's predisposition to resist change in general, as opposed to beliefs regarding the value of change versus stability (White et al., 2020; Oreg et al., 2008). The RC-B was not intended to be used in the current model, but it was included in this study to validate the observed Belief Change measurement.

Secondly, we measured Belief Change by participant's willingness or ability to change their mind after being presented with evidence that could contradicted and/or refute their prior beliefs. Refutation texts for both GMF and VAX topics were used as an informational intervention task. A typical refutation text identifies misconceptions, refutes them, and then provides a scientific explanation of why the misconception was incorrect (Thacker et al., 2020). By simultaneously activating individuals' epistemic beliefs and prior knowledge (i.e., misconceptions) alongside information to-be-learned, refutations texts have been shown to generate cognitive conflict between previously acquired misconceptions or beliefs and new information (Vivian, 2018). This task was chosen for the current study due to demonstrated effectiveness at inducing belief change over and above a simple presentation or exposure to

expository matter-of-fact educational material. If a participant did not have any prior misconceptions or false beliefs regarding either of the topics it would be reflected in their knowledge measure scores. The participants recruited for this study were not sought as content knowledge experts on GMFs or VAX and, given the specificity of each topic, it was considered unlikely that a participant would already have beliefs that are completely in-line with the material presented in each refutation text; thus, the current study was not designed accounting for such cases.

Immediately following the respective knowledge measure, we administered the intervention refutational text regarding GMFs (Heddy et al., 2017; see Appendix F), which was developed from a measure that has been reviewed by an expert on GMFs and used in prior research (Broughton et al., 2012). The GMF refutation text contains 631 words and was determined to be at a 12th-grade reading level according to Flesch-Kincaid, with a reading ease score of 43.6. The Flesch-Kincaid grade level score is based on a formula that takes into account the number of sentences, syllables, and words, estimating a grade level score to represent the readability of a text and how many years of education would most likely be needed to understand the text (Kincaid et al., 1975). Reading ease scores range from 1 to 100, with higher scores indicating text that is generally easier to read and understand. Next, immediately following the respective knowledge measure, participants were given a refutation text regarding VAX adapted from Kessler et al. (2019) with information from the Centers for Disease Control and Prevention (2022), tailored to refute misperceptions regarding the topics of vaccination and vaccines without explicitly focusing on childhood vaccination (see Appendix G). The VAX refutation text is slightly longer than the GMF

refutation text; containing 795 words, and was determined to also be at the 12th-grade reading level according to Flesch-Kincaid, with a reading ease score of 47.3.

To ensure that participants actually read each refutation text thoroughly and completely, engaging with all information presented, they were instructed that there would be a test on the material afterward. Each post-reading "test" simply contained a single question – "How well did you process the information in the text you just read? There is no right or wrong answer" – with responses ranging from 1 = *skimmed it quickly* to 7 = *read it very carefully*. Two identical attention check questions rated on a 5-point Likert scale – "I've been to every country in the world." – were used near the start of the study and just before the end of the study. These two questions were intentionally the same and allowed us to gauge whether participants were being consistent in providing self-reflective and evaluative responses throughout the study.

To conclude the study, we administered the second round of GMF and VAX knowledge measures along with the self-ratings of performance on each. The extent to which participants' beliefs changed according to the new information presented in each refutation text was assessed using the standardized summed difference scores from the initial objective knowledge assessments of GMF and VAX and the second, post-refutation knowledge assessments. This difference score served as the measured Belief Change outcome. Using this methodology, it is possible for participants to have a negative belief change score indicating that their beliefs did indeed change, just in the wrong direction.

Demographics

In addition to age, gender, and ethnicity, participants responded to questions regarding education level, religiosity, and political orientation (see Appendix H).

Design and Procedure

The current investigation was a correlational study that explored the latent constructs of Thinking Style and Conspiracist Belief while assessing the role of the Dunning-Kruger effect as a mediator to better understand and possibly predict Belief Change. Data were collected using the interactive online survey platform Qualtrics, which did not require scheduled experimental sessions. Participants were recruited both from the university's Psychology-1 research participation website, SONA, and through Amazon's MTurk system for a non-student sample of U.S. adults. Participants read a consent form and then checked a box to confirm their consent, indicating the start of the study (see Appendix I for consent forms and a study description used as recruitment material). They then proceeded to the surveys and informational refutation text interventions during a single session, taking up to one hour in total.

The study began with the prior knowledge question, the knowledge assessment, and the respective self-rated accuracy assessment for the GMF topic, followed by the refutation text intervention for the GMF topic, and then each again for the VAX topic. Participants then proceeded with the Thinking Style, Generic Conspiracist Belief, and Resistance to Change – Belief (RC-B) measures. All items in each measure were presented in randomized order to avoid possible ordering effects. Demographic questions were then answered and, once again, the same GMF and VAX knowledge assessments along with their corresponding accuracy

assessment question. To conclude the study, participants were thanked for their participation, provided with a unique ID code, and directed back to the respective study landing page in order to submit their unique ID and receive compensation for participation.

Data collection was closed for participants recruited via SONA on the participation requirement deadline near the end of the academic semester. Data collection for participants recruited through MTurk took place serially in batches of 9 participants each, with one batch of nine collected only after the previous batch had been completed and closed. All batches also had a 48-hour rolling closure date which required that they complete the study within two days of providing informed consent (indicating the start of the study). Since both SONA and the MTurk participants were directed to Qualtrics to take part in the study and respond to the surveys, a built-in Qualtrics function closed all in-progress responses and marked them as expired one week after their individual initial start times. Due to the nature of each recruitment method, SONA data collection began one week before MTurk data collection did, and it commenced four weeks after MTurk data collection ended. The MTurk sample was collected over the course of two weeks in total, yet it unsurprisingly was able to collected a similar number of responses as the SONA recruitment method.

