How Beliefs Influence Perceptions of Choices

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Abstract

People bring many beliefs to everyday decisions. Beliefs, such as those about health, can vary in both degree to which people believe them and degree to which they are correct. While prior work has found that it is difficult to correct mistaken beliefs, it has also shown that causal models may be more effective than other types of information for getting people to adopt correct information. However, it is an open question as to whether such information will change beliefs enough to influence decision-making. Through two experiments in the health domain we investigate (1) how degree of belief influences how people assess options, and (2) whether new information changes people's assessment of how reasonable those options are. Our results demonstrate the impact of incorrect beliefs on decision-making, and the difficulty of using causal models to correct these beliefs.

Keywords: decision making; beliefs; causal models

Introduction

People hold a myriad of beliefs about how the world works. From believing carrot juice can cure diabetes, to believing one vote may sway an election, to believing saving money is essential for a happy retirement, beliefs can vary in how correct or mistaken they may be. When making decisions, people begin with these existing beliefs, accumulate evidence, and update their beliefs (Usher, Tsetsos, Yu, & Lagnado, 2013; Cogley & Sargent, 2008). In everyday situations, people's existing beliefs influence how they frame decisions, determine what evidence to gather, and use the evidence to update their beliefs (Porot & Mandelbaum, 2021). Importantly, people may hold an array of incorrect beliefs that vary from mainstream (Braun et al., 2000; Boyer & Petersen, 2018) to conspiratorial in nature (Oliver & Wood, 2014b, 2014a; Norris, Garnett, & Grömping, 2020). In this paper we investigate how correct and incorrect beliefs influence decisions.

Much work has focused on the first stage of the pipeline: how to correct people's mistaken beliefs (Seifert, 2002). This has been studied extensively in the context of misinformation (Ecker et al., 2022), and whether there can be negative consequences of repeating incorrect information when debunking it (Swire-Thompson, DeGutis, & Lazer, 2020). Recent work shows that despite concerns over a "backfire effect," correcting misinformation does not make it more likely to stick (Ecker, Lewandowsky, & Chadwick, 2020). However, this only means that corrections do not exacerbate misinformation, it does not mean that such corrections are successful at reducing beliefs in incorrect information. In general, it is difficult to correct false beliefs (Nyhan & Reifler, 2010; Nyhan, Reifler, & Ubel, 2013).

A key challenge is that people can hold conflicting beliefs. Belief perseverance suggests people go to great lengths to maintain potentially incorrect beliefs (Jelalian & Miller, 1984). This does not preclude people from also believing correct information (Harmon-Jones & Mills, 2019). Rather, the discomfort induced by this conflict may instead lead people to selectively avoid information that increases dissonance (Cotton & Hieser, 1980; Orcullo & Teo, 2016). Even when people seemingly accept a correction, it may still influence their beliefs through the continued influence effect (CIE) (Johnson & Seifert, 1994; Ecker & Antonio, 2021). Once again, discomfort plays a role and has been shown to mediate continued belief in misinformation (Susmann & Wegener, 2022). This suggests that corrections leading to greater discomfort are less likely to be believed.

One potential approach to correcting misinformation is with causal models, including causal explanations of events and visual depictions such as graphical models (Danks, 2014). Research has found that causal structures are more likely to continue to be believed, and that providing a correct causal model rather than a collection of facts is more likely to displace an incorrect causal structure (Johnson & Seifert, 1994; Nyhan & Reifler, 2015). This suggests that rather than providing information as a collection of facts, presenting such information in a causal structure that provides an alternate explanation for an outcome (e.g., development of diabetes) may make it more likely to replace existing incorrect beliefs. Causal models have been explored extensively in decision-making (Sloman & Hagmayer, 2006), and have been shown to improve decisions when they are closely targeted to the decision at hand (Kleinberg & Marsh, 2021). However, prior work has not examined the relationship between pre-existing (and possibly incorrect) beliefs and causal models in the context of decisions.

