Effect of Religiosity on the Conjunction Fallacy

Jordan M. Navarro

Department of Cognitive Science, Carleton College

CGSC 400

Dr. Jason Decker

April 18, 2022

Abstract

This paper is an examination of the published literature that is centered around the conjunction fallacy, religiosity, and the relationship between them based on various books and journal articles. Both the conjunction fallacy and religiosity continue to be relevant in the current literature, yet they are more often explored separately than collectively. This paper examines both these topics in a more collective manner by discussing results obtained from research conducted across various disciplines, including cognitive science, philosophy, psychology, and theology. There are 18 items included in this review, and the period of time it covers spans from 1977 to 2021. Consideration of the included literature demonstrates that there is much contention with regard to the effect of religiosity on the conjunction fallacy—that is to say, some articles indicate that religiosity leads people to being more likely to commit conjunction errors, whereas other articles indicate the very opposite—that there is no difference, in terms of likelihood to commit conjunction errors, between those who are religious and those who are not. Additionally, this paper explores the relationship between religiosity and intuitive thinking, the dual-process theory, and articles pertaining to human reasoning ability more generally.

Keywords: conjunction fallacy, human reasoning, religiosity

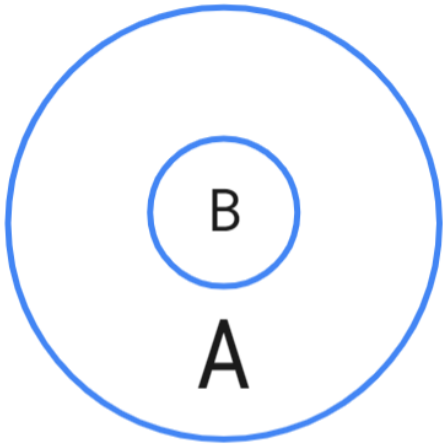
Effect of Religiosity on the Conjunction Fallacy

Probability is the branch of mathematics concerned with numerical descriptions with regard to how likely some event is to occur, or how likely it is that some proposition is true. The probability of an event is expressed as a real number between 0 and 1, where 0 indicates impossibility of the event and 1 indicates certainty. An event with a higher probability is more likely to occur than one whose probability is lower. For example, suppose that you are flipping a fair (unbiased) coin. Since the coin is fair, the two possible outcomes ("heads" and "tails") are both equally probable. And since no other outcomes are possible, the probability of the coin landing on heads is 50% and the probability of the coin landing on tails is also 50%.

One of the most fundamental laws of probability is the extension rule (Tversky & Kahneman, 1983). The probability of an event A may be written as $P(A)$. An extension of some event is a set that includes all the possible outcomes of that event. So if the extension of event A includes the extension of event B (that is, $\text{Ext}(A) \supset \text{Ext}(B)$), then the probability of event A will necessarily be greater than or equal to the probability of event B (that is, $P(A) \geq P(B)$) (see Figure 1). Tversky and Kahneman (1983) write, "Because the set of possibilities associated with a conjunction [$A\&B$] is included in the set of possibilities associated with [event] [B], the same principle can also be expressed by the conjunction rule [$P(A\&B) \leq P(B)$ (or $P(A\&B) \leq P(A)$)]" (p. 294). That is, a conjunction cannot be more probable than one of its constituents (Tversky & Kahneman, 1983).

Figure 1

Extension Rule in Probability Theory



Note. Because all the possible outcomes of event *B* (that is, the extension of event *B*) are fully contained within all the possible outcomes of event *A* (that is, the extension of event *A*), it is impossible for event *B* to obtain without event *A* obtaining. It follows then that the probability of event *A* will necessarily be greater than or equal to the probability of event *B*. Own work.

In the last couple of decades cognitive psychologists have shown that, in certain contexts, people tend to reason in ways that violate standard rules of logic and probability theory (Gilovich et al., 2002; Hastie & Dawes, 2001; Samuels et al., 2002, as cited in Moro, 2009). However, it is not clear how we should interpret these results and the criteria which we use to assess people's performance are not straightforward matters. As a result, these issues have led to various debates among both psychologists and philosophers (Adler, 1984, 1991; Cohen, 1981, 1982; Gigerenzer, 1996; Kahneman & Tversky, 1996; Samuels & Stick, 2004, as cited in Moro, 2009).

In this paper I will focus on a particular error people seem especially prone to commit that is centered around conjunctions; the tendency to commit this error is known as "the

conjunction fallacy". The conjunction fallacy occurs when one judges a conjunction (for example, "A and B") to be more probable than one of its conjuncts (either "A" or "B"). Perhaps the most notable instance of this fallacy is the Linda problem, where the following puzzle is considered:

> Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. [Which of the two alternatives is more probable?]
>
> [(a)] Linda is a bank teller. (T)
>
> [(b)] Linda is a bank teller and is active in the feminist movement. (T&F)
>
> (Tversky & Kahneman, 1983, pp. 297, 299)

Most people (85%) who are presented with this puzzle indicate that the conjunction (b) is more probable than the single event (a), despite the fact that this violates the conjunction rule in probability theory: the probability of a conjunction cannot exceed the probability of any of its conjuncts (see Figure 2) (Moro, 2009; Tversky & Kahneman, 1983). Moro (2009) justified this as follows:

