Of Tinfoil Hats and Thinking Caps: Reasoning is More Strongly Related to
Implausible than Plausible Conspiracy Beliefs

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Abstract

People who strongly endorse conspiracy theories typically exhibit biases in domain-general reasoning. We describe an *overfitting hypothesis*, according to which (a) such theories overfit conspiracy-related data at the expense of wider generalisability, and (b) reasoning biases reflect, at least in part, the need to reduce the resulting dissonance between the conspiracy theory and wider data. This hypothesis implies that reasoning biases should be more closely associated with belief in implausible conspiracy theories (e.g., the moon landing was faked) than with more plausible ones (e.g., the Russian Federation orchestrated the attack on Sergei Skripal). In two pre-registered studies, we found that endorsement of implausible conspiracy theories, but not plausible ones, was associated with reduced information sampling in an information-foraging task and with less reflective reasoning. Thus, the relationship between belief in conspiracy theories and reasoning is not homogeneous, and reasoning is not linked specifically to the “conspiracy” aspect of conspiracy theories. Instead, it may reflect an adaptive response to the tension between implausible theories and other beliefs and data.

Keywords: conspiracy theories, reasoning, information sampling, Jumping-to-conclusions, reflective reasoning, overfitting

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A conspiracy theory is an explanation – of an event or state of the world – that involves a secretive group of perpetrators pursuing their own desired goals (Dentith, 2016). Conspiracy theories often have negative consequences both for their believers and for society at large, such as reduced vaccine uptake (Jolley & Douglas, 2014), increased consumption of alternative medicine (Oliver & Wood, 2014; Lamberty & Imhoff, 2018), higher group prejudice (Swami, 2012; Jolley et al, 2019), and reduced compliance with containment behaviour in relation to COVID-19 (Imhoff & Lamberty, 2020). Though many well-known conspiracy theories seem highly implausible (e.g., the 9/11 attacks were perpetrated by Western governments to justify foreign policy), others appear more plausible (e.g., Donald Trump and the Russian Federation secretly colluded during the 2016 election). Here we develop and explore the idea that implausible conspiracy theories are overfitted conclusions that “explain away” unsettling information by maximising the likelihood of conspiracy-relevant data. We hypothesise that reasoning biases should relate more strongly to implausible conspiracy theories than to plausible ones, because implausible theories induce the potential for more dissonance and hence are more likely to be associated with dissonance-reducing reasoning biases. In two studies, we therefore examine how belief in both plausible and implausible conspiracy theories relate to several aspects of reasoning, including information sampling, reasoning style (intuitive vs. reflective reasoning), and confirmation bias.

The framework for our research is the hypothesis that conspiracy theories are examples of *overfitting*. According to this Overfitting Hypothesis, belief in a conspiracy theory represents a choice of location on a continuum between two different types of explanation. One explanation (e.g., the Earth is flat and NASA are concealing it) may account

for a particular subset of data (e.g., sensory cues of a flat environment) very well, in that it makes the data highly likely and therefore unsurprising. That explanation may, however, generalise poorly to data outside of that subset (e.g., photographs of Earth from space). It is therefore “implausible”, in that it is inconsistent with broader data patterns and priors. An alternative, more “plausible” explanation (e.g., the Earth is round) may perform worse at maximising the likelihood of the specific dataset, but be more consistent with other data and priors. Thus, conspiracy theories are overfitted to information sampled in an immediate context, maximising its likelihood at the expense of wider plausibility, but at the same time performing less well with out-of-sample data.

There are psychological costs and benefits associated with approaches at different points on the continuum. Overfitted beliefs—including conspiracy theories—can be costly given their poor generalisability. New information may either introduce uncertainty, or demand increased cognitive effort so it can be accommodated within the belief. This is consistent with people’s general preference for simpler, flexible explanations over complex ones (Lombrozo, 2007; see also Johnson et al., 2019). If a particular subset of data induces sufficient anxiety, however, then these costs may be outweighed by the anxiety-reducing benefit of explaining that data away with an overfitted explanation.

The likelihood that overfitted conspiracy theories maximise can be broken down into two components (Wojtowicz & DeDeo, 2020). The first relates to the descriptiveness of an explanation (how likely it makes the data points when considered independently), and the second concerns co-explanation (how likely it makes that particular pattern or co-occurrence of data points) (see Wojtowicz & DeDeo, 2020 for extensive discussion). In intuitive terms, descriptiveness and co-explanatory power appear to underlie part of the appeal of conspiracy theories: such explanations are remarkable for their focus on information not otherwise explained by official accounts (Keeley, 1999; Brotherton, 2015; Andrade, 2020; Wojtowicz

& DeDeo, 2020). For instance, 9/11 conspiracy theorists frequently highlight the BBC's premature report of Building 7's collapse, even as it stood visibly behind the reporter (Brotherton, 2015). Furthermore, susceptibility to conjunction fallacies, where people believe that the co-occurrence of two events is more likely than either event alone, is associated with endorsement of conspiracy theories (Brotherton & French, 2014; Moulding et al., 2016; Dagnall et al., 2017; Šrol, 2020).

Various broad consequences follow from the Overfitting Hypothesis. Firstly, endorsement of conspiracy theories should be more likely in unsettling contexts where the short-term benefits of explaining away unpleasant information (i.e., alleviating anxiety) outweigh the future costs of holding beliefs that do not generalise. Consistent with this, conspiracy theories often emerge during times of societal crisis (van Prooijen & Douglas, 2017), for instance wars or regime changes (e.g., Byford & Billig, 2001; Krekó, 2019). People also prefer conspiratorial explanations following events with larger negative consequences compared to events with small negative consequences (e.g., a car crash causing death vs. minor injury) (LeBoeuf & Norton, 2012; Leman & Cinnirella, 2013; van Prooijen & van Dijk, 2014; Radnitz & Underwood, 2017). Conspiracy theories are also more appealing during states of epistemic uncertainty, existential threat, or social identity challenge (Chater & Loewenstein, 2016; Douglas et al., 2017; van Prooijen, 2019). Conspiracy belief is also higher amongst more generally unsettled populations, such as people higher in state and trait anxiety, psychosocial stress, schizotypy, and paranoia (Darwin et al., 2011; Grzesiak-Feldman, 2013; Brotherton & Eser, 2015; Swami et al., 2016).