There were some initial issues with MTurk data collection regarding an excess of fraudulent responses and bots, so to safeguard against having to compensate invalid responses while maintaining a reasonable Requester approval rating in Amazon Web Services, unique attention checks and other indirect indicators were added to identify and reject fraudulent responses. These indicators included multiple “hidden” questions that were modified with JavaScript to ensure they were only visible to bots and not seen by human

respondents. If any of these “honeypot” questions were answered, the respondent was automatically redirected to an alternative end-of-survey message and their response recorded. Additionally, when a respondent reached the end of the survey, they were provided with a unique completion code and instructed to proceed to the next page, reaching the actual survey-end page, and then return to the MTurk landing page to enter their unique code. These codes were cross-validated from Qualtrics to confirm that they matched those entered in MTurk. A standard CAPTCHA was also placed at the beginning of the survey to act as a challenge-response authentication. Furthermore, a particular attention check in addition to those previously mentioned was placed at the end of the second GMF knowledge measure near the end of the survey. This question did not have a response requirement requesting an answer, and it was worded to seem like part of the measure itself – “Common activities associated with genetic modification include - if you are reading this, please choose "Other" and "Internet" as your response, making sure to select both responses...”. Participants who did not select the correct responses or only selected a single response were further investigated for careless response patterns or potential fraud. As a final indicator of low quality and possibly fraudulent or invalid responses, timing metadata was collected for each refutation text and overall survey duration. Cases with unrealistic times spent reading either of the refutation texts or time taken overall to complete the study were closely inspected for additional signs that they might be from a bot, fraudulent, invalid, incomplete, or otherwise demonstrating a sincere lack of attention and effort. After implementing these additional checks and indicators, the number of rejected responses collected from MTurk dropped approximately 70% (from four invalid responses to just one, per batch of nine).

Results

Descriptive statistics for all measured variables in the study are reported in Table 2. The standardized competence and confidence scores used for calculating the final Dunning-Kruger effect are reported in place of the categorical indicator score, while the resultant indicator score frequencies are reported in Table 3.

Table 2

Descriptive Statistics for All Measured Variables (N = 226)

Variable	M	SD	median	min	max	range	skew	kurtosis	se
AOT	13.98	5.49	13	6	30	24	0.45	-0.56	0.37
CMT	15.68	5.28	15	6	30	24	0.28	-0.67	0.35
PIT	17.58	6.18	18	6	30	24	-0.20	-0.88	0.41
PET	14.13	5.45	14	6	30	24	0.50	-0.40	0.36
GM	8.35	3.52	9	3	15	12	-0.07	-1.04	0.23
ET	7.32	3.47	7	3	15	12	0.37	-0.97	0.23
MG	7.15	3.35	7	3	15	12	0.33	-0.93	0.22
PW	6.97	3.17	7	3	15	12	0.42	-0.79	0.21
CI	9.15	3.15	10	3	15	12	-0.30	-0.65	0.21
RC-B	30.84	7.10	31	10	50	40	-0.23	-0.05	0.47
DK.Confidence (std.)	0.00	1.69	-0.05	-5.66	4.32	9.98	-0.10	-0.24	0.11
DK.Competence (std.)	0.00	1.58	0.10	-5.27	3.26	8.53	-0.40	0.13	0.10
Belief Change	0.00	1.32	.005	-3.66	4.51	8.17	0.18	0.48	0.09

Table 3

Dunning-Kruger Score Frequencies

Quadrant Indicator	*n*	%
1	69	30.53
2	39	17.26
3	77	34.07
4	41	18.14

Univariate and multivariate assumptions of normality, skewness, and a positive definite matrix were first tested in the *mvnormalTest* and *matrixcalc* packages in R Studio and provided mixed results. The covariance matrix contained all positive eigenvalues, and all multivariate assumptions of skewness and kurtosis were met. A Q-Q plot was visually inspected and showed no severe deviations from normality, although, a Shapiro-Wilk test of univariate normality revealed that the four Thinking Styles indicators and the Belief Change outcome score were not normally distributed.

Recall, we assessed belief change twice, once with the self-report RC-B measure and once with an information intervention technique. One purpose of this was as an attempt to gain validity information about our information intervention technique. To get that information, we ran a simple bivariate correlation between the two ($r(224) = -0.03$, $p = 0.62$; see Table 4). From this we conclude that the refutation intervention was not particularly successful at inducing Belief Change.

Table 4

RC-B Correlations with Confidence Intervals

Variable	*M*	*SD*	1	2	3
1. RC-B	30.84	7.1			
2. RC-B Preference for Tradition	13.73	4.49	.92** [.90, .94]		
3. RC-B Preference for Gradual Change	17.11	3.47	.86** [.82, .89]	.59** [.49, .67]	
4. Belief Change	0.00	1.32	-0.03 [-.16, .10]	0.00 [-.13, .13]	-0.07 [-.20, .06]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in brackets indicate the 95% confidence intervals. * indicates $p < .05$. ** indicates $p < .01$.

We also ran another simple bivariate correlation between Belief Change scores and standardized summed self-ratings of how well-informed participant believed themselves to be on each topic ($r(224) = -0.14$, $p = 0.03$). This revealed a small but significant correlation between the two.