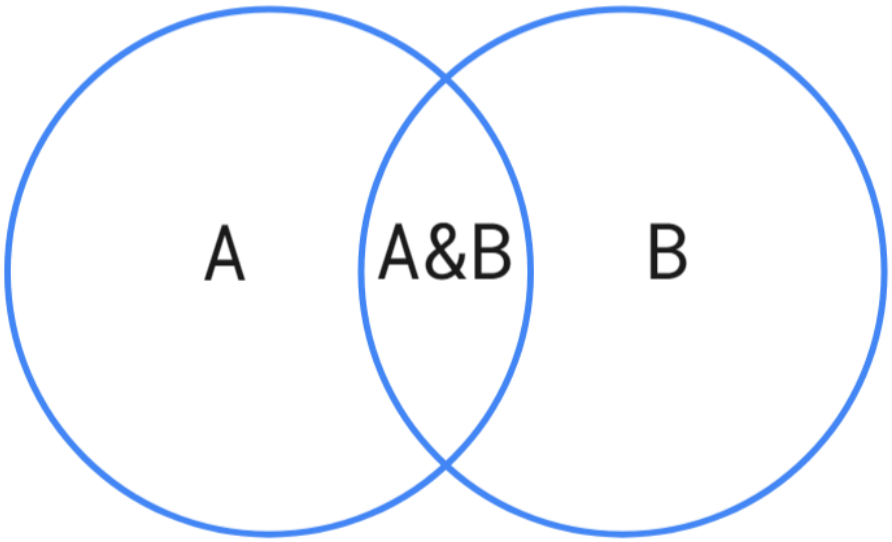
> If event (b) (in symbols, [T]&F) occurs, then, necessarily, event (a) (in symbols, [T]) will occur as well, that is, if Linda is a feminist bank teller, necessarily, she will be a bank teller. But event (a) may occur without (b) occurring, that is, Linda may be a non-feminist bank teller. Thus, (b) can never be more likely to occur than (a). (p. 2)

Through this research, the existence of the conjunction fallacy became widely recognized. But that does not mean that there are no longer any interesting questions to explore. One such question is whether the tendency to commit conjunction errors is uniformly spread throughout

the general population or if there are any specific factors that might make certain population groups more or less susceptible to the conjunction fallacy. And while there are a myriad of factors that could potentially be explored with regard to the conjunction fallacy, I will focus on religiosity for the purposes of this paper.

Figure 2

Conjunction Rule in Probability Theory



Note. If the conjunction of any two events obtains, then it must be the case that at least one of its conjuncts has obtained. Indeed, while it is possible for either event *A* or event *B* to obtain without both events *A* and *B* obtaining, it is impossible for both events *A* and *B* to obtain without either event *A* or event *B* obtaining. It follows then that the probability of both events *A* and *B* obtaining together cannot exceed the probability of either event *A* or event *B* obtaining individually. Own work.

Kahneman (2011) discusses two modes of thought, namely System 1 and System 2, to describe the two different thought processes people go through when making decisions; this is known as the "dual-process theory". The foundations of dual-process theory likely comes from William James, an American philosopher, historian, and psychologist, and the first educator to offer a psychology course in the United States. James distinguished between two ways of knowing things (Weed, 2008). Weed (2008) writes:

> one could know something intuitively, in direct experience, as one sees a paper or a desk that is immediately before one's eyes, which he described as "an all around embracing" of the object by thought, or one could know through "an outer chain of physical or mental intermediaries connecting thought and thing," as westerners know Indian tigers. (p. 3)

James understood the intuitive form of knowledge as direct apprehension that was unmediated by anything, and truth for intuitive knowledge was a matter of awareness of one's direct experiences (Weed, 2008). In contrast, knowledge in the other sense was more representational. That is, one could only know that a belief was true if they arrived at it based on a context that the world would have to supply (Weed, 2008). For James, the intuitive form of knowledge is what could allow people to overcome unprecedented situations, whereas the representational form of knowledge derived its contents only from past experiences—describing it as "only reproductive".

System 1 is often described as a reflex system in the sense that it is fast, intuitive, and emotional (Kahneman, 2011). Its operations can be characterized as an automated mode of thinking. Tay et al. (2016) write, "It is generated without much conscious effort and channels the available information through a subconscious pattern recognition based on similar past situations…this is often described as the 'gut feeling'." (Hogarth, 2001; Hogarth, 2005, p. e98) System 1 comes into effect when we address problems that we have significant prior experience

with, when we address problems that seemingly require little to no mental effort to solve, and when we are under time constraints (Tay et al., 2016).