Secondly, it follows from the Overfitting Hypothesis that conspiracy believers will adopt cognitive strategies that minimise the costs associated with holding implausible beliefs. For instance, the literature on “deliberate ignorance” shows that people often prefer to avoid unpleasant information, even when that information is costless to obtain and is potentially

useful for decision making (Hertwig & Engel, 2016; Golman et al., 2017; Sharot & Sunstein, 2020). For conspiracy believers, the costs of attending to out-of-sample data will likely be higher, either because such data will often be inconsistent with the conspiracy belief (inducing dissonance) or because cognitive effort is required to accommodate new data within the belief (at the cost of parsimony).

Consistent with this expectation, conspiracy believers typically exhibit a range of reasoning biases. Two studies using the Jumping-to-Conclusions task—which tests how much information people gather before forming conclusions—found that participants who strongly endorse conspiracy theories also sampled less information (Moulding et al., 2016; Pytlik et al., 2020). More generally, conspiracy belief correlates negatively with effortful, reflective reasoning (Swami et al., 2014; van Prooijen, 2017; Ballová Mikušková, 2018; Stanley et al., 2020). Social media users who are most active on conspiracy theory pages show evidence of confirmation bias: Compared to less active users, they have more friends or contacts with similar user behaviour, and they interact more with supporting posts than debunking ones (Quattrociocchi et al., 2016). Thus, the cognitive biases associated with belief in conspiracy theories may represent an adaptive response to the tensions induced by belief in overfitted conspiracy theories.

Another consequence of the Overfitting Hypothesis is that the costs of overfitted beliefs should be greater when conspiracy beliefs are implausible, and hence that dissonance-reducing cognitive strategies should be more strongly associated with belief in implausible conspiracy theories. Not all conspiracy theories are equally lacking in generalisability or plausibility (Keeley, 1999, 2007). Cassam (2019) distinguishes between “Conspiracy Theories” and “conspiracy theories”. The uppercase term refers to a distinct subset of conspiracy theory, distinguished by additional features (e.g., political motives, speculative logic, contrarianism, esotericism). Conspiracy Theories frequently sail against the available

evidence (e.g., gun massacres are staged to promote liberal gun reform), question the scientific consensus (e.g., climate change is a financially driven fiction), and may even deny established views on physical reality (e.g., the Earth is flat, and NASA are hiding it).

Cassam's lowercase label denotes a broad category of epistemic claims that include any given theory about conspiracy, including historically established conspiracies (e.g., the Watergate scandal, the Moscow Show Trials), and allegations that are unconfirmed but are consistent with available evidence, public belief, or official consensus (e.g., Russian involvement in the poisoning of Sergei Skripal in Salisbury, UK). For present purposes, a conspiracy theory can be considered plausible to the extent that it generalises to out-of-sample data.

Most prior empirical and theoretical work has focused on belief in implausible Conspiracy Theories. One exception is Moulding et al. (2016), who included a measure of belief in historically established conspiracy theories (e.g., about CIA activity in relation to Project MK-Ultra). Endorsement of these true conspiracy theories was not significantly correlated with information sampling in the Jumping-to-Conclusions task, nor with susceptibility to contextually neutral conjunction fallacies. There was a positive correlation between susceptibility to conspiratorially themed conjunction fallacies and belief in true conspiracy theories, although this correlation was weaker than the equivalent correlation with implausible Conspiracy Theories. No studies, however, have directly looked at plausibility as a factor in the relationship between reasoning and conspiracy belief.

Plausibility has been considered in work on acceptance of fake news. Pennycook & Rand (2019) found that plausibility ratings of news headlines from another sample predicted the effect size of correlations between analytical reasoning and acceptance of those headlines. Specifically, acceptance of the most implausible headlines was most strongly predictive of reduced analytical reasoning, whereas acceptance of the most plausible headlines was most

strongly predictive of increased analytical reasoning. Similar differences may therefore exist between different conspiracy theories depending on their plausibility.

Reasoning biases should therefore be more strongly correlated with belief in implausible Conspiracy Theories than with belief in more plausible alternatives. This Plausibility Hypothesis derives from the Overfitting Hypothesis¹, and is tested here in two pre-registered studies which examine how performance on different reasoning tasks relates to different conspiracy beliefs. In Study 1, we show that belief in implausible Conspiracy Theories, but not plausible ones, is associated with reduced information sampling and more intuitive reasoning. We replicate and extend this finding in Study 2 using a different measure of conspiracy beliefs.

Study 1

Study 1 examines a variety of conspiracy theories that differ in plausibility and tests whether reasoning biases are more strongly associated with belief in some conspiracy theories than others. We hypothesised that reasoning biases will strongly correlate with belief in implausible Conspiracy Theories, but weakly (or not at all) with belief in more plausible ones. To test this Plausibility Hypothesis, this study used three reasoning tasks.

Firstly, to test information sampling, we used the Jumping-to-Conclusions task (JTC; Phillips & Edwards, 1966; Garety et al, 1991). This task has been widely used in the literature on delusional beliefs (e.g., Huq et al, 1988; van der Leer et al, 2015, 2017) and twice with conspiracy beliefs (Moulding et al, 2016; Pytlik et al, 2020). In a standard version of this task, participants are presented with two information pools (e.g., jars of coloured beads) and a breakdown of their contents (e.g., 85% pink vs. 15% green beads). On each trial,

¹ The Overfitting Hypothesis as described was not considered in the pre-registration documents, which focus purely on the Plausibility Hypothesis as outlined. Rather, the Overfitting Hypothesis was developed in response to the results.

a pool is secretly selected at random, and participants are presented with one unit of information (e.g., one bead) at a time until the participant indicates that they have seen enough information to guess which pool was selected. Of interest is how many pieces of information are sampled before a selection is made. Secondly, the ability to override impulsive responses was examined with the Cognitive Reflection Test (CRT; Frederick, 2005). The original CRT is widely used in online studies, so to avoid possible familiarity effects, we used a more recent, adapted version (Primi et al, 2015). Finally, as a test of confirmation bias, we included the Wason Card Task (WCT; Wason, 1968).