Structural modeling assessment is a two-step process: first, a confirmatory factor analysis to determine fit of measured variables to latent constructs; second, the structural tests the fit of hypothesized paths between the latent and latent or measured variables. Using the *lavaan* package in R Studio, we first tested the measurement model consisting of AOT, CMT, PIT, and PET as measured indicators of Thinking Styles, and GM, ET, MG, PW, and CI as measured indicators of Conspiracist Beliefs. Model fit was assessed using the Relative Chi-Square test $\chi^2(65.04, 26) = 2.50$, $p < .05$, Indices of Comparative Fit (*CFI* = .961), Adjusted Goodness of Fit (*AGFI* = .891), the Non-Normed Fit/Tucker-Lewis Index (*NNFI/TLI* = 0.945), and the Root Mean Square Error of Approximation (*RMSEA* = 0.082) and found to be adequate on all accounts. Table 5 lists all relevant SEM fit indices and their fit criterion.

Table 5

Goodness of Fit Indices and Thresholds

Test Name	Good Fit	Acceptable Fit	Source
Relative Chi-Square (χ^2/df)	<3.00	<5.00	Marsh & Hocevar (1985) Jöreskog & Sörbom (1993)
Comparative Fit Index (*CFI*)	0.95 ≥ 0.90	≥ 0.90	Bentler (1990) Hu & Bentler (1999)
Adjusted Goodness-of-Fit Index (*AGFI*)	≥ 0.90	> 0.80	Hair et al. (2010) Hooper et al. (2008) Schumacker & Lomax (2010)
Non-Normed Fit/Tucker-Lewis Index (*NNFI/TLI*)	0.95 ≥ 0.90	≥ 0.90	Bentler & Bonett (1980) Tucker & Lewis (1973)

Root Mean Square Error of Approximation (RMSEA)	$0.06 \leq 0.08$	$0.08 \leq 0.1$	Browne & Cudeck (1993) MacCallum et al. (1996)
Chi-Square (χ^2)	Low χ^2 relative to degrees of freedom with p-value < 0.05		Bamdad Mehrabani et al. (2023); Hu & Bentler (1999)

In a structural model, all structural paths represent hypothesized relationships that are tested using estimated path coefficients and the overall model is evaluated against goodness of fit indices. The present structural model, using maximum likelihood (ML) estimation procedures in the *lavaan* package of R Studio, was constructed to test the general hypotheses that Thinking Styles are predictive of Conspiracist Belief, which, in turn, is mediated by the Dunning-Kruger effect to predict Belief Change. With an adequate fit of the measurement model to the observed data matrix, the structural model was constructed with the addition of total standardized high/low median split scores on both objective knowledge measures (competence) and self-rated performance (confidence) as an indicator of the Dunning-Kruger effect, and total standardized difference scores of the combined GMF and VAX knowledge measures administered pre- and post-intervention (refutation text) as indicators of Belief Change ($\alpha = .80$).

Univariate and Multivariate assumptions for the proposed SEM were tested and provided mixed results similar to those of the measurement model. Given the relatively large sample size and the partially violated univariate assumption of normality, we chose to continue with the Maximum Likelihood (ML) estimation procedure. The initial structural model, which had predicted direct paths between Thinking Styles and Conspiracist Belief, then Conspiracist Belief and Belief Change when mediated by the Dunning-Kruger effect, adequately fit the

data with a significant Relative Chi-Square test ($\chi^2(106.99, 43) = 2.49$, $p < .05$; *CFI* = .941; *AGFI* = .867; *NNFI/TLI* = .925; *RMSEA* = .081). The resultant mediated latent structural model with all path coefficients is presented in Figure 4, with dashed-paths indicating the fixed loadings used for estimating the initial model, followed by the list of all standardized parameter estimates (path coefficients) in Table 6.

Figure 4

Mediated Latent Structural Model of Belief Change

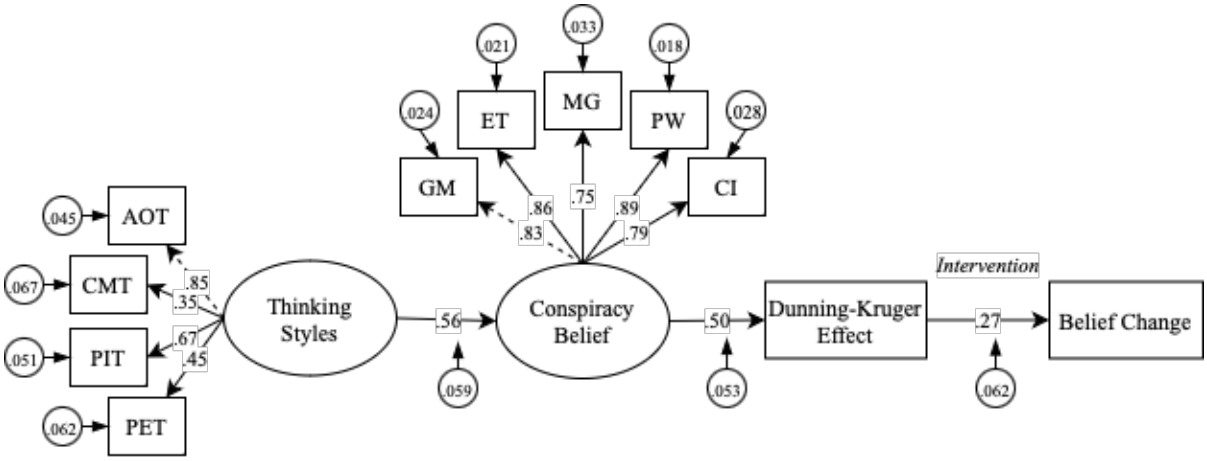


Table 6

Standardized Parameter Estimates

Construct	Indicator	Standardized Estimated Path Coefficients	Error
Thinking Styles	AOT	0.8455	0.0459
	CMT	0.3479	0.0668
	PIT	0.6730	0.0506
	PET	0.4473	0.0621
Conspiracist Belief	GM	0.8310	0.0240
	ET	0.8570	0.0214