In this work, we are specifically interested in how beliefs about health can be influenced. Everyday health guidance, such as about diet and exercise, generally provides information (e.g., getting 30 minutes of physical activity a few times a week can reduce the risk of diabetes) without directly ad-

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dressing people's existing beliefs (e.g., CBD oil is not an effective substitute for exercise). This is true even though providing just facts is a less effective strategy for changing incorrect beliefs (Shtulman & Valcarcel, 2012; Hake, 1998). An open question raised by prior work is how the degree of belief influences action. That is, people may have a range of beliefs of varying degrees of correctness, and may have varying degrees of belief in each (e.g., thinking carrot juice is only a possible diabetes cure versus being certain that drinking coffee cures a sore throat) (Eriksson & Hájek, 2007). Degrees of belief can be thought of as probabilities (Chater, Tenenbaum, & Yuille, 2006; Skyrms, 1980), and numerous normative theories have been developed to model how they should be used to make decisions (Slovic, Fischhoff, & Lichtenstein, 1977; Einhorn & Hogarth, 1981). However two key questions remain. One is how beliefs actually inform decisions in everyday situations where there may be complex sets of beliefs, preferences, and options, and the second is how incorrect beliefs can be eliminated or reduced to enable better decisions.

Taken together, prior work suggests that causal models can be useful for changing beliefs in misinformation, and may be useful for decision-making, but has not examined the relationship between misinformed beliefs and causal models in decision-making. Thus it is an open question as to whether causal models can change or interact with people's degree of belief, and whether they increase belief in correct information, decrease belief in incorrect information, or both. To give effective guidance to the general public about health and other topics it is critical to understand this interaction. To address this, we examine how people's beliefs influence health decisions and in particular, how they use new information to reason about health choices. In Experiment 1 we test how people's degree of belief in a variety of statements about diabetes relates to how they judge the reasonability of diabetes management and prevention options across a range of scenarios. This experiment establishes the link between beliefs and perception of choice options. In Experiment 2 we introduce new information in the form of causal models, examining how people's beliefs and new information interact in their decision-making.

Experiment 1

In Experiment 1 we investigate how health beliefs relate to health decisions. We focus on decision-making surrounding prevention and management of Type 2 diabetes (T2D) as it affects nearly 10% of the population and is thus prevalent enough for people to have beliefs about even if they do not have personal experience. Further, unlike conditions treated by something like surgery (where the treatment is overseen and undertaken by a professional), the prevention and management of T2D relies on everyday decisions made by the individual. Thus their beliefs may play a significant role and it is vital to understand how their correctness influences decision-making.

Method

Participants We recruited 300 U.S. residents ages 18-64 through Prolific. We excluded seven participants who reported difficulties using sliders in the experiment, and one participant who provided nonsensical answers (e.g., listing a year instead of a country in the demographic questionnaire). A total of 292 participants remain in analysis. They identified as 41% male, 55% female, and 4% non-binary. Participants were compensated $4.50 due to the estimated 30 minute study duration.

Materials We aimed to test how decisions related to people's endorsement of an array of health beliefs that varied in whether they were correct and what their target was. We used a set of 16 statements developed for a separate study that varied in how reasonable they are to believe and how central they are to diabetes. In this previous work, we conducted a pilot test on 32 statements to identify statements that varied in degrees of reasonableness: true statements, statements that are wrong and reasonable to believe, statements that are wrong and unreasonable to believe, and statements that are wrong and represent conspiracy theories. Statements further varied in centrality, being either central to diabetes (i.e., about causes or treatments of diabetes) or peripheral to diabetes (i.e., information unrelated to causes or treatments of diabetes or about other health conditions such as the effects of caffeine). For the purposes of this study, we are not interested in the levels of reasonableness and centrality. Rather we selected statements across these categories to test statements that varied in believability. We selected for inclusion in this study two central and two peripheral statements for each of the four reasonableness levels, for a total of 16 statements. Example statements are as follows:

- Diabetes is usually caused by a lack of insulin in the body. (*True central statement*)
- Our brains need glucose to function, and carbohydrates are a key source of glucose. (*True peripheral statement*)
- CBD oil reduces blood sugar. (*Reasonably wrong central statement*)
- Caffeine stunts kids' growth. (*Reasonably wrong peripheral statement*)
- Drinking carrot juice will cure diabetes. (*Unreasonably wrong central statement*)
- People who do insulin injections are more likely to become IV drug users. (*Unreasonably wrong peripheral statement*)
- Medications intentionally cause diabetes as a side effect so people will have to buy insulin to treat it. (*Conspiracy central statement*)
- Fluoride in drinking water is just a way for chemical companies to dump their waste into the environment. (*Conspiracy peripheral statement*)

We created a set of 16 decision-making questions representing everyday choices related to managing or preventing T2D. The scenario developed in each question was designed to correspond to one of the statements described previously. For example, for the statement "CBD oil reduces blood sugar." we presented a question about a person who is considering using CBD oil for blood sugar management. Participants were not told whether these beliefs were correct or where the people in the scenarios learned this information. To develop these decision-making questions, we used prior research on decisions individuals make while managing their diabetes (Chatterjee, Khunti, & Davies, 2017) along with prior work investigating common misconceptions about T2D (Ul Haq et al., 2015; Vluggen, Hoving, Schaper, & De Vries, 2018) to develop incorrect answer options. The questions spanned a range of choices related to T2D including choices related to diet, activity, and insulin use. The questions all described an individual and decision context, and participants were asked to judge the options for that person, rather than for themselves, to reduce the potential of receiving only socially desirable responses.

Each question presented the situation along with four options and asked participants to rate each of the options on a sliding scale from 0 (not at all reasonable) to 100 (completely reasonable). Each answer option represented a specific action to take (e.g., start doing yoga twice a week). For each question there was one option that corresponded to guidance given by public health agencies such as the Centers for Disease Control and Prevention, World Health Organization, and American Diabetes Association. For brevity, we will refer to that option as the "correct" option. The other three options instead reflected actions not supported by mainstream medicine. Importantly, one of the four options represented the target health belief statement for that question. (e.g., "Replace his regular medication with CBD oil"). We refer to this option as the "target wrong" option.[1] Below is an example of a question and answer options.

Oliver has type 2 diabetes, and his blood sugar is often high. He is trying to stick to regular mealtimes, consume more whole grains, vegetables, fruits, healthy fats (such as avocado, plant oils, nuts, fish), and take insulin when needed. Today Oliver learned that using CBD oil may help to reduce blood sugar and is considering adding it to his diet.

How reasonable are each of these options for Oliver? Rate from 0 (not at all reasonable) to 100 (completely reasonable).

(A) Replace his regular medication with CBD oil.
(B) Use non-cannabis alternative methods such as ginger shots.
(C) Use insulin to keep his blood sugar under control.
(D) Check online forums where people discuss CBD oil for diabetes.

Procedure Participants began by reading an introduction to the study and consenting to participate. Next, participants were provided with instructions on how to complete the survey. Then they were given the 16 decision-making questions and rated the reasonability of each answer option. The question and answer option order were randomized by participant. After that, participants were asked to rate the believability of all 16 statements on a scale from 0 (not at all believable) to 100 (completely believable) using sliders. The order of the statements was randomized for each participant. Finally, we collected demographic information from participants, including age, gender, education, country of birth, and race/ethnicity. The survey ended with a debrief, in which participants were informed that some of the statements they rated were false or even conspiracy theories, and were provided with links to reliable information sources about T2D. We also asked participants for any comments and whether they had experienced any technical difficulties.

Data analysis We used linear mixed modeling (LMM) to analyze our data. Our goal is to see how believability of the 16 health-related statements influenced reasonability ratings for the options related to those statements. Participants may believe a given statement to varying degrees. As such, in all analyses, we entered believability ratings as a continuous predictor of our measure of interest, reasonability, with a diagonal covariance structure. We included random intercepts at the participant level. We used an alpha of .05 for all analyses.