The Plausibility Hypothesis predicts that reasoning biases would correlate with belief in more implausible but not plausible conspiracy theories. Specifically, the hypothesis predicts that degree of belief in implausible (but not plausible) conspiracy theories would correlate with a lowered decision threshold in the JTC, fewer correct responses in the CRT and WCT, and higher rates of intuitive responding and confirmation bias in the CRT and WCT respectively.

Method

Hypotheses, sample sizes, methods, and analysis plan for Study 1 were all pre-registered before data collection. The pre-registration documentation, R scripts for all analyses, and raw data can be accessed via the following link: <https://osf.io/25u3h/>.

Participants

Power analysis using G* Power (Faul et al, 2007, 2009) indicated that for 95% power of finding a medium effect ($r = 0.3$) in a one-tailed analysis with alpha at 0.01 in all intended analyses, a minimum of 163 participants was necessary. As pre-registered, a slightly larger sample of 204 people was recruited using Amazon Mechanical Turk to increase the probability of finding a diversity of views with each conspiracy belief and to minimise the

impact of potential exclusions. To minimise the risk of bots, only respondents with 50 or more previously accepted HITs (Human Intelligence Tasks) and a prior approval rating over 90% were recruited. Ten participants were excluded for failing an attention check, leaving a total of 194 participants (71 Female, 119 Male, 3 withheld, 1 “Non-Binary”. Mean age = 36.3, SD = 11.2. 5 withheld; see Supplementary Materials for political and religious orientations). The sampling plan and exclusion criteria were pre-registered.

Materials

Table 1 shows the list of conspiracy theories used in this study, which were rated by a modest prior pilot sample ($n = 35$) from 0 to 10 for plausibility. Based on these results, the twelve items were grouped into four three-item categories. The three highest scoring items (concerning former President Trump’s relationship with Russia, the Salisbury nerve agent attack, and climate change denial as a cover-up) were labelled the Plausible category, as they were the only items that scored above the midpoint of the scale. As these items have received serious consideration by official authorities, they are rendered less implausible than the other items. The next three items concerned implausible conspiracy theories that involve governments, whilst the next three pointed to various liberal groups (e.g., scientists). These two sets of three were labelled Government Agenda and Liberal Agenda respectively. Finally, the three most implausible items were labelled the Space-related category, as these items challenged established views on the physical world, for instance relating to aliens (e.g., David Icke’s reptilians) or planets (e.g., Flat Earth).

An adapted version of the JTC task was used (See Supplementary Materials for task components). The task contained information about two fictional high schools, along with the percentage of their students who passed an exam (either 20-30% or 70-80%). A range (i.e., 20-30%) was used instead of an exact percentage (30%) to discourage participants from calculating exact answers from the specific sequences of information they saw, instead

promoting attention towards general patterns of information. Four sequences each of forty grades were constructed. Two sequences contained 24 Pass and 16 Fail grades and vice versa in the other two. The exact sequences of grades shown were deliberately controlled rather than genuinely random (see Supplementary Materials) to ensure that all participants were shown the same patterns. Sequences were constrained so that no rating appeared more than three consecutive times.

The adapted CRT consisted of three numerical reasoning questions (e.g., if 3 elves can wrap 3 toys in one hour, how many elves are needed to wrap 6 toys in 2 hours?; Primi et al, 2015; see Supplementary Materials for all items). Responses were collected in open numerical format. Finally, for the WCT, six custom trials were developed using the standard task format (Wason, 1968; see Supplementary Materials for items). Each problem consisted of four cards containing particular values (e.g., p , q , $not\ p$, $not\ q$), plus a given logical rule (e.g., if p , then q). To solve the problem, the participant had to indicate which card(s) must be turned over to test the rule. Selections that only included cards that potentially verified the rule (i.e., p , q , or both) were categorised as confirmation bias. The “correct” response included both an appropriate verification (p) and a falsification choice ($not\ q$).

Table 1

Conspiracy Theories in Study 1, their respective categories, and mean ratings and 95% CIs of plausibility given by the pilot sample, listed from highest to lowest plausibility rating

Reference	Item	Category	Alleged perpetrator	Mean Plausibility (pilot)
Climate Cover-Up	The denial of climate change is a deliberate strategy by big companies to maintain profits.	Plausible	Big Businesses	7.20 [6.14 – 8.25]

Salisbury	The nerve agent poisoning of Sergei and Yulia Skripal in Salisbury, United Kingdom, was covertly orchestrated by the Russian secret service.	Plausible	Russian secret service	6.56 [5.56 – 7.56]
Trump & Russia ²	Donald Trump secretly colluded with the Russian Federation during the 2016 US Presidential Election, to influence the outcome.	Plausible	Donald Trump and Russia	5.89 [4.64 – 7.14]
MLK	The assassination of Martin Luther King Jr., was actually perpetrated by the US government.	Government Agenda	US Government	4.55 [3.35 – 5.75]
False Flag	Atrocities blamed on Islamic Terrorism (e.g.: 9/11, 7/7) are actually perpetrated by Western governments to justify overseas military activity.	Government Agenda	Western Governments	3.19 [2.03 – 4.21]
Drugs	Western governments secretly distribute drugs to ethnic minorities to damage particular communities.	Government Agenda	Western Governments	3.04 [2.05 – 4.03]
Feminism	Feminism and campaigns for gender equality are just part of a secret agenda to hurt male rights.	Liberal Agenda	Feminists	2.01 [1.03 – 2.99]
Gun Control	Gun massacres attributed to right-wing shooters (e.g.: Christchurch, Charleston) are actually staged by liberals to promote gun control.	Liberal Agenda	Liberals	1.91 [0.83 – 2.98]

² Two items (Trump & Russia, Flat Earth) were phrased slightly differently in the preregistration document than the actual experiment. Participants saw the items as phrased in Table 1.