In contrast, System 2 is the slower, more analytical, more logical side to the thinking process (Kahneman, 2011). Its operations can be characterized as careful procedures which incorporate logical judgment and mental searches for additional information based on prior learning and experience (Tay et al., 2016). While it is indeed much slower and more cognitively demanding than System 1, System 2 is more likely to lead to better decisions being made (Tay et al., 2016). Tay et al. (2016) write, "The analytical system is engaged usually when there is uncertainty, complexity, or the outcomes give little room for error but there is time to think." (Croskerry, 2008; Moulton et al., 2007, p. e98)

That said, System 2 is *lazy*. Instead of it being the case that System 2 evaluates problems which immediately appear simplistic, System 1 will operate unopposed, even at the cost of arriving at a correct answer—System 2 is *that* much more inclined to not emerge until absolutely necessary (Kahneman, 2011). Although System 1 is more likely to lead to incorrect assessments being made than System 2, the fast and frugal heuristics which it is packaged with are generally useful, and this is why we rely on it more immediately than System 2.

In the Linda problem people are given a representative description of a fictitious person named Linda and asked to evaluate whether a conjunction used to describe her is more or less probable than one of its conjuncts. In accordance with both the conjunction and extension rules in probability theory, we would expect them to arrive at the conclusion that the option containing only one of the conjuncts is more probable. But, again, 85% of people did not arrive at this conclusion. Tversky and Kahneman (1983) argue that most people get this problem wrong because they rely on a heuristic procedure known as "representativeness" when making

probability judgments. The option containing the conjunction seems more representative of Linda because it offers a seemingly higher-quality description of the sort of person that Linda *would* be if she was deeply concerned with issues of discrimination and social justice and participated in anti-nuclear demonstrations. However, the representativeness of some description has no bearing on the probabilities of particular alternatives, so the option containing the conjunction should still be attributed a lower probability than the option containing only one of its conjuncts.

Representativeness is an assessment of the degree of correspondence between an outcome and a model (Tversky & Kahneman, 1983). Referring back to the fair coin example, one might empirically investigate representativeness by asking people which of two sequences of heads and tails is more representative of a fair coin. Tversky and Kahneman (1983) comment on the directionality of this relation more generally:

> It is natural to describe a sample as more or less representative of its parent population or a species (e.g., robin, penguin) as more or less representative of a superordinate category (e.g., bird). It is awkward to describe a population as representative of a sample or a category as representative of an instance. (p. 296)

That is, it would make little sense to say that some larger, more general group is representative of a smaller, more specific group to which it is related, as the smaller group necessarily partially constitutes that larger group. Instead, it makes much more sense to describe the smaller group as more or less representative of the larger group, as the larger group is the entire group from which the smaller group is derived. The Linda problem can be understood as a scenario where a representative description attempts to show that a category (either that Linda is a bank teller or that Linda is a bank teller and is active in the feminist movement) is representative of various

instances (these include the qualities attributed to her, her major, how she felt about particular issues as a student, and what she did about them). In consideration of my previous explanation, it should be apparent by now that it does not make sense to attribute a greater probability to a particular category on the basis of the perceived degree of correspondence it has in relation to particular instances.

Tversky and Kahneman (1983) write, "When the model and the outcomes are described in the same terms, representativeness is reducible to similarity." (p. 296) Similarity between two or more things is what leads people to make judgments with representativeness in mind instead of making valid probability judgments, and, more pertinently, System 1 is what allows us to erroneously reason in this manner more generally. As we have already discussed, one of the situations where System 1 comes into effect is when we address problems that seemingly require little to no mental effort to solve, and the Linda problem is a prime example of this. Clearly, then, the automatic System 1 manages to make us much more susceptible to the conjunction fallacy than if we were to primarily rely on the more analytical System 2.

Holdcroft (2006) determined that religiosity is a complex concept and difficult to define for two reasons. The first reason is that the English language is incredibly imprecise (Holdcroft, 2006). By this, I take it she means that the flexibility in meaning to words and phrases leaves much room for interpretation, and this allows every person to experience language in a very different way. Holdcroft (2006) writes, "Colloquially, in *Roget's Thesaurus* (Lewis, 1978), religiosity is found to be synonymous with such terms as religiousness, orthodoxy, faith, belief, piousness, devotion, and holiness." (p. 89) Indeed, the fact that religiosity can be interpreted in all these different ways showcases that the impreciseness of the English language can inhibit our understanding of words and phrases more generally. But impreciseness does not only affect our

interpretations of various words and phrases; it also affects the ways in which we judge probabilistic assertions.

Balance Legal Capital LLP (2018) conducted a survey of 250 people who were asked to assess probabilistic phrases, such as “near certainty” and “significant likelihood”, for their percentage chance of success (see Appendix). Rothkopf (2018) found that there was substantial variability in terms of the way that probabilistic phrases are interpreted. He writes, “The phrases ‘*significant likelihood*’, ‘*serious possibility*’ and ‘*reasonably arguable*’ showed the largest variance between respondents, making them the phrases most likely to lead to confusion in legal advice.” (Rothkopf, 2018, para. 9) These results suggest that there is little use in legal advice as commonly expressed simply because both lawyers and clients interpret it in noticeably different ways. And if people attribute widely different probabilities to phrases which seemingly call for similar judgments, then it should not be surprising that people struggle with assessing probabilities more generally.