For the 4 true health belief statements, we would expect that finding the statement to be more believable would predict seeing the choice that aligns with that statement as more reasonable and options that do not align with that statement as less reasonable. For our options, this would mean participants should rate the target correct choice as more reasonable and the target wrong option as less reasonable. For example, imagine a person correctly believes that a fasting blood sugar level of 210 is too high. They should think an option for a person of taking insulin as instructed by the doctor that represents a correct option would be more reasonable than just waiting until blood sugar drops, which represents a target wrong option for this question.

For the 12 incorrect health belief statements, we again would expect that greater belief in a statement would make options that align with that statement seem more reasonable and options that do not seem less reasonable. In the case of the incorrect health belief statements, the target wrong option should seem more reasonable because it aligns with the statement and the correct option should be see as less reasonable. For example, if a person believes CBD oil reduces blood sugar (an incorrect statement), then they may believe that op-

[1]For the 12 incorrect health belief statements, the target wrong option was a rephrasing of the belief statement to be relevant to the given question. For the 4 true health belief statements, the target wrong option was a restatement of the true statement to make it incorrect.

tion A from the previous question example would be more reasonable than option C, the correct answer based on medical advice. To test these predictions, we analyzed reasonability ratings for true versus incorrect health belief statements separately for both the correct and target wrong options.

Results

The mean believability ratings for true and incorrect statements were ($M = 75.05, SD = 28.32$) and ($M = 21.93, SD = 26.57$) respectively. The mean reasonability ratings for target correct answer options ($M = 68.72, SD = 34.09$) and target wrong answer options ($M = 33.62, SD = 34.32$) followed a similar pattern, suggesting the items were overall perceived as intended.

We used LMMs to test the relationship between correct health beliefs and reasonability ratings of answer options. Believability ratings for correct health belief statements were a significant positive predictor of reasonability ratings for correct options, $b = .075, t(1036.2) = 3.32, p < .001$. In contrast, believability ratings for correct health belief statements were a significant negative predictor of reasonability ratings for target wrong options, $b = -.056, t(480.1) = -2.41, p = .016$. In short, the more people believed true health information, the more reasonable they thought correct options and the less reasonable they thought target wrong options were.

We then used similar LMMs to test the relationship between incorrect health beliefs and reasonability ratings. We found that believability ratings for incorrect health belief statements were a significant positive predictor of reasonability ratings for target wrong options, $b = .172, t(2195.8) = 9.37, p < .001$. Correspondingly, we found that believability ratings for incorrect health belief statements were a significant negative predictor of reasonability ratings for correct options, $b = -.097, t(2042.5) = -4.67, p < .001$. In other words, the more people believed incorrect health statements, the less reasonable they found the correct option and the more reasonable they found the target wrong option.

Discussion

Our findings indicate the relationship that incorrect beliefs have with selecting correct decision-making options. The more believable people found a statement, the more reasonable they thought an option corresponding to that statement. This is what we hope for with correct information. That is, believing a true statement is actually true predicts thinking an option related to that statement is reasonable for action. However, believing incorrect information also makes options related to that incorrect information seem more reasonable and makes correct information seem less reasonable. This is an important finding in the context of information delivery to improve decisions. Our results imply that increasing people's belief in correct information by providing factual guidance may not be sufficient if they also hold incorrect beliefs. Instead, these beliefs may reduce efficacy of the guidance if they are not addressed.

Experiment 2

In Experiment 1 we established the link between beliefs and health decisions. Building on work showing that causal information can correct mistaken beliefs, we now examine how people's rating of options is influenced by new causal information. If causal models can overcome the continued influence effect (CIE), we expect that people will rate the options based on true information higher and decrease their ratings of incorrect information.