Climate Hoax	Climate change is deliberately overblown as part of a financial scam by scientists.	Liberal Agenda	Scientists	1.75 [0.74 – 2.77]
Moon Landing	The Apollo Moon landings were staged by the US government in order to win the space race.	Space-related	The US Government	1.38 [0.55 – 2.20]
Flat Earth	The earth is flat, and scientists are concealing it from society.	Space-related	Scientists	0.75 [0.08 – 1.43]
Reptilians	World events are secretly coordinated by shape-shifting reptilians, disguised as prominent human world figures.	Space-related	Reptilians	0.46 [0.03 – 0.89]

Procedure

Participants completed the three reasoning tasks in random order followed by the conspiracy-theories questionnaire, which was deliberately placed last to avoid priming participants with conspiratorially themed material. To limit demand characteristics, participants were told that their assistance was needed to test potential exam questions for students.

For the JTC task, participants read information about the two high schools, including the pass and fail rates of their respective students. Figure 1 shows a screenshot of the task. On each trial, participants viewed one grade at a time (e.g., “Student 1: Pass”), along with a reminder of the two schools’ overall pass rates and a small list of the grades shown so far, denoted by letters (F for Fail, P for Pass). After each grade was revealed, participants indicated whether or not they wanted to see another grade. If the participant indicated “yes”, another grade was presented. The sequence continued until the participant indicated “no” or until forty grades were seen, at which point the participant chose which school they thought the students attended. Forty was determined to be a sufficiently high upper bound to ensure a wide range of stopping points and to avoid ceiling effects (and indeed no participant reached

forty). To ensure that any one specific sequence did not affect performance, the task was repeated four times.

In the CRT, participants were instructed that they would be given three numerical reasoning problems to complete. Finally, in the WCT, participants viewed an abstract example problem with a logical rule and four cards before the task started. Participants were instructed that they would see six such items and that the task was to indicate which card(s) must be turned over to test the rule.

For the conspiracy-theories questionnaire, participants were asked to indicate their agreement with each conspiracy theory on slider scales, ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). To give this measure some extra granularity, responses were given with two decimal places. An additional item was included as an attention check (“This question is an attention check. Please select/indicate the number ‘5’.”). The presentation order of the conspiracy items was randomised, except for the attention check which was always at the halfway point (7th item). After this questionnaire, demographic information was requested (gender, age, religious orientation, and political orientation), and a full debrief was provided.

Figure 1

Screenshot from the Jumping-to-Conclusions task within Qualtrics.

The following student has been selected at random:

Student 3 - this student achieved: **PASS**.

Please consider which high school you think this particular student might have attended.

3 grades so far:

P, F, P

Yew Field High School	70-80% passes.
Bradnell High School	20-30% passes.

Would you like to sample another high school grade?

No - I have sampled enough
information to choose a school

3 ☐

Yes - show me another grade

☒

Data Analysis

Analysis was conducted using R (version 3.5.1), and all inferential statistics were crosschecked using statcheck.io (Rife et al., 2016). Alpha was set to 0.01 for all analyses to provide moderate protection against multiple comparisons. As pre-registered, for the JTC task, the Decision Threshold was calculated by averaging the number of samples taken across the four trials, constituting the sole dependent variable. In the CRT, two dependent variables were computed: the number of correct answers and the number of intuitive wrong answers. Finally, for the WCT, two dependent variables were computed: the number of correct answers and the number of answers that indicated confirmation bias. As specified in the pre-registration, the four categories of conspiracy were each examined for internal reliability using Cronbach's Alpha, with a cut-off of 0.7 (see results below). Reliable categories were collapsed by averaging across their respective conspiracy theories. Items within unreliable categories were analysed individually. Where appropriate, exploratory post-hoc comparisons

between correlation coefficients of interests were undertaken with Steiger's Z test (Steiger, 1980) using the 'cocor' package in R (Diedenhofen & Musch, 2015), controlling for the intercorrelation between the conspiracy beliefs or categories being compared.

Results

Figure 2 shows the mean degree of belief (out of 7) for each individual conspiracy theory and the four aggregated categories. Consistent with expectations and with the initial pilot, mean belief was highest for the plausible category ($M = 4.54$, 95% CI [4.33, 4.75]), followed by Government Agenda ($M = 3.44$, 95% CI [3.17, 3.70]) and Liberal Agenda categories ($M = 2.87$, 95% CI [2.59, 3.16]), and lowest for the Space-related category ($M = 2.49$, 95% CI [2.22, 2.75]). Three categories were sufficiently reliable (Government Agenda, $\alpha = .89$; Liberal Agenda, $\alpha = .93$; Space-related, $\alpha = .90$) and were collapsed by averaging across their respective conspiracy theories. The Plausible category was just below the pre-registered threshold of .7 ($\alpha = .64$), and therefore the three conspiracy theories in this category—Climate Cover-up, Trump & Russia, Salisbury—were analysed separately. Thus, for all tasks, each measure was analysed with six bivariate regressions, one for each item in the Plausible category, and one for each of the three implausible categories (Government Agenda, Liberal Agenda, Space-related).

Figure 2

Mean ($\pm$ 95% CI) degree of belief in the four categories of conspiracy theories and the twelve individual conspiracy theories in Study 1 with overlaid violin plot, which shows the density of individual beliefs. Left-most (darkest) columns in each plot indicate the full category, and the three lighter columns represent the individual conspiracy theories that constitute the category. Belief was highest for the plausible category and lowest for the space-related items.

Jumping-to-Conclusions Task. We hypothesized that belief in more implausible conspiracy theories would more strongly correlate with lower information sampling. As predicted, Figure 3 shows significant negative correlations of moderate to strong magnitude, such that a reduced decision threshold was associated with belief in the Government Agenda [$r(192) = -.40, p < .001$], Liberal Agenda [$r(192) = -.47, p < .001$], and Space-related

categories [$r(192) = -.56, p < .001$]. No reliable correlations were found for the items in the Plausible category [Climate Cover-up: $r(192) = -.01, p = .86$; Trump & Russia: $r(192) = -.07, p = .30$; Salisbury: $r(192) = -.05, p = .48$].

These correlations were compared using exploratory Steiger's Z tests. Government Agenda beliefs were more strongly correlated with decision threshold than any Plausible item [Climate Cover-up: $z = 4.44, p < .001$; Trump & Russia: $z = 3.76, p < .001$; Salisbury: $z = 4.29, p < .001$], as were Liberal Agenda [Climate Cover-up: $z = 4.80, p < .001$; Trump & Russia: $z = 4.10, p < .001$; Salisbury: $z = 4.86, p < .001$], and Space-related categories [Climate Cover-up: $z = 6.45, p < .001$; Trump & Russia: $z = 6.11, p < .001$; Salisbury: $z = 6.26, p < .001$]. Finally, Space-related beliefs were more strongly correlated with reduced decision threshold than Government Agenda [$z = 3.51, p < .001$] and Liberal Agenda beliefs were [$z = 2.60, p = .009$], though there was no reliable difference between the strength of correlation with these latter two categories [$z = 1.33, p = .18$]. These results are consistent with the Plausibility Hypothesis: Implausible conspiracy beliefs were more strongly associated with reduced information sampling than plausible conspiracy beliefs.

Figure 3

Correlations between Conspiracy Beliefs and Decision Threshold in the Jumping-to-Conclusions task (Study 1). The top row contains the three implausible categories; belief in these conspiracy theories was negatively correlated with decision threshold. The bottom row contains individual plausible items; decision threshold was not significantly correlated with belief in these items. Error band = 95% CI.

Cognitive Reflection Test. We hypothesised that belief in more implausible conspiracy theories would correlate negatively with fewer correct answers and positively with more intuitive answers in the Cognitive Reflection Test (CRT). Consistent with this hypothesis, Figure 4A shows significant negative correlations between correct responses and Government Agenda [$r(192) = -.38, p < .001$], Liberal Agenda [$r(192) = -.43, p < .001$], and Space-

related conspiracy beliefs [$r(192) = -.52, p < .001$]. None of the Plausible items significantly correlated with correct responses [Climate Cover-Up: $r(192) = .02, p = .82$; Trump & Russia: $r(192) = -.13, p = .072$; Salisbury: $r(192) = .01, p = .84$].

We then compared the strength of these correlations with exploratory Steiger's Z tests. Government Agenda beliefs were more strongly correlated with correct responses than all three Plausible items [Climate Cover-up: $z = 4.46, p < .001$; Trump & Russia: $z = 2.85, p = .004$; Salisbury: $z = 4.73, p < .001$], as were Liberal Agenda [Climate Cover-up: $z = 4.58, p < .001$; Trump & Russia: $z = 3.07, p = .002$; Salisbury: $z = 5.02, p < .001$] and Space-related conspiracy beliefs [Climate Cover-up: $z = 6.09, p < .001$; Trump & Russia: $z = 4.76, p < .001$; Salisbury: $z = 6.29, p < .001$]. Correlations involving Liberal Agenda and Government Agenda were similar in magnitude [$z = 0.96, p = .34$]. Space-related beliefs were more strongly correlated with correct responses than were Government Agenda beliefs [$z = 2.92, p = .004$], and mildly stronger than Liberal Agenda beliefs, though not significantly so [$z = 2.39, p = .017$]. Like those from the JTC task, these results are consistent with the Plausibility Hypothesis: Belief in the three more implausible categories was more strongly correlated with correct answers than was belief in the plausible items, with the Space-related category producing the strongest results.

Turning to intuitive CRT responses, Figure 4B shows that Government Agenda beliefs only showed a mild, non-significant association with intuitive responses [$r(192) = .14, p = .047$]. As expected, however, significant positive correlations were found with Liberal Agenda [$r(192) = .20, p = .005$] and Space-related beliefs [$r(192) = .19, p = .008$]. Again, none of the Plausible items emerged as significant predictors of intuitive CRT response [Climate Cover-up: $r(192) = -.06, p = .41$. Trump & Russia: $r(192) = .03, p = .64$. Salisbury: $r(192) = -.08, p = .27$].

Exploratory comparisons were again conducted with Steiger's Z tests. Government Agenda beliefs were more strongly correlated with intuitive responses than was belief in the Salisbury item [$z = 2.58, p = .0098$] and slightly more so than belief in the Climate Cover-up item [$z = 2.21, p = .027$], but not the Trump & Russia item [$z = 1.19, p = .23$]. Liberal Agenda beliefs were more strongly correlated with intuitive responses than was belief in the Salisbury item [$z = 3.01, p = .003$], and slightly more so compared to Climate Cover-up belief [$z = 2.54, p = .011$]. No difference emerged compared with Trump & Russia belief [$z = 1.59, p = 0.11$]. Space-related conspiracy beliefs were more strongly correlated with intuitive responses than were belief in the Salisbury [$z = 2.97, p = 0.003$] and Climate Cover-up items [$z = 2.66, p = 0.008$], but not the Trump & Russia item [$z = 1.77, p = .077$]. Lastly, Government Agenda did not differ from Liberal Agenda in correlation strength with intuitive answers [$z = 0.95, p = .34$], and Space-related items also did not differ from either of the other implausible categories [Government Agenda: $z = 0.89, p = .37$; Liberal Agenda: $z = 0.22, p = .82$]. These results are broadly consistent with the Plausibility Hypothesis. Implausible conspiracy beliefs were more related to intuitive responding than plausible items, although this difference was less stable than for correct answers.

Figure 4

Correlations between Conspiracy Beliefs and measures on the Cognitive Reflection Test in Study 1. A: Correct responses correlated negatively with belief in the implausible categories, but not in the plausible items. B: Intuitive wrong answers correlated positively with belief in both Liberal Agenda and Space-related conspiracy theories and mildly with Government agenda conspiracy theories. Error band = 95% CI.

Wason Card Task. We hypothesised that belief in more implausible conspiracy theories would negatively correlate with the number of correct responses and positively correlate with rates of confirmation bias. As shown in Figure 5, the implausible categories all produced mild, but not significant, negative correlations with correct answers as expected [Government Agenda: $r(192) = -.17, p = .018$; Liberal Agenda: $r(192) = -.17, p = .020$; Space-related: $r(192) = -.18, p = .014$]. Beliefs in plausible items, however, were unrelated to correct responses [Climate Cover-up: $r(192) = .09, p = .23$; Trump & Russia: $r(192) = .04, p = .58$; Salisbury: $r(192) = -.09, p = .24$].

Comparing these correlations with exploratory Steiger's Z tests, Government Agenda was more strongly correlated with correct WCT answers than was Climate Cover-up belief [$z = 2.81, p = .005$] and slightly more than was Trump & Russia belief [$z = 2.29, p = .022$], but not Salisbury [$z = 1.00, p = .32$]. Liberal Agenda beliefs were slightly more strongly correlated with correct answers than was Climate Cover-up [$z = 2.47, p = .014$] or Trump & Russia belief [$z = 1.96, p = .05$], and comparable to belief in the Salisbury item [$z = 0.88, p = .38$]. Space-related beliefs were more strongly correlated with correct WCT answers than was Climate Cover-up beliefs [$z = 2.80, p = .005$] and slightly more than Trump & Russia belief [$z = 2.44, p = .015$], but not Salisbury [$z = 1.02, p = .31$]. No difference emerged between the correlations involving implausible beliefs [all p 's $> .79$]. Belief in implausible conspiracy theories was therefore more strongly linked to fewer correct answers than plausible conspiracy beliefs, though not consistently.

In terms of confirmation bias, in contrast to the hypothesis, there was no reliable effect for Government Agenda [$r(192) = -.12, p = .092$], a mild *negative* correlation for Liberal Agenda [$r(192) = -.18, p = .014$], and a reliable negative correlation with Space-related beliefs [$r(192) = -.22, p = .002$]. The mild effects were in the opposite direction to what was predicted. Plausible items were unrelated to incidences of confirmation bias [Climate Cover-up: $r(192) = .002, p = .98$; Trump & Russia: $r(192) = -.06, p = .39$; Salisbury: $r(192) = .10, p = .17$]. Comparing these correlations with Steiger's Z tests, belief in Government Agenda conspiracy theories was slightly more strongly correlated with confirmation bias than belief in the Salisbury item [$z = 2.55, p = .011$], but not more so than the Climate Cover-up [$z = 1.34, p = .18$] or Trump & Russia items [$z = .64, p = .52$]. Belief in Liberal Agenda conspiracy theories was more strongly correlated with confirmation bias than was belief in the Salisbury item [$z = 2.96, p = .003$], but not more so than belief in the Climate Cover-up [$z = 1.75, p = .080$] nor Trump & Russia items [$z = 1.09, p = .27$]. Finally,

Space-related beliefs were more strongly correlated with confirmation bias than was belief in the Salisbury item [$z = 3.55, p < .001$], and slightly more so than belief in a Climate Cover-up [$z = 2.41, p = .016$], but not belief in the Trump & Russia item [$z = 1.82, p = .068$].

Figure 5

Correlations between Conspiracy Beliefs and measures on the Wason Card Task (Study 1).

A: Correct responses were mildly negatively correlated with belief in the implausible categories but not with belief in the plausible items. B: Rates of confirmation bias were negatively correlated with Liberal Agenda and Space-related conspiracy beliefs. Error band = 95% CI.

Discussion

Belief in implausible conspiracy theories, but not plausible ones, correlated with multiple biases in reasoning, including reduced information sampling and an intuitive reasoning style. This pattern was most apparent in the Jumping-to-Conclusions task (JTC), where belief in all three implausible categories, but not belief in the plausible items, was strongly associated with reduced information sampling. This divergence is broadly consistent

with Moulding et al (2016), who reported that reduced information sampling was associated with belief in false conspiracy theories, but not historically true ones. A similar pattern emerged with the Cognitive Reflection Test (CRT): Plausible items produced no significant correlations, and implausible categories were more strongly associated with both fewer correct responses and more intuitive wrong answers. These results suggest that both reduced sampling and intuitive reasoning style are more relevant for implausible conspiracy beliefs than plausible ones.

Though the differences between implausible and plausible conspiracy beliefs were fairly stable, more variation was found when comparing different implausible categories with each other (see Figures 3 and 4). Compared to Government and Liberal Agenda, the Space-related category resulted in stronger correlations with decision threshold and correct answers. This pattern suggests a graded impact of plausibility on the link between conspiracy belief and reasoning, whereby increasingly implausible beliefs are more strongly associated with biases in reasoning. For intuitive answers, however, all three categories were more comparable in magnitude, suggesting that reasoning biases have similar links with any sufficiently implausible belief.

Belief in implausible Conspiracy Theories was weakly negatively correlated with correct answers in the Wason Card Task (WCT). Notably, only around 5% of all trials were answered correctly by participants which may indicate a floor effect. Unexpectedly, confirmation bias was negatively correlated with belief in Space-related Conspiracy Theories, and mildly negatively correlated with belief in Liberal Agenda Conspiracy Theories. Although this result was not predicted, it may reflect optimal responding. Confirmation bias in the WCT has been suggested to be “adaptively rational” (Anderson, 1990) in that it maximises the information gained about the question under evaluation (see Oaksford & Chater, 1994). Indeed, almost 70% of all responses constituted confirmation bias. Negative

correlations between belief in implausible Conspiracy Theories and correct answers may reflect a failure to falsify, whereas negative correlations with confirmation bias may reflect an additional failure to select the most informative choices. As both variables were unrelated to plausible conspiracy beliefs, these failures may be specific to belief in implausible Conspiracy Theories, as observed with measures on the JTC task and CRT. This interpretation is tentative, however, given that Government Agenda beliefs were unrelated to confirmation bias, and that implausible and plausible beliefs did not consistently correlate differently with confirmation bias in a statistically significant way.

Study 2

Study 1 used a 1-to-7 scale to measure belief in each conspiracy. Though this type of scale is commonly used to assess conspiracy belief (e.g., Brotherton & French, 2014; Swami et al., 2014), people's subjective judgments in other domains are inherently relative in nature. Specifically, people's subjective judgments of numerous quantities are assumed to reflect the relative ranked position of the to-be-judged items within a comparison context (Stewart et al., 2006). This relative ranking applies, for example, in people's judgments of personalities (Wood et al., 2012), their beliefs about the appropriateness of criminal sentences (Aldrovandi et al., 2013), and their satisfaction with the timeliness of student feedback (Brown et al., 2015). Asking participants to provide such relative information directly may thus produce clearer results.

In the context of the present paper, a likely comparison context is "other people's beliefs". Study 2 therefore attempts to replicate the findings of Study 1 using a relative-rank measure of conspiracy belief. Scale endpoints were defined in terms of hypothetical individuals who hold the most extreme belief or non-belief in each conspiracy theory, and participants were asked to state where they believe they rank within the population. The

hypotheses, as in Study 1, are that reasoning biases (e.g., lowered decision threshold, more intuitive CRT responses) are associated with belief in implausible, but not more plausible, conspiracy theories.

Method

Hypotheses, sample sizes, methods, and analysis plan for Study 2 were all pre-registered before data collection. Pre-registration documents, R scripts, and data can be accessed via the following link: <https://osf.io/7mqz2/>.

Participants

200 participants were recruited from Amazon M-Turk, sufficient for 95% power in all intended analyses for finding a medium effect ($r = 0.3$) in a one-tailed analysis with alpha at .01 (Faul et al., 2007, 2009). Unexpectedly, 134 participants failed the attention check and were excluded in line with our pre-registered analysis plan, leaving only 66 participants. A number of emails, however, were received from participants explaining that they did not understand the attention check, suggesting that the high rate of failure was not solely due to inattentiveness. Under a more flexible criterion (see Materials), only 58 participants were excluded, bringing the total to 142 participants (56 Female, 86 Male. Mean age: 36.8, SD: 10.9. See Supplementary Materials for political and religious orientations). With alpha at .01, this gave us approximately 92% power of finding a medium effect size ($r = 0.3$).

Materials

Study 2 used the same design, materials, and procedure as Study 1, with the following changes. Instead of a 1-to-7 response scale for each of the twelve conspiracy theories (see Table 1), participants were presented with a graphic as shown in Figure 6, depicting silhouetted figures in a line-up. Participants were asked to imagine that the figures were standing in order of their belief in a given statement, with the leftmost figure holding the

lowest degree of belief, and the rightmost figure holding the highest belief. Participants were asked to click on the graphic to indicate where they would place themselves on this scale.

The scale was divided into 20 clickable regions from left to right, ranging from 1 (lowest) to 20 (highest degree of belief).

In addition, one item was included as an attention check, asking participants to select any three points on the scale, using the same graphical display. As mentioned, a sizable number of participants failed this check, possibly because selecting three scale points represented a departure from the conspiracy belief items, where participants were selecting one point. As a result, participants may not have understood that they could click more than once for the same question. We therefore used a more flexible criterion which included anyone who exclusively selected either the third leftmost or third rightmost point (i.e., the 18th figure) on the scale; this strategy was communicated in emails from respondents who were uncertain about how to answer the question. Of the 134 participants who failed the pre-registered attention check (selecting three different figures), 60 participants selected only the third-leftmost figure, and 16 participants selected the third-rightmost figure.

Figure 6

An example item from the survey, featuring the relative rank scale used in Study 2. Twenty different clickable regions are included from left (Lowest degree of belief) to right (Highest degree of belief).

Click on the picture below to indicate where you would place yourself relative to the population, from leftmost (lowest degree of belief) with rightmost (highest degree of belief), for the following statement:

The Earth is flat, and scientists are concealing it from society.

Data Analysis

Analysis was conducted using R (version 3.5.1), and all inferential statistics were crosschecked using statcheck.io (Rife et al., 2016). Alpha was set to .01 to provide some measure of protection against multiple comparisons. The same three dependent measures (JTC task: Decision Threshold, CRT: Correct answers, Intuitive answers, WCT: Correct answers, Confirmation bias) were calculated as in Study 1.

As most participants unexpectedly failed the pre-registered attention check, we were concerned over the small sample size. We therefore ran our pre-registered analysis plan, but included the 142 participants who passed either the original check or the post-hoc flexible alternative outlined (see Materials). A summary of the same analysis with only the pre-registered check applied ($n = 66$) is included in the Supplementary Materials, with generally similar, though less statistically robust, results. As with Study 1, exploratory comparisons between correlation coefficients were undertaken where appropriate with Steiger's Z test.

Results

Figure 7 shows the strength of belief in the twelve individual conspiracy theories in their four respective categories. As in Study 1, mean belief was highest for the plausible category ($M = 11.98$, 95% CI [11.21, 12.75]), followed by Government Agenda ($M = 8.80$, 95% CI [7.78, 9.72]) and Liberal Agenda categories ($M = 7.35$, 95% CI [6.35, 8.35]), and lowest for the Space-related category ($M = 6.30$, 95% CI [5.30, 7.30]). The four categories were examined for internal reliability using Cronbach's Alpha. Similar to Study 1, the implausible categories all met the pre-registered criteria of .7 (Government Agenda, $\alpha = .85$; Liberal Agenda, $\alpha = .90$; Space Related: $\alpha = .91$). The Plausible category was not sufficiently reliable (Plausible: $\alpha = .65$). Plausible items were therefore analysed separately whilst other categories were collapsed.

Figure 7

Mean (+/- 95% CI) degree of belief in the four categories of conspiracy theories and the twelve individual conspiracy theories in Study 2, with overlaid violin plot. Left-most (darkest) columns in each plot indicate the full category, and the three lighter columns represent the individual conspiracy theories that constitute the category. Belief was highest for the plausible category and lowest for the space-related items.

Jumping-to-Conclusions Task. We hypothesised that the decision threshold would correlate negatively with belief in the implausible categories of conspiracy theory, but not the plausible items, as was found in Study 1. As expected, Figure 8 displays significant negative correlations between Decision Threshold and Government Agenda [$r(140) = -.35, p < .001$], Liberal Agenda [$r(140) = -.45, p < .001$], and Space-related categories [$r(140) = -.48, p < .001$]. For the Plausible items, Climate Cover-up was unrelated to Decision Threshold [$r(140) = -.07, p = .38$]. Belief in the Trump & Russia item was mildly correlated with Decision Threshold, though not significantly so [$r(140) = -.19, p = .024$]. Finally, there was a significant negative correlation between Decision Threshold and belief in the Salisbury item [$r(140) = -.26, p = .002$].

Comparing correlations with exploratory Steiger's Z tests, Space-related beliefs were more strongly correlated with Decision Threshold than were all three Plausible items [Climate Cover-up: $z = 4.02, p < .001$; Trump & Russia: $z = 3.22, p = .001$; Salisbury: $z = 2.62, p = .009$]. Liberal Agenda beliefs were more strongly correlated with Decision Threshold than was Climate Cover-up beliefs [$z = 3.34, p < .001$], and slightly more strongly correlated than was belief in the Trump & Russia item [$z = 2.49, p = .013$] and Salisbury beliefs [$z = 2.04, p = .041$]. Finally, Government Agenda beliefs were more strongly correlated than belief in a Climate Cover-up [$z = 2.85, p = .004$], but not reliably stronger than Trump & Russia [$z = 1.90, p = .057$] or Salisbury conspiracy beliefs [$z = 1.10, p = .27$]. No reliable difference emerged between the correlations involving Government Agenda and Liberal Agenda [$z = 1.44, p = .15$]. Space-related beliefs were more strongly correlated with decision threshold than Government Agenda beliefs [$z = 2.58, p = .0098$], but they were not significantly different than Liberal Agenda beliefs [$z = 0.66, p = .51$]. This pattern fits the Plausibility Hypothesis in that implausible conspiracy beliefs were again most strongly related to a reduced decision threshold as in Study 1, though the difference with plausible items was slightly less consistent.

Figure 8

Correlations between Conspiracy Beliefs and Decision Threshold in the Jumping-to-Conclusions task in Study 2. The top row contains the three implausible categories; belief in these conspiracy theories was negatively correlated with decision threshold. The bottom row contains individual plausible items. Belief in the Salisbury item was also negatively correlated with Decision Threshold, Trump & Russia was mildly correlated, and Climate Cover-up belief did not correlate with decision threshold. Error band = 95% CI.

Cognitive Reflection Test. As with Study 1, we hypothesised that belief in implausible categories would be associated with fewer correct answers and more intuitive responses in the Cognitive Reflection Test (CRT). Consistent with this prediction, Figure 9A displays strong negative correlations between correct responses and Government Agenda [$r(140) = -.40, p < .001$], Liberal Agenda [$r(140) = -.47, p < .001$], and Space-related conspiracy beliefs

$[r(140) = -.46, p < .001]$. There was no correlation between correct CRT responses and Climate Cover-up $[r(140) = .02, p = 0.82]$ or Trump & Russia $[r(140) = -.12, p = 0.17]$. Belief in the Salisbury item was mildly negatively associated with correct responses $[r(140) = -.22, p = .0099]$.

Comparing correlations with exploratory Steiger's Z tests, beliefs in Space-related conspiracy theories were more strongly correlated with correct responses than any plausible item [Climate Cover-up: $z = 4.79, p < .001$. Trump & Russia: $z = 3.86, p < .001$; Salisbury: $z = 2.94, p = .003$], as were beliefs in the Liberal Agenda items [Climate Cover-up: $z = 4.37, p < .001$; Trump & Russia: $z = 3.40, p < .001$; Salisbury: $z = 2.71, p = .007$]. Government Agenda beliefs were more strongly correlated with correct responses than Trump & Russia [$z = 3.51, p < .001$] and Climate-Cover up beliefs [$z = 4.47, p < .001$], but only slightly stronger than the Salisbury item [$z = 2.32, p = .020$]. This is broadly consistent with the Plausibility Hypothesis, though, as in the JTC task, the differences between implausible and plausible beliefs were slightly less consistent. Correlations involving Liberal Agenda and Government Agenda did not differ in magnitude [$z = 0.94, p = .35$], nor did Space-related beliefs from either [Government Agenda: $z = 1.21, p = .23$, Liberal Agenda: $z = 0.06, p = .95$]. This result contrasts with the results of Study 1, where correct answers were more strongly associated with Space-related beliefs.

For intuitive responses in the CRT, Figure 9B shows a significant positive correlations with Government Agenda $[r(140) = .31, p < .001]$, Liberal Agenda $[r(140) = .35, p < .001]$, and Space-Related conspiracy beliefs $[r(140) = .34, p < .001]$. No significant correlations were found with the plausible items [Climate Cover-up: $r(140) = .004, p = .96$; Trump & Russia: $r(140) = .07, p = .42$; Salisbury: $r(140) = .09, p = .29$].

In comparing the correlations with exploratory Steiger's Z tests, Government Agenda beliefs were more strongly related to intuitive responses than were beliefs in all three

Plausible items [Climate Cover-up: $z = 3.19, p = .001$. Trump & Russia: $z = 2.88, p = .004$. Salisbury: $z = 2.65, p = .008$], as was the Space Related category [Climate Cover-up: $z = 3.21, p = .001$. Trump & Russia: $z = 2.88, p = .004$. Salisbury: $z = 2.81, p = .005$]. Liberal Agenda beliefs produced stronger correlations than Salisbury [$z = 2.62, p = .009$] and Climate Cover-up items [$z = 2.97, p = .003$], and slightly stronger than Trump & Russia [$z = 2.57, p = .