Holdcroft (2006) also noted that interest in religiosity could be found across several academic disciplines and that each approaches religiosity in a different way (Cardwell, 1980; Demerath & Hammond, 1969, as cited in Holdcroft, 2006). For example, theologians might address religiosity from the viewpoint of faith, religious educators might address it based on belief and orthodoxy, psychologists might decide to focus on devotion, holiness, and piousness, and sociologists might consider belief acceptance, church attendance, church membership, doctrinal knowledge, and living the faith (Cardwell, 1980; Groome, 1998; Groome & Corso, 1999, as cited in Holdcroft, 2006). Indeed, the fact that religiosity is understood differently across academic disciplines suggests that there is no clear definition of it to which we can appeal. For the purposes of this paper, I consider religiosity to be a function of both a person’s general

tendency to commit themselves to religious beliefs and their inclination to resign to faith-based beliefs or belief systems instead of belief systems where evidence is of paramount importance. Although this definition might initially seem too broad to be applicable in any particular context, it fits very well in consideration of the articles subsequently explored.

Shenhav et al. (2012) found a link between religiosity and intuitive thinking. As we have already discussed, intuitive thinking is characterized by going with one's first instinct and quickly reaching decisions based on automatic cognitive processes (Kahneman, 2011; Shenhav et al., 2012). Bargh (1989) defined an automatic cognitive process as a type of cognitive processing which is "*unintentional*, *involuntary*, *effortless* (i.e., not consumptive of limited processing capacity), *autonomous*, and *occurring outside awareness*" (p. 3). This is important to note because there might be a relationship between susceptibility to the conjunction fallacy and intuitive thinking.

Lu (2015) tested a prediction of Seymour Epstein's integrative theory of personality, known as "cognitive-experiential self-theory" (CEST), that suggests that people with an experiential-intuitive cognitive style are more likely to commit conjunction errors than those with an analytical-rational cognitive style, and he tested this prediction using a revised Linda problem derived from Tversky and Kahneman (1983). Lu (2015) investigated the Linda problem in four variations (groups), and participants assessed various affirmative events and their respective conjunctions according to which group they were assigned (see Table 1). He found that rational and experiential cognitive styles did not influence the propensity for committing the conjunction fallacy in a way that was statistically significant, and this is contrary to what the CEST would predict (Lu, 2015). These results suggest that people who are characterized by an

analytical-rational cognitive style are not more inclined to adhere to the extension rule in probability theory than those who are characterized by an experiential-intuitive cognitive style.

Previous studies have shown that belief in non-theistic paranormal phenomena is positively associated with error rates in probabilistic reasoning (French & Stone, 2014; Irwin, 2009; Rogers, 2015; Wiseman & Watt, 2006, as cited in Rogers et al., 2018). Rogers et al. (2018) examined the extent to which belief in extrasensory perception (ESP), psychokinesis (PK) or life after death (LAD), plus need for cognition (NFC) and faith in intuition (FI), predict one's propensity for committing confirmatory conjunction errors. They had participants complete 16 confirmatory conjunction problems and, as a result of the study, arrived at three conclusions (Rogers et al., 2018). First, stronger paranormal belief was associated with committing 1.32 (as related to ESP), 3.16 (PK), or 1.27 (LAD) times more conjunction errors, respectively, and this supports previous claims that those who believe in paranormal phenomena are particularly susceptible to the conjunction fallacy (Brotherton & French, 2014; Dagnall et al., 2016; Prike et al., 2017; Rogers et al., 2009, 2011, 2016, 2017, as cited in Rogers et al., 2018). Second, those who believed in paranormal phenomena made a similar amount of conjunction errors regardless of whether the problem depicted a paranormal event or a non-paranormal one (Rogers et al., 2018). Third, those who believed in paranormal phenomena more strongly demonstrated more extreme confirmatory conjunction biases than those who were relatively skeptical of paranormal claims (Rogers et al., 2018). These results suggest that, more generally, believers of paranormal phenomena are more susceptible to the conjunction fallacy.

Bakhti (2018) examined the effects of religious priming, compared with reflective priming and neutral priming, on susceptibility to the conjunction fallacy. Priming occurs when a person's exposure to a certain stimulus influences his or her response to a subsequent stimulus,

without any awareness of the connection. In Bakhti's (2018) study, participants were randomly assigned to one of the three priming conditions, and priming occurred via a scrambled sentence task where participants had to rearrange words that were either religious (for example, "pray"), reflective (for example, "reason"), or neutral (for example, "paper") in terms of its content. After participants completed the scrambled sentence task (which contained a total of 10 sentences), they responded to a question assessing for the conjunction fallacy and a religiosity questionnaire (Bakhti, 2018). Bakhti (2018) writes, "The priming effect was expected to last [the duration of the conjunction fallacy question] because previous studies have shown that long-term semantic priming is effective after an 8-item lag between prime and target word" (Becker et al., 1997, as cited in Bakhti, 2018) (p. 188). Bakhti (2018) found that participants who had undergone the religious prime were significantly more likely to succumb to the conjunction fallacy, compared with those who had undergone the reflective priming condition. While these results clearly show that people who are under the effects of some religious stimulus are more likely to commit conjunction errors, it does not say much about people whose religious beliefs are more stable.