Method

Participants We recruited 600 U.S. residents ages 18-64 through Prolific. The sample size was increased relative to Experiment 1 to maintain 300 participants per condition with 2 conditions. We excluded 23 participants who reported difficulties using the sliders and one participant whose group number was not recorded due to the survey being reloaded. Of the 576 participants remaining in analysis, 49% were female, 49% were male, and 2% identified as non-binary. Participants were compensated \$4.50 based on the expected study duration of 30 minutes.

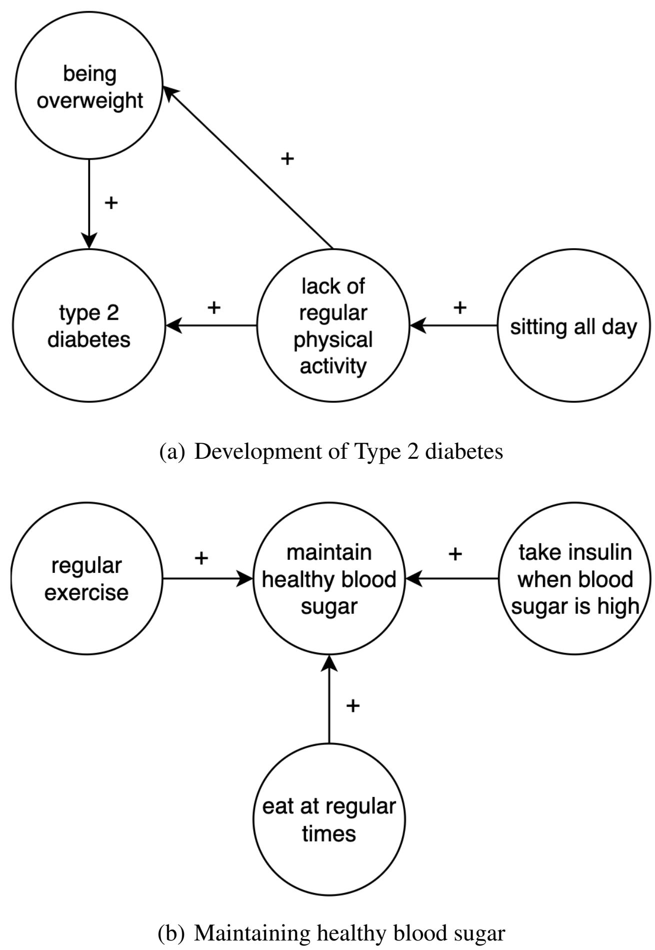

Figure 1: Diagrams used in Experiment 2.

Materials We used the same decision-making questions from Experiment 1 and developed a causal diagram for each question. The diagrams each contained 3-4 nodes and included pathways corresponding to the option developed based on true health information. For example, Figure 1 shows the diagrams corresponding to the questions about development of type 2 diabetes and maintaining healthy blood sugar. Panel b is the graph that was shown with the example question provided in Experiment 1. In the question the target correct answer is to use insulin, and the diagram shows that this is one factor that contributes to the desired outcome. Participants in the diagram condition saw the same questions and answer options, with the diagrams placed in between the scenario and options.

Procedure In addition to the procedure used in the first experiment, participants were also instructed on the meaning of nodes and arrows in the causal diagrams, using example diagrams. Participants were randomized to one of two groups, either receiving no diagrams (no diagram condition, $N = 283$), or receiving a diagram for each question (diagram condition, $N = 293$).

Data Analysis We used LMM to analyze the impact of group on reasonability ratings. We entered group (diagram, no diagram) as a fixed effect and reasonability ratings as our dependent variable of interest with a diagonal covariance structure. We included random intercepts at the participant level. We ran our analyses separately for correct and target wrong options to see how the presence of a causal model would influence the reasonability of these options.

Results

We first analyzed whether reasonability ratings for correct options increased depending on whether a causal model was provided. We did not find a significant main effect of group for correct options, $p = .855$. In other words, seeing a causal model did not change how reasonable the correct option was considered to be, despite depicting that correct option. We then analyzed whether reasonability ratings for target wrong options changed depending on whether a model was present. We again did not find a main effect of group, $p = .460$.