	MG	0.7466	0.0325
	PW	0.8937	0.0178
	CI	0.7883	0.0284
Conspiracist Belief	Thinking Styles	0.5593	0.0589
DK Effect	Conspiracist Belief	0.5013	0.0525
Belief Change	DK Effect	0.2702	0.0617

Note. All path coefficients were significant at $p < .001$

Discussion

In this study we set out to investigate if the latent constructs of Thinking Styles and Conspiracist Belief are related to or even predictive of Belief Change when accounting for mediational effects of the Dunning-Kruger effect. The results show support for our models initial hypotheses; after taking into account the level of disparity between an individual's knowledge of a subject and their self-rated confidence in that knowledge, differences in intuitive versus analytical thinking and open- and closed-mindedness, along with a general tendency to endorse proposed explanations of an event or concept that are in opposition to a more conventional/well-supported explanation, are significantly related to whether or not an individual will change their beliefs when presented with factual information that may oppose their currently held beliefs.

The relationship between thinking styles and conspiracist belief, and between conspiracist belief and belief change when mediated by the observed Dunning-Kruger effect, were all statistically significant. However, the structural model's estimated path coefficients were rather small, indicating that these relationships were not particularly strong and additional variance in belief change could potentially be account for elsewhere. It appears that other factors would help to explain the often-difficult process of simply evaluating one's own beliefs, let alone the further challenges associated with revising said beliefs. The small but significant negative correlation between self-rated prior knowledge across both topics and belief change scores contradicted past research demonstrating that individuals who have informed prior beliefs are relatively unaffected by all types of new information (Huffman et al., 2007). This revealed that prior beliefs did influence participants susceptibility to new

information, with those who rated themselves as more informed scoring lower on Belief Change outcome.

Overall, our findings demonstrate that prior belief has a direct, albeit small, influence on belief change, while we failed to find evidence that thinking styles of dual processing and open- and closed-mindedness directly impact belief change. This most likely has to do with our operationalization of Belief Change, highlighting potential issues in its measurement and expressing the importance of further validating such a measure. Also, the strength of such informed prior beliefs should be taken into consideration.

A notable limitation of this study that need be mentioned has to do with the method employed for measuring Belief Change. We summed standardized knowledge measure scores across topics of GMF and VAX to calculate difference scores indicative of belief change. By simply combining scores across topics and then calculating the difference, we overlooked possible differential effects of the topic on the relationships in the structural model. Ideally, each topic should be modeled individually, or as separate groups in a grouped SEM, so that any effects of the topic on variable relationships could be identified. In a similar vein, the refutation text intervention for the two topics used in this study would benefit from further validation. Additionally, the structural model should account for covariates such as religiosity, and political orientation, while holding some demographic variables like education and age constant, to avoid confounds and more accurately represent the relationship between both the latent and the measured factors in the structural model. Also, reflecting on the fact that mood states and emotion have been proven to influence the amount of effort individuals spend on processing new information and evaluating their own beliefs

(Connors & Halligan, 2015), future research would benefit from investigating other potentially mediating and moderating effects of factors such as motivation, emotion, intellectual humility, confidence in science, and need for closure. Lastly, the imbalance of respondents in each samples demographic categories represents an additional limitation of this study. By combining samples, we negated some of the potential effects of such skewed data, but future researchers should first measure baseline beliefs regarding GMF and VAX, strength of those beliefs, and account for prior knowledge of each subject when calculating potential Dunning-Kruger effects and Belief Change scores.

Why can a person believe something for which there is no evidence and yet also fail to believe something for which there is overwhelming evidence? With this question in mind, our study established a preliminary model with the intention of painting a clearer picture of how individual differences may be related to whether or not someone might change their mind. One of the main questions to come from this study concerns the measurement of belief change. The philosophical endeavor of defining belief coupled with the empirical demands of quality psychological research have led us into a thicket from which many researchers have returned with even more questions. This investigation provided contradictory evidence to past research on the effects of prior beliefs and raised important questions and interesting considerations for researchers with grand intentions of developing a well-verified measure of belief change. Though there may not be a collectively agreed-upon and reliable model of such relationships predicting belief change, by identifying aspects of thinking styles and general predispositions toward conspiracist ideation we humbly contribute to the consolidation of a large and somewhat contradictory body of knowledge on the predictors of

belief and belief change, potentially allowing for a greater understanding of the persistence of unfounded beliefs and misperceptions in today's era of ever-increasing misinformation and uninformed opinions incorrectly regarded as facts.

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Appendices

A. Comprehensive Thinking Styles Questionnaire (4-CTSQ) (Newton et al., 2021)

Please indicate the extent to which you agree or disagree with the following statements. Participants respond to each question on a scale from 1 = *Strongly disagree* to 5 = *Strongly agree*

1. It is important to be loyal to your beliefs even when evidence is brought to bear against them.
2. Whether something feels true is more important than evidence.
3. Just because evidence conflicts with my current beliefs does not mean my beliefs are wrong.
4. There may be evidence that goes against what you believe but that does not mean you have to change your beliefs.
5. Even if there is concrete evidence against what you believe to be true, it is OK to maintain cherished beliefs.
6. Regardless of the topic, what you believe to be true is more important than evidence against your beliefs.
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.
20. Thinking is not my idea of an enjoyable activity.
21. I try to avoid situations that require thinking in depth about something.
22. I am not a very analytical thinker.
23. Reasoning things out carefully is not one of my strong points.
24. Thinking hard and for a long time about something gives me little satisfaction.