Wabnegger et al. (2021) examined the relationship between specific beliefs (belief in conspiracy theories, religiosity) and the susceptibility to conjunction errors in specific domains. In their experiment, participants were presented with scenarios related to COVID-19 conspiracies, miraculous healings, and situations found in daily life (control condition), and each scenario included one statement about a single event and a second statement about a conjunction of two events co-occurring (Wabnegger et al., 2021). Wabnegger et al. (2021) hypothesized both that the belief in conspiracy theories would be positively associated with the susceptibility to conjunction errors in the COVID-19 conspiracy-related scenarios and that general religiosity would be positively associated with the susceptibility to conjunction errors in the scenarios

describing miraculous healings. Belief in conspiracy theories was measured using the Generic Conspiracist Beliefs Scale (GCB) (Brotherton et al., 2013), which measures the susceptibility to believe in conspiracy theories using 15 items, such as "Certain celebrities and/or public figures actually faked their own deaths in order to escape the spotlight" and "The government has employed people in secret to assassinate others", rated on a five-point Likert-type scale, where 1 indicates that a particular statement is definitely not true and 5 indicates that it is definitely true (see Table 2) (Wabnegger et al., 2021). General religiosity was measured using the general religiosity subscale of the multidimensional instrument for the measurement of religious-spiritual well-being (MI-RSWB 48) (Unterrainer et al., 2010, as cited in Wabnegger et al., 2021), which uses 8 items, such as "My faith gives me a feeling of security." and "It is possible for me to find contentment in intimate conversations with God." and has it that items are rated on a six-point Likert-type scale, where 1 indicates that a person strongly disagrees with a particular statement and 6 indicates that they strongly agree (see Table 3 for an English version of the general religiosity subscale of the MI-RSWB 48) (Unterrainer et al., 2012; Wabnegger et al., 2021). They found that the number of conjunction errors committed in the domain related to COVID-19 conspiracies was only associated with the belief in conspiracy theories, whereas the number of conjunction errors committed in the domain describing miraculous healings was only associated with general religiosity (Wabnegger et al., 2021). Additionally, there was no association between the assessed beliefs and conjunction errors committed in the control condition. These results suggest that susceptibility to the conjunction fallacy is domain-specific and that it might *not* be valid to assert that religiosity makes one more susceptible to the conjunction fallacy more generally.

Park (2007) codified both religion and spirituality as a *meaning system* consisting of cognitive, motivational, and affective components, and these components are reflected in a person's global beliefs, global goals, and a sense of meaning or purpose (Park, 2005; Reker & Wong, 1988, as cited in Park, 2007). Under this view, both religion and spirituality can act as a significant constituent through which people interpret, evaluate, and respond to their experiences and encounters. Park (2007) suggests that understanding both religiousness and spirituality in this way allows for a more clear portrayal of the various pathways through which both may influence psychological and physical health, and these pathways include a sense of meaning and purpose that religion can provide; social support; attributing scared qualities to an object or goal; people's perceptions of the extent to which various forces, including themselves, people who are more powerful than them, chance, and God; health behaviors and lifestyle; appreciation for life; and the experiencing of affect or stress. Unfortunately, there is not much existing empirical research that explicitly tests the theories considering both religion and spirituality as a meaning system. Park (2007) writes, "For many of the pathways, suggestive data on the linkages between [both religion and spirituality], the psychosocial mediators, and the physical health outcomes is available, but few studies have actually tested the pathways that have been proposed." (p. 325) But based on everything we have discussed thus far, thinking about both religion and spirituality in terms of a meaning system seems considerably important with regard to understanding what differentiates the ways religious and nonreligious people reason and arrive at conclusions.

But Mahoney and DeMonbreun (1977) compared the problem-solving skills of 30 Ph.D. scientists to those of 15 conservative Protestant ministers. During the experiment, participants were informed that their task was to derive a simple relational rule, where the sequence "2, 4, 6" sufficed as an example of what the rule could generate (Mahoney & DeMonbreun, 1977). They

were instructed to generate other triads of numbers to test their hypotheses about the rule (Mahoney & DeMonbreun, 1977). The experimenter would inform the participants about whether their triads conformed to the rule (Mahoney & DeMonbreun, 1977). Participants were allowed to declare their hypothesis when they felt confident in its accuracy, but if their hypothesis was incorrect, then they were instructed to continue attempting to derive the rule (Mahoney & DeMonbreun, 1977). The task proceeded until the participants either derived the correct rule, the participants gave up on deriving the rule, or when 10 minutes had passed (Mahoney & DeMonbreun, 1977). Contrary to popular assumption, the difference between the reasoning skills of the scientists and the nonscientists was not significant. Initially, this would seem to contradict both the results of Bakhti's (2018) study and the results of Rogers et al.'s (2018) study, but those two studies focused particularly on the conjunction fallacy instead of reasoning skills more generally. With regard to what Park (2007) found, it seems to be the case that, while it can give color to people's experiences and their interpretations of them, being religious might not result in any change in one's ability to reason sufficiently.