Discussion

In our second experiment, we supplied one group of participants with causal diagrams meant to aid them in making decisions while another group received the same questions without diagrams. Overall, we did not find an effect of causal model presentation. While previous work found that causal models could help supplant incorrect information (Johnson & Seifert, 1994; Nyhan & Reifler, 2015), we did not find support for this in our reasonability ratings. Instead, we find that providing additional causal information did not help people reduce how reasonable they found unsuitable decision options. It is possible that within the context of our experiment people actually adopted new information from our models, but that new information was held alongside their existing beliefs and did not change their reasonability ratings. In other words, people may have learned something that could change their beliefs but it was not translated into their ratings. It is a question for future research to determine how quickly learning new information updates beliefs and results in decision options changing in their acceptability.

General Discussion

In this paper we were interested in investigating how believing both accurate and inaccurate information relates to thinking about options in decision making. We found that believing correct information predicted believing correct options were reasonable and incorrect options were not. Importantly, incorrect beliefs further predicted believing correct options were unreasonable. Based on prior work showing causal models can be used to reduce belief in incorrect information, we attempted to provide people with correct causal models to help emphasize correct knowledge and break the hold of incorrect knowledge. We were not successful with the general causal models we provided. In line with prior work (Michal, Zhong, & Shah, 2021), we found that regardless of new information individuals learn, their prior beliefs continue to strongly shape their decision-making.

Our findings resonate with previous work demonstrating the difficulty of correcting misinformation (Walter & Murphy, 2018). We attempted to provide corrections with directed causal graphs. Much work in computer science has used machine learning techniques to discover exactly these types of models from real-world data. These methods aim to uncover the causal relationships between observable variables such as diet and disease risk so that this can be used in decision-making. In general these models can be very complex as they may include causal relationships between dozens of observed variables. Given that previous work has found that complicated diagrams can impede decision making (Kleinberg & Marsh, 2021), we used simple models closely targeted to the decision at hand (rather than providing general knowledge about disease risk factors) that should be interpretable to users. It is possible that we did not find an effect of diagrams because people could not figure out how to use the models we provided in their decision making. Prior work has shown that causal models can be useful for decision-making (Sloman & Hagmayer, 2006), but given that we specifically probe situations where people's beliefs may contradict medical knowledge, it is possible that this conflict is responsible for the results observed. That is, if our models did not align with people's beliefs, they may have rejected the models in their decision-making and continued basing ratings on their prior beliefs. Alternatively, if people already believed the causal relationships presented in our models then there may be no room for their reasonability ratings to increase. It is a question for future research to explore what type of models would be most successful at creating lasting belief change, and how that may differ by domain. Modifying incorrect health beliefs may be specifically challenging because of the influence of direct personal experience (Korshakova, Marsh, & Kleinberg, 2022), such as having a cold and noticing symptoms lessened after eating an orange. An individual's social circle, including family and friends may continue to reinforce such lay beliefs by sharing similar experiences, which may be simply illusory correlations (Torres, Barberia, & Rodríguez-Ferreiro, 2022; Chapman & Chapman, 1969; Blanco, Moreno-Fernández, & Matute, 2020).

Our results highlight the importance of understanding how beliefs may compete in decision making. In our first experiment we see how incorrect health beliefs may negatively impact perceptions of medically optimal health choices, and in our second experiment we find that a common intervention to correct beliefs does not change people's assessment of health choices. These results add to the literature showing that people can hold inconsistent beliefs (Shtulman & Valcarcel, 2012; Legare & Gelman, 2008; Legare, Evans, Rosengren, & Harris, 2012). As such, we could imagine people in our experiments endorsing correct and incorrect health belief statements rather than feeling they must choose between these beliefs. Our findings further suggest that both types of beliefs may be influential when translating these beliefs into actions. Future work is needed to identify where along the path from belief to action we can most successfully intervene to influence behavior.