Items 1-6: Actively Open-minded Thinking (reverse score each item or the scale mean)
Items 7-12: Close-Minded Thinking
Items 13-18: Preference for Intuitive Thinking
Items 19-24: Preference for Effortful Thinking (reverse score each item or the scale mean)

B. Generic Conspiracist Beliefs Scale (GCBS) (Brotherton et al., 2013)

Indicate the degree to which you believe each statement is likely to be true on the following scale:
1 = *Definitely not true*; 2 = *Probably not true*; 3 = *Not sure/cannot decide*; 4 = *Probably true*; 5 = *Definitely true*

1. The government is involved in the murder of innocent citizens and/or well-known public figures, and keeps this a secret.
2. The power held by heads of state is second to that of small unknown groups who really control world politics.
3. Secret organizations communicate with extraterrestrials, but keep this fact from the public.
4. The spread of certain viruses and/or diseases is the result of the deliberate, concealed efforts of some organization.
5. Groups of scientists manipulate, fabricate, or suppress evidence in order to deceive the public.
6. The government permits or perpetrates acts of terrorism on its own soil, disguising its involvement.
7. A small, secret group of people is responsible for making all major world decisions, such as going to war.
8. Evidence of alien contact is being concealed from the public.
9. Technology with mind-control capacities is used on people without their knowledge.
10. New and advanced technology which would harm current industry is being suppressed.
11. The government uses people as patsies to hide its involvement in criminal activity.
12. Certain significant events have been the result of the activity of a small group who secretly manipulate world events.
13. Some UFO sightings and rumors are planned or staged in order to distract the public from real alien contact.
14. Experiments involving new drugs or technologies are routinely carried out on the public without their knowledge or consent.
15. A lot of important information is deliberately concealed from the public out of self-interest.

Note:
1, 6, 11 = Government Malfeasance (GM)
2, 7, 12 = Extraterrestrial Cover-up (ET)
3, 8, 13 = Malevolent Global Conspiracies (MG)
4, 9, 14 = Personal Well-being (PW)
5, 10, 15 = Control of Information (CI)

C. GMF Knowledge Assessment (Broughton et al., 2012; Heddy et al., 2017)

Below are statements about genetically modified foods. Please choose the answer that is the **most consistent with your own knowledge**.

1. Genetically modifying foods occurs through…
    a. natural processes.
    b. artificial processes.
    c. all of the above
    d. none of the above

2. Processes used by scientists to modify the genetic makeup of plants and animals include which of the following?
    a. Cloning
    b. Hormone injection
    c. Cross-pollination
    d. All of the above

3. When using gene cloning methods, a genetically modified organism is…
    a. an exact replica of the donor organism.
    b. a bit different than the donor organism.
    c. in no way similar to the donor organism.
    d. Gene cloning methods cannot be used to genetically modify organisms.

4. Cross-pollination is considered to be a process through which plants can be…
    a. genetically modified.
    b. cloned.
    c. hormone injected.
    d. exactly replicated.

5. Which of the following can genetically modify plants or animals?
    a. Farmers/Gardeners
    b. Scientists
    c. Animals
    d. All of the above

6. What will happen to the genetic offspring of plants and animals that have been genetically modified?
    a. The genes will be passed to the new offspring.
    b. The offspring's genetic makeup will revert back to its original state.
    c. A genetic mutation will occur.
    d. They will be physically or mentally disabled.

7. Injecting hormones into a plant or animal may change what about that organism?

   a. **The size of the plant or animal**
   b. The genetic makeup of that plant or animal
   c. All of the above
   d. None of the above

8. Adding to or inhibiting a plant's or animal's DNA occurs only in…
   a. laboratories.
   b. nature.
   c. farms.
   d. all of the above

9. When were processes used to modify a plant's or animal's DNA developed?
   a. In the past 10 years
   b. In the past 50 years
   c. In the past 100 years
   d. Longer than 100 years

10. Methods that are NOT used in producing genetically modified foods include which of the following?
   a. Gene cloning methods
   b. Hormone injection
   c. Cross-pollination
   d. Selective pollination

Note: Correct choices are represented in bold.

[post-refutation knowledge assessment instructions will read: "Below are the same statements about Genetically Modified Foods that you answered previously. Now that you have learned more about GMF's, please rate them again. We are not interested in what you have learned or can remember from the texts, but rather whether your views have shifted. Please choose the answer that is the **most consistent with your current beliefs**."]

D. VAX Knowledge Assessment (Adapted from myths and facts about COVID-19 vaccines; Centers for Disease Control and Prevention, 2022).

Below are statements about vaccination and vaccines. Please indicate **to the best of your knowledge** whether each statement is True or False:

1. Vaccines and the ingredients they contain are generally safe.
2. The natural immunity a person gets from being sick with COVID-19 is better than the immunity they get from COVID-19 vaccination.*
3. Vaccines do not cause an increase in variants.
4. Vaccination against diseases that have been eradicated is not necessary.*
5. An mRNA vaccine is not considered a real vaccine.*
6. Vaccines, especially the COVID-19 vaccine, may contain microchips or other "unnatural" material.*
7. Receiving a vaccine often results in adverse reactions.*
8. Vaccination, particularly COVID vaccines, can alter a person's DNA.*
9. A COVID-19 vaccine will not make me sick with COVID-19.
10. Most illnesses targeted by vaccines are very serious and require vaccination.
11. Vaccines cause autism.*
12. Over 85% of US scientists believe that all children should be required to be vaccinated.
13. Over 90% of new COVID cases, hospitalizations, and deaths occur among people who are unvaccinated or not yet fully vaccinated.

Note: False statements are indicated with an asterisk*

[post-refutation knowledge assessment instructions will read: "Below are the same statements about Vaccination/Vaccines that you answered previously. Now that you have learned more about VAX, please rate them again. We are not interested in what you have learned or can remember from the texts, but rather whether your views have shifted. Please choose the answer that is the **most consistent with your current beliefs**."]