So if there does turn out to be a relationship between religiosity and the conjunction fallacy, is there a reason to think that the reason has something to do with religiosity's relationship to the representativeness heuristic? As Shenhav et al. (2012) has already shown, there does appear to be a link between religiosity and intuitive thinking. And while the representativeness heuristic is also associated with intuitive thinking, they are only related in the sense that appealing to the heuristic goes against what one would expect people to do in accordance with both the conjunction and extension rules in probability theory. That is, to arrive at the conclusion that 85% of people did when they were asked for their response pertaining to the Linda problem would necessarily mean that these people violated standard rules of logic and

probability theory in favor of appealing to the representativeness heuristic (Tversky & Kahneman, 1983).

It seems obvious then to suggest that intuition underlies any possible relationship between religiosity and the representativeness heuristic, but, again, Lu (2015) found that those who were characterized better by an analytical-rational cognitive style were not more inclined to adhere to the rules of probability theory that we are concerned with than those who were characterized better by an experiential-intuitive cognitive style—that is to say, variance in cognitive style did not yield any significant differences in terms of likelihood to commit conjunction errors. Even further, with Wabnegger et al. (2021) showing that susceptibility to the conjunction fallacy might be domain-specific, it might only be valid to assert that religiosity could affect responses to problems such as the Linda problem where the content of the representative description is clearly religious in nature. This would have it be the case that nothing about any sort of relationship between religiosity and the representativeness heuristic could be inferred from the fact that so many people arrived at the conclusion that, in the Linda problem, the conjunction is more probable than the single event. After all, the Linda problem makes no explicit mention of religion and there does not seem to be an obvious, or even tangential, connection between the problem and religiosity.

None of this suggests that Tversky and Kahneman (1983) are mistaken in their belief that the representativeness heuristic is the reason that most people arrive at the wrong conclusion about the Linda problem. Instead, it suggests that religiosity and the representativeness heuristic might just have different effects with regard to the conjunction fallacy. Religiosity's effect on the conjunction fallacy seems considerably debatable, whereas the representativeness heuristic's effect on the conjunction fallacy seems much more apparent. Tversky and Kahneman (1983)

argue that intuitive judgments of all sorts, when they are concerned with probabilities, are not likely to be logical or consistent, that is they will fail to satisfy the constraints of probability theory. However, in consideration of the articles explored throughout this paper, it does not seem to be the case that Tversky and Kahneman's (1983) claim entails that the intuition that characterizes religiosity leads to those who are religious committing more conjunction errors.

The findings that I have examined throughout this paper suggest that there is much contention with regard to the effect of religiosity on the conjunction fallacy. While some articles indicate that religiosity (or, at least, a religious prime) leads people to being more likely to commit conjunction errors, other articles indicate the very opposite—that there is no difference, in terms of likelihood to commit conjunction errors, between those who are religious and those who are not. Additionally, there does seem to be a relationship between religiosity and intuitive thinking, but again it is contentious with regard to whether intuitive thinking leads people to being more likely to commit conjunction errors. What we can say for certain is that all of us are equally affected in terms of what the dual-process theory predicts—that is, no matter our religious status, we all deal with the processes entailed by System 1 and System 2. And related articles suppose that, while they might take on a different perspective of their environment, religious people reason just as effectively as those who are nonreligious. Exploring this research topic allowed me to appreciate the interdisciplinary nature of cognitive science and, in particular, the relations between cognitive science, philosophy, psychology, and theology. This paper should have satisfactorily accounted for the various results that have been obtained about the effect of religiosity on the conjunction fallacy.

References

Bakhti, R. (2018). Religious versus reflective priming and susceptibility to the conjunction fallacy. *Applied Cognitive Psychology*, *32*(2), 186–191. https://doi.org/10.1002/acp.3394

Balance Legal Capital LLP. (2018). Litigation superforecasting survey. https://www.balancelegalcapital.com/litigation-superforecasting-survey/

Bargh, J. A. (1989). Conditional automaticity: Varieties of automatic influence in social perception and cognition. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 3–51). The Guilford Press.

Brotherton, R., French, C. C., & Pickering, A. D. (2013). Measuring belief in conspiracy theories: The generic conspiracist beliefs scale. *Frontiers in Psychology*, *4*, 1–15. https://doi.org/10.3389/fpsyg.2013.00279

Holdcroft, B. B. (2006). What is religiosity? *Journal of Catholic Education*, *10*(1), 89–103. https://doi.org/10.15365/joce.1001082013

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Lu, Y. (2015). Is experiential-intuitive cognitive style more inclined to err on conjunction fallacy than analytical-rational cognitive style? *Frontiers in Psychology*, *6*, 1–8. https://doi.org/10.3389/fpsyg.2015.00085

Mahoney, M. J., & DeMonbreun, B. G. (1977). Psychology of the scientist: An analysis of problem-solving bias. *Cognitive Therapy and Research*, *1*(3), 229–238. https://doi.org/10.1007/bf01186796

Moro, R. (2009). On the nature of the conjunction fallacy. *Synthese*, *171*(1), 1–24. https://doi.org/10.1007/s11229-008-9377-8

Park, C. L. (2007). Religiousness/spirituality and health: A meaning systems perspective. *Journal of Behavioral Medicine*, *30*(4), 319–328. https://doi.org/10.1007/s10865-007-9111-x