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References

Blanco, F., Moreno-Fernández, M. M., & Matute, H. (2020). Are the symptoms really remitting? how the subjective interpretation of outcomes can produce an illusion of causality. *Judgment and Decision Making*, *15*(4), 572–585. doi: 10.1017/S1930297500007506

Boyer, P., & Petersen, M. B. (2018). Folk-economic beliefs: An evolutionary cognitive model. *Behavioral and Brain Sciences*, *41*, e158.

Braun, B. L., Fowles, J. B., Solberg, L., Kind, E., Healey, M., & Anderson, R. (2000). Patient beliefs about the characteristics, causes, and care of the common cold. *Journal of Family Practice*, *49*(2), 153–153.

Chapman, L. J., & Chapman, J. P. (1969). Illusory correlation as an obstacle to the use of valid psychodiagnostic signs. *Journal of abnormal psychology*, *74*(3), 271.

Chater, N., Tenenbaum, J. B., & Yuille, A. (2006). Probabilistic models of cognition: Conceptual foundations. *Trends in cognitive sciences*, *10*(7), 287–291.

Chatterjee, S., Khunti, K., & Davies, M. J. (2017). Type 2 diabetes. *The Lancet*, *389*(10085), 2239-2251. doi: https://doi.org/10.1016/S0140-6736(17)30058-2

Cogley, T., & Sargent, T. J. (2008). Anticipated utility and rational expectations as approximations of bayesian decision making. *International Economic Review*, *49*(1), 185–221.

Cotton, J. L., & Hieser, R. A. (1980). Selective exposure to information and cognitive dissonance. *Journal of Research in Personality*, *14*(4), 518–527.

Danks, D. (2014). *Unifying the mind: Cognitive representations as graphical models*. Mit Press.

Ecker, U. K., & Antonio, L. M. (2021). Can you believe it? an investigation into the impact of retraction source credibility on the continued influence effect. *Memory & Cognition*, *49*, 631–644.

Ecker, U. K., Lewandowsky, S., & Chadwick, M. (2020). Can corrections spread misinformation to new audiences? testing for the elusive familiarity backfire effect. *Cognitive Research: Principles and Implications*, *5*, 1–25.

Ecker, U. K., Lewandowsky, S., Cook, J., Schmid, P., Fazio, L. K., Brashier, N., ... Amazeen, M. A. (2022). The psychological drivers of misinformation belief and its resistance to correction. *Nature Reviews Psychology*, *1*(1), 13–29.

Einhorn, H. J., & Hogarth, R. M. (1981). Behavioral decision theory: Processes of judgement and choice. *Annual review of psychology*, *32*(1), 53–88.

Eriksson, L., & Hájek, A. (2007). What are degrees of belief? *Studia Logica*, *86*, 183–213.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics*, *66*(1), 64–74.

Harmon-Jones, E., & Mills, J. (2019). An introduction to cognitive dissonance theory and an overview of current perspectives on the theory. *Cognitive dissonance: Reexamining a pivotal theory in psychology*.

Jelalian, E., & Miller, A. G. (1984). The perseverance of beliefs: Conceptual perspectives and research developments. *Journal of Social and Clinical Psychology*, *2*(1), 25–56.

Johnson, H. M., & Seifert, C. M. (1994). Sources of the continued influence effect: When misinformation in memory affects later inferences. *Journal of experimental psychology: Learning, memory, and cognition*, *20*(6), 1420.

Kleinberg, S., & Marsh, J. (2021). It's complicated: Improving decisions on causally complex topics. *Proceedings of the Annual Meeting of the Cognitive Science Society*, *43*(43).

Korshakova, E., Marsh, J. K., & Kleinberg, S. (2022). Health information sourcing and health knowledge quality: Repeated cross-sectional survey. *JMIR Formative Research*, *6*(9), e39274.

Legare, C. H., Evans, E. M., Rosengren, K. S., & Harris, P. L. (2012). The coexistence of natural and supernatural explanations across cultures and development. *Child development*, *83*(3), 779–793.