E. Resistance to Change-Beliefs Scale (RC-B) (White et al., 2020)

Please rate your agreement with the following statements:
1 = *strongly disagree*; 2 = *somewhat disagree*; 3 = *neither agree nor disagree*; 4 = *somewhat agree; 5 = strongly agree*

1. Approaches used by people in the past are generally the most effective.
2. If society is going to change, it should occur slowly and naturally.
3. The established way of doing things should be protected and preserved.
4. Fast or radical changes are unwise and dangerous.
5. Traditions reflect wisdom and knowledge.
6. Making sudden changes tends to create more problems than solutions.
7. Slow, gradual change helps prevent catastrophes and mistakes.
8. Quick changes are acceptable if they restore things to how they were before.
9. Following traditions tends to create a closed-minded society (R).
10. Established traditions are the best way to run society.

Preference for tradition subfactor items 1, 3, 5, 9, 10
Preference for gradual change subfactor items 2, 4, 6, 7, 8
(R) indicates an item that is reverse-scored.

F. GMF Refutation Text (Broughton et al., 2012; Heddy et al., 2017)

The following text presents several common misconceptions alongside facts about genetically modified foods. **Please thoroughly and completely read the text, making sure to engage with the information presented. You will be tested on your comprehension afterward.**

*[GMF 5]

Have you ever wondered just what it means when you hear the term “genetically modified foods"? Along those same lines, have you ever thought about how genetically modified foods are developed? Each of those questions are quite interesting to think about given that some of the foods we eat may have been genetically modified. In answer to the first question, genetically modified foods are those that have been modified via genetic engineering or other more traditional methods in order to produce heritable improvements in plants or animals for specific uses (Bickell, 2021). In other words, they are foods that have been modified at the gene level to produce a desired trait that would most likely not occur through natural processes. So, just what processes are involved in genetically modifying foods?

*[GMF 2 & 3]

You may think that genetically modifying foods is the same process as cloning. This belief is not correct. Cloning involves making an exact genetic copy of an organism. All of the genetic information is identical between those two organisms. In contrast, genetically modified food can be produced by gene cloning methods; however, the protein in the genetically modified organism has been modified somewhat so that the host (modified) organism will express the desired trait. Thus, the genetically modified organism is not necessarily an exact replica of the donor organism.

*[GMF 2, 5, 6, 7, & 10]

Instead of cloning you may think that injecting hormones into a plant or animal is involved in the production of genetically modified foods. This belief is also incorrect. Injecting hormones into a plant or animal can increase its growth rate or its size. However, injecting hormones does not modify the genetic makeup of the plant or animal. In contrast, genetically modified foods have had some of their characteristics changed at the gene level.

*[GMF 1, 4, 5, 6, & 8]

Now you know that genetically modified foods are those foods that have had some of their genetic information changed or new DNA added or suppressed. You may think that the development of genetically modified foods occurs only in laboratories by scientists. Not so! Genetic modifications may happen through natural processes. For example, one type of a natural process for genetic modification of plants is cross-pollination. Cross-pollination occurs when the pollen from one plant is crossed with the pollen of a second plant. Corn plants are often cross-pollinated through wind transport which occurs when the wind carries pollen from one corn crop to a separate corn crop in nearby fields. When corn plants of

different varieties are cross-pollinated, the seeds they produce will be genetically different than the original corn plants. The corn produced by these cross-pollinated plants is a combination of the two varieties of corn. The corn seeds from the new cross-pollinated plant will carry the new genetic information. That new genetic information will continue to be a part of that plant's offspring.
*[GMF 1, 4, 5, 8 & 9]

Since it is the case that genetically modified foods can occur through natural processes you may wonder just how long genetic modification of foods has been taking place. You may hold the belief that genetically modified foods are only a product of contemporary scientific research. This belief is not correct! Indeed, for many centuries farmers and gardeners have used cross-pollination of plants in an attempt to produce plants or flowers that would have particular qualities. For example, farmers have used selective pollination of plants in hopes of producing sweeter fruits or more colorful flowers. Even today, farmers and gardeners use cross- pollination in hopes of producing sweeter corn or more colorful decorative corn.

*[GMF 1, 4, & 9]

In summary, genetically modified foods are those foods that have had some of their genetic information changed. Some foods can be genetically modified through natural processes such as cross-pollination. Farmers have used the process of genetically modifying foods for centuries as they attempt to develop plants with desired characteristics.

Reading Engagement Question:
How well did you process the information in the text you just read? There is no right or wrong answer.
1 = *Not well at all*; 2 = *Slightly well*; 3 = *Moderately well*; 4 = *Very well*; 5 = *Extremely well*

Note: *[Text in brackets indicate which knowledge assessment items are addressed. For review purposes only, not to be seen by respondents.]

G. VAX Refutation Text (Adapted from Kessler et al., 2019)

The following text presents several common misconceptions alongside factual information regarding vaccination and vaccines. **Please thoroughly and completely read the text, making sure to engage with the information presented. You will be tested on your comprehension afterward.**

*[Introduction]

In the wake of a global pandemic, beliefs concerning vaccination/vaccines have been inundated with different and sometimes contradictory information from various sources. Navigating this landscape of information can be quite confusing and often leads to incorrect conclusions.