Rogers, P., Fisk, J. E., & Lowrie, E. (2018). Paranormal belief, thinking style preference and susceptibility to confirmatory conjunction errors. *Consciousness and Cognition*, *65*, 182–196. https://doi.org/10.1016/j.concog.2018.07.013

Rothkopf, R. (2018, November 23). *Litigation superforecasting survey results part 1: BLC*. Balance Legal Capital - litigation and arbitration finance. Retrieved from https://www.balancelegalcapital.com/litigation-superforecasting-miscommunication/

Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: Cognitive style influences belief in God. *Journal of Experimental Psychology: General*, *141*(3), 423–428. https://doi.org/10.1037/a0025391

Tay, S. W., Ryan, P. M., & Ryan, C. A. (2016). Systems 1 and 2 thinking processes and cognitive reflection testing in medical students. *Canadian Medical Education Journal*, *7*(2), e97–e103. https://doi.org/10.36834/cmej.36777

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review*, *90*(4), 293–315. https://doi.org/10.1037/0033-295x.90.4.293

Unterrainer, H.-F., Nelson, O., Collicutt, J., & Fink, A. (2012). The English version of the multidimensional inventory for religious/spiritual well-being (MI-RSWB-E): First results from British college students. *Religions*, *3*(3), 588–599. https://doi.org/10.3390/rel3030588

Wabnegger, A., Gremsl, A., & Schienle, A. (2021). The association between the belief in coronavirus conspiracy theories, miracles, and the susceptibility to conjunction fallacy. *Applied Cognitive Psychology*, *35*(5), 1344–1348. https://doi.org/10.1002/acp.3860

Weed, L. E. (2008). The concept of truth that matters. *William James Studies*, *3*, 1–24. https://www.jstor.org/stable/26203716

Table 1

Means and Median Probability Estimates in the Experiment

	Probability Estimates	
Items[a]	**Mean (%)**[b]	**Median (%)**
Group 1 (*N* = 104[c])		
Linda is a bank teller. (*T*)	13.3 (1.2)	10
Linda is active in the feminist movement. (*F*)	78.1 (1.8)	80
Linda takes Yoga classes. (*Y*)	42.0 (2.2)	50
Linda is a teacher in elementary school. (*P*)	17.7 (1.5)	15
Linda is a bank teller and is active in the feminist movement. ($T \wedge F$)	**30.2 (2.5)**	30
Linda takes Yoga classes and is a teacher in elementary school. ($Y \wedge P$)	**22.3 (2.1)**	15.5
Group 2 (*N* = 37)		
Linda is a bank teller. (*T*)	32.2 (4.2)	30
Linda is active in the feminist movement. (*F*)	67.5 (3.8)	70
Linda is an executive. (*D*)	39.9 (4.3)	40
Linda subscribes to a popular liberal magazine. (*M*)	72.0 (3.8)	80
Linda is a bank teller and is active in the feminist movement. ($T \wedge F$)	**38.6 (4.2)**	40
Linda is an executive and subscribes to a popular liberal magazine. ($D \wedge M$)	**49.8 (4.1)**	50
Group 3 (*N* = 41)		

Linda is an avid reader. (*R*)	72.1 (2.8)	80
Linda is active in the feminist movement. (*F*)	72.2 (2.9)	80
Linda is an executive. (*D*)	40.0 (3.0)	40
Linda subscribes to a popular liberal magazine. (*M*)	68.6 (3.5)	75
Linda is an avid reader and is active in the feminist movement. ($R \wedge F$)	**66.9 (3.1)**	70
Linda is an executive and subscribes to a popular liberal magazine. ($D \wedge M$)	**44.5 (3.3)**	50
Group 4 (*N* = 42)		
Linda is a bank teller. (*T*)	24.3 (3.2)	20
Linda is very shy. (*S*)	11.7 (2.3)	7
Linda is a teacher in elementary school. (*P*)	43.7 (4.5)	50
Linda is active in crafts like needlepoint. (*C*)	31.2 (3.7)	20
Linda is a bank teller and is very shy. ($T \wedge S$)	**15.2 (2.8)**	10
Linda is a teacher in elementary school and is active in crafts like needlepoint. ($P \wedge C$)	**31.4 (3.6)**	30

Note. This table shows the means and median probability estimates of affirmative events and their respective conjunctions. From *Is experiential-intuitive cognitive style more inclined to err on conjunction fallacy than analytical-rational cognitive style?* (p. 4), by Y. Lu, 2015, Lausanne, Switzerland: Frontiers Media SA. Copyright 2015 by Lu.

[a] In the version given to participants, the labels P, F, T, Y, R, S, M, C, D, $T \wedge F$, $Y \wedge P$, $D \wedge M$, $R \wedge F$, $T \wedge S$, and $P \wedge C$ were omitted. [b] Standard errors with 95% confidence intervals are in parentheses. Boldface indicates a significant difference, relative to the conjunctions and their corresponding unlikely constituents ($p < 0.05$). [c] There are so many more participants in Group 1 because the Experiment was conducted firstly through Group 1, however, the likelihood types of the Group 1's statements are mostly the likelihood type of "Unlikely $\wedge$ Likely" and have not enough data in relation to the types of "Likely $\wedge$ Likely" and "Unlikely $\wedge$ Unlikely."