Legare, C. H., & Gelman, S. A. (2008). Bewitchment, biology, or both: The co-existence of natural and supernatural explanatory frameworks across development. *Cognitive Science*, *32*(4), 607–642.

Michal, A. L., Zhong, Y., & Shah, P. (2021). When and why do people act on flawed science? effects of anecdotes and prior beliefs on evidence-based decision-making. *Cognitive Research: Principles and Implications*, *6*(1), 1–23.

Norris, P., Garnett, H. A., & Grömping, M. (2020). The paranoid style of american elections: explaining perceptions of electoral integrity in an age of populism. *Journal of elections, public opinion and parties*, *30*(1), 105–125.

Nyhan, B., & Reifler, J. (2010). When corrections fail: The persistence of political misperceptions. *Political Behavior*, *32*(2), 303–330.

Nyhan, B., & Reifler, J. (2015). Displacing misinformation about events: An experimental test of causal corrections. *Journal of experimental political science*, *2*(1), 81–93.

Nyhan, B., Reifler, J., & Ubel, P. A. (2013). The hazards of correcting myths about health care reform. *Medical care*, 127–132.

Oliver, J. E., & Wood, T. (2014b). Medical conspiracy theories and health behaviors in the united states. *JAMA internal medicine*, *174*(5), 817–818.

Oliver, J. E., & Wood, T. J. (2014a). Conspiracy theories and the paranoid style (s) of mass opinion. *American journal of political science*, *58*(4), 952–966.

Orcullo, D. J. C., & Teo, H. S. (2016). Understanding cognitive dissonance in smoking behaviour: A qualitative study. *International Journal of Social Science and Humanity*, *6*(6), 481–484.

Porot, N., & Mandelbaum, E. (2021). The science of belief: A progress report. *Wiley Interdisciplinary Reviews: Cognitive Science*, *12*(2), e1539.

Seifert, C. M. (2002). The continued influence of misinformation in memory: What makes a correction effective? In *Psychology of learning and motivation* (Vol. 41, pp. 265–292). Elsevier.

Shtulman, A., & Valcarcel, J. (2012). Scientific knowledge suppresses but does not supplant earlier intuitions. *Cognition*, *124*(2), 209–215.

Skyrms, B. (1980). Higher order degrees of belief. *Prospects for pragmatism*, 109–137.

Sloman, S. A., & Hagmayer, Y. (2006). The causal psychologic of choice. *Trends in cognitive sciences*, *10*(9), 407–412.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. *Annual review of psychology*, *28*(1), 1–39.

Susmann, M. W., & Wegener, D. T. (2022). How attitudes impact the continued influence effect of misinformation: The mediating role of discomfort. *Personality and Social Psychology Bulletin*, 01461672221077519.

Swire-Thompson, B., DeGutis, J., & Lazer, D. (2020). Searching for the backfire effect: Measurement and design considerations. *Journal of applied research in memory and cognition*, *9*(3), 286–299.

Torres, M. N., Barberia, I., & Rodríguez-Ferreiro, J. (2022). Causal illusion in the core of pseudoscientific beliefs: The role of information interpretation and search strategies. *Plos one*, *17*(9), e0272201.

Ul Haq, N., Akbar, N., Iqbal, Q., Naseem, A., Azhar, S., & Bashir, S. (2015). Assesment of dietry knowledge, myths and misconceptions among diabetic patients. *Value in Health*, *18*(3), A65.

Usher, M., Tsetsos, K., Yu, E. C., & Lagnado, D. A. (2013). *Dynamics of decision-making: from evidence accumulation to preference and belief* (Vol. 4). Frontiers Media SA.

Vluggen, S., Hoving, C., Schaper, N., & De Vries, H. (2018). Exploring beliefs on diabetes treatment adherence among dutch type 2 diabetes patients and healthcare providers. *Patient education and counseling*, *101*(1), 92–98.

Walter, N., & Murphy, S. T. (2018). How to unring the bell: A meta-analytic approach to correction of misinformation. *Communication monographs*, *85*(3), 423–441.