*[VAX 1 & 6]

You might think that we just don't know enough about vaccines yet to say they aren't dangerous, they might cause variants of a disease or even contain microchips. However, this is not so! Given the increased number of vaccines administered, there is now a large amount of data available on vaccine safety. All vaccines go through clinical trials to test safety and effectiveness, with high standards set by The Food and Drug Administration (FDA) for vaccine developers to meet (NASEM, 2021). Nearly all the ingredients in general vaccines and COVID-19 vaccines are also food ingredients – fats, sugars, and salts. Even people with allergies to certain foods, insects, latex, or other common allergens can safely receive the COVID-19 vaccine (Maragakis & Kelen, 2022). As a matter of fact, the COVID-19 vaccines authorized by the FDA were not developed using fetal tissue and they do not contain any unnatural material like implants, microchips or tracking devices (Kelen & Maragakis, 2022).

*[VAX 5, 8, & 9]

If you think that the COVID-19 vaccine is not a "real" vaccine, you might be mistaken. The term "vaccine" includes viral vector, protein subunit, and mRNA vaccinations. Some vaccines are created using messenger RNA (mRNA), which allows a faster approach than the traditional way vaccines are made (Kelen & Maragakis, 2022). mRNA vaccines don't actually change your DNA, rather, they induce production of a protein to stimulate the immune system and then they quickly break down afterwards (Kelen & Maragakis, 2022). As a matter of fact, they can't even get you sick with what they are vaccinating against. A study published in August 2021 indicates if you had COVID before and are not vaccinated, your risk of getting reinfected is more than two times higher than for those who were infected and got vaccinated (Cavanaugh et al., 2021).

*[VAX 2, 3, 4, 7, & 12]

Instead of getting a shot, you might think that gaining a natural immunity is better, or that you don't even need a vaccination against something that doesn't exist anymore. This belief is also incorrect! Vaccines are still necessary in modern times. Diseases like measles, meningitis, polio, rubella, and whooping cough seem uncommon because vaccines are doing their job. Many young adults today may be unaware of the toll these diseases took before the

vaccination program was developed over 50 years ago. Life used to be especially brutal for children with a huge number of fatalities from the diseases mentioned above. The U.S. vaccination program has been one of the most successful health campaigns in history in terms of lives saved. According to survey data from the world's largest general scientific society (the American Association for the Advancement of Science), 86% of US scientists believe that all children should be required to be vaccinated (Pew Research Center, 2015). Even though diseases can mutate, decreasing transmission and infection through vaccination has been proven critical for limiting the emergence of future variants (NASEM, 2021). Simply put, the benefits of vaccination substantially outweigh the minimal risks and reactions that rarely occur.

*[VAX 10, 11, & 13]

Nevertheless, you may still believe that most illnesses targeted by vaccines are not that serious, so it is unnecessary to get vaccinated. This is a potentially life-threatening misconception. For example, before there were vaccines nearly every child in the United States got measles by age 15. Roughly 450 died each year, 48,000 were hospitalized, 7,000 had seizures, and about 1,000 suffered permanent brain damage. Unvaccinated children were 23 times more likely to develop whooping cough, nine times more likely to be infected with chicken pox, and 6.5 times more likely to be hospitalized with pneumonia than vaccinated children from the same communities. The polio virus left up to 20,000 people paralyzed in the 1950's – unable to walk or even breathe. Thanks to vaccines, there has not been a case of polio in the US in many years. Notice that a common theme in these descriptions is how harmful or prevalent these diseases used to be. Not to mention, in states that report breakthrough cases of COVID-19, more than 9 in 10 new cases hospitalizations and deaths occurred among people who are unvaccinated or not fully vaccinated (Kates et al., 2021). Lastly, to address the misconception that vaccines cause autism, all scientific evidence demonstrates that this is completely false and was the result of one grossly inaccurate article published (now retracted) which was written by an author who has since been stripped of his medical license and now represents a model of "bad science" (Gould, 2017; Institute of Medicine, 2004). [For more information, research Andrew Wakefield (1998) and the history of Thimerosal use in vaccines]

<u>Reading Engagement Question:</u>
How well did you process the information in the text you just read? There is no right or wrong answer.
1 = *Not well at all*; 2 = *Slightly well*; 3 = *Moderately well*; 4 = *Very well*; 5 = *Extremely well*

Note: *[Text in brackets indicate which knowledge assessment items are addressed. For review purposes only, not to be seen by respondents.]

H. Demographics

What is your current age in years? _____

Which gender identity do you most identify with?

1. Male
2. Female
3. Transgender
4. Non-binary/non-conforming
5. Other
6. Prefer not to say

Which ethnic/racial group do you most identify with?

1. White/Caucasian
2. Hispanic/Latino
3. Black/African American
4. Middle Eastern
5. Asian
6. Pacific Islander
7. Native American
8. Multi-ethnic or Mixed race
9. Other
10. Prefer not to say

What is the highest level of school you have completed or the highest degree you have received?

1. Less than high school degree
2. High school graduate (high school diploma or equivalent including GED)
3. Some college but no degree
4. Associate degree in college (2-year)
5. Bachelor's degree in college (4-year)
6. Master's degree
7. Doctoral degree
8. Professional degree (JD, MD)

Which of the following best describes your current political outlook/orientation?

1. Extremely liberal
2. Liberal
3. Moderately liberal
4. Moderate - middle of the road
5. Moderately conservative
6. Conservative
7. Extremely conservative
8. Other: _____

9. Don’t know

How would you describe your current political affiliation?

1. Democrat
2. Republican
3. Independent (unaffiliated)
4. Other: _____
5. Don’t know

What religion do you currently identify with, if any?

1. Buddhism
2. Christianity
3. Hinduism
4. Islam
5. Judaism
6. Paganism
7. Agnostic/uncertain
8. None/atheism
9. Other

In general, how important is religion in your life?

1. Not at all important
2. Slightly important
3. Moderately important
4. Very important
5. Extremely important

I. Recruitment Material & Online Participant Consent Form for SONA & MTurk

[SONA Recruitment Material] - Instructions/Description
Complete questionnaires and read two short texts online for 1 hour credit. We would like you to complete eight questionnaires online concerning thinking styles and knowledge with confidence regarding topics of genetically modified foods and vaccination/vaccines, as well as read two short texts, which will take a total of about 40 to 60 minutes to complete. To receive full credit (1 hour) you must complete all questionnaires and answer most every question honestly. You will only receive partial credit if your responses demonstrate a genuine lack of attention and/or effort.

REQUEST FOR YOUR PARTICIPATION IN RESEARCH

TITLE OF THE STUDY
Thinking Style, Conspiracy Belief, and the Role of the Dunning-Kruger Effect in Modeling Belief Change

NAME OF THE RESEARCHER
Professor Gregory J. Feist, PhD
Lucas Cusano, Research Assistant, candidate for MA in Psychology.

You have the opportunity to complete this research study for course credit as designated by your instructor. Please take your time in deciding if you would like to participate. You may complete an alternative assignment for equal course credit by reading and summarizing a scholarly journal article.

You must be at least 18 years old to participate in this study.

PURPOSE
The purpose of this study is to establish models of individual differences which may account for a propensity for conceptual change.

PROCEDURES
Should you agree to participate, you will be asked to rate how much you agree or disagree with a series of statements. You will also be given two short texts to read and asked to indicate your level of engagement. All materials will be presented online. The expected average time to complete the study is between 40 and 60 minutes (although some may take less or more time).

POTENTIAL RISKS
There are no foreseeable risks involved with participation in this study.

POTENTIAL BENEFITS
By participating in this study you may help contribute to generalizable knowledge regarding individual differences.

COMPENSATION
You can earn up to 1 hour credit toward your course requirement in Psychology 1.
To receive full credit (1 hour) you must complete all questionnaires and answer most every question honestly. You will only receive partial credit if your responses demonstrate a genuine lack of attention and/or effort.

CONFIDENTIALITY
All questionnaires have no direct identifying questions on them. Awarded course credit will not be associated with any identifiable information.

PARTICIPANT RIGHTS
Your participation in this study is completely voluntary. You can refuse to participate in the entire study or any part of the study without any negative effect on your relations with San Jose State University. You also have the right to skip any question you do not wish to answer. This consent form is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You will not waive any rights if you choose not to participate, and you will only receive partial credit for partial participation.

QUESTIONS OR PROBLEMS
You are encouraged to ask questions at any time during this study.

- For further information about the study, please contact Professor Gregory J. Feist at 408-924-5617 or greg.feist@sjsu.edu
- Complaints about the research may be presented to Dr. Clifton Oyamot, Chair of the Psychology Department at 408-924-5600.
- For questions about participants' rights or if you feel you have been harmed in any way by your participation in this study, please contact **Dr. Richard Mocarski,** Associate **Vice President for Research**, San Jose State University, at 408-924-2479 or irb@sjsu.edu

CONSENT
Clicking "SUBMIT" indicates that you voluntarily agree to be a part of the study, that the details of the study have been explained to you, that you have been given time to read this document, and that your questions have been answered.

If you have read and agree to the conditions in this consent page, please click "SUBMIT" to continue to the online questionnaires.

SUBMIT

[MTurk Recruitment Material] - Instructions/Description

Complete questionnaires and read two short texts online for $5.00 compensation. We would like you to complete eight short questionnaires online concerning thinking styles and knowledge with confidence regarding topics of genetically modified foods and vaccination/vaccines, as well as read two short texts, which will take a total of about 40 to 60 minutes to complete. To receive full compensation, you must complete all questionnaires, answering most every question honestly, and submit the HIT for review. Your submitted task will be rejected and you will not be compensated for duplicate or fraudulent responses, or responses which demonstrate a genuine lack of attention and/or effort.

REQUEST FOR YOUR PARTICIPATION IN RESEARCH

TITLE OF THE STUDY

Thinking Style, Conspiracy Belief, and the Role of the Dunning-Kruger Effect in Modeling Belief Change

NAME OF THE RESEARCHER

Professor Gregory J. Feist, PhD
Lucas Cusano, Research Assistant, candidate for MA in Psychology.

PURPOSE

The purpose of this study is to establish models of individual differences which may account for a propensity for conceptual change.

PROCEURES

Should you agree to participate, you will be asked to rate how much you agree or disagree with a series of statements. You will also be given two short texts to read and asked to indicate your level of engagement. All materials will be presented online. The expected average time to complete the study is 40 minutes (although some may take less or more time).

POTENTIAL RISKS

There are no foreseeable risks involved with participation in this study.

POTENTIAL BENEFITS

By participating in this study you may help contribute to generalizable knowledge regarding individual differences.

COMPENSATION

You can earn up to $5.00 in compensation if you complete all questionnaires and submit the human intelligence task (HIT) for review. Upon review, if most every item has been responded to and responses do not demonstrate a genuine lack of attention and/or effort, you will receive full compensation.

CONFIDENTIALITY
All questionnaires have no direct identifying questions on them and compensation for participation in this study will not be associated with any identifiable information.

PARTICIPANT RIGHTS
Your participation in this study is completely voluntary. You can refuse to participate in the entire study or any part of the study without any negative effect on your relations with the researcher. You also have the right to skip any question you do not wish to answer. This consent form is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You will not waive any rights if you choose not to participate.

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CONSENT
Clicking "SUBMIT" indicates that you voluntarily agree to be a part of the study, that the details of the study have been explained to you, that you have been given time to read this document, and that your questions have been answered.

If you have read and agree to the conditions in this consent page, please click "SUBMIT" to continue to the questionnaires, or "DECLINE" to exit this study.

SUBMIT DECLINE