Table 2

GCB Scale Items and Standardized Factor Loadings Obtained with Confirmatory Factor Analysis

Scale Item		Factor				
		GM	**MG**	**ET**	**PW**	**CI**
1.	The government is involved in the murder of innocent citizens and/or well-known public figures, and keeps this a secret	0.75				
6.	The government permits or perpetrates acts of terrorism on its own soil, disguising its involvement	0.86				
11.	The government uses people as patsies to hide its involvement in	0.82				

	criminal activity		
2.	The power held by heads of state is second to that of small unknown groups who really control world politics	0.77	
7.	A small, secret group of people is responsible for making all major world decisions, such as going to war	0.83	
12.	Certain significant events have been the result of the activity of a small group who secretly manipulate world events	0.91	
3.	Secret organizations		0.75

	communicate with extraterrestrials, but keep this fact from the public			
8.	Evidence of alien contact is being concealed from the public	0.87		
13.	Some UFO sightings and rumors are planned or staged in order to distract the public from real alien contact	0.80		
4.	The spread of certain viruses and/or diseases is the result of the deliberate, concealed efforts of some organization		0.74	
9.	Technology with mind-control		0.69	

	capacities is used on people without their knowledge			
14.	Experiments involving new drugs or technologies are routinely carried out on the public without their knowledge or consent	0.77		
5.	Groups of scientists manipulate, fabricate, or suppress evidence in order to deceive the public			0.69
10.	New and advanced technology which would harm current industry is being suppressed			0.75
15.	A lot of important informatio			0.70

	n is deliberately concealed from the public out of self-interest

Note. This table shows GCB scale items and their respective standardized factor loadings. Factor loadings are correlation coefficients between observed variables and latent common factors. Factor loadings can also be viewed as standardized regression coefficients, or regression weights. *N = 225. GM, government malfeasance, ET, extraterrestrial cover-up, MG, malevolent global conspiracies, PW, personal wellbeing, CI, control of information.* From *Measuring belief in conspiracy theories: the generic conspiracist beliefs scale* (p. 8), by R. Brotherton, C. C. French, and A. D. Pickering, 2013, Lausanne, Switzerland: Frontiers Media SA. Copyright 2013 by Brotherton, French, and Pickering.

Table 3

General Religiosity Inventory for Religious/Spiritual Well-Being

Number	Dimension	Item
1	GR	My faith gives me a feeling of security.
7	GR	It is possible for me to find contentment in intimate conversations with God.
13	GR	I will be able to overcome all problems with God's help.
19	GR	In certain moments in my life, I feel very close to God.
25	GR	With God's help, I will be happy once again.
31	GR	I know that God is merciful.
37	GR	I enjoy attending to religious community events.
43	GR	I feel the presence of God in nature.

Note. This table shows the general religiosity inventory for religious/spiritual well-being. Number: Item number in the Questionnaire; Dimension: GR = General Religiosity. Adapted from *The English Version of the Multidimensional Inventory for Religious/Spiritual Well-Being (MI-RSWB-E): First Results from British College Students* (p. 598), by H. F. Unterrainer, O. Nelson, J. C. Mcgrath, and A. Fink, 2012, Basel, Switzerland: Multidisciplinary Digital Publishing Institute.

Appendix

Litigation Superforecasting Survey

PUT A NUMBER ON IT

- A survey by Balance Legal Capital LLP

You're a **straight-talking, no-nonsense advisor**.

What do **you** mean when you say **"significant risk"** in your advice? What do you understand when you read **"strong prospects"** in other people's assessments?

As litigation funders, we review numerous merits opinions from litigators and barristers and see little consensus around what people mean by such "probabilistic language" and how those phrases convert into a percentage. Multiple studies have shown that people attach very different meanings to these phrases. We have decided to conduct a study of our own.

We want YOU to **put a number on *probabilistic* phrases like this commonly seen in legal advice.**

It will take less than 1 minute of your time.

Participants in the survey will receive the results after the survey period closes. Results will be aggregated and anonymised.

Let's find out what our legal community really means.

Put a number on it.

For more on why "putting a number on it" is important, you might like to read this.

1. Please convert these 10 probabilistic phrases into a percentage chance of success; i.e. between 1 - 100.

Near certainty *

More likely than not *

Significant likelihood *

Fair chance *

Strong prospects *

Reasonably arguable *

Serious possibility *

Reasonable prospects *

Good prospects *

On balance *

2. What best describes your interaction or role with the legal profession? Please tick one. *

⚪ **Lawyer in a law firm** *

- ⚪ **Barrister** *
- ⚪ **In-house lawyer** *
- ⚪ **Corporate client or user of legal advice** *
- ⚪ **Accountant** *
- ⚪ **Insolvency practitioner** *
- ⚪ **Insurer** *
- ⚪ **Finance** *
- ⚪ **Other** *

3. Please enter your email address so that we can send you the results.

Email *

example@example.com (Balance Legal Capital LLP, 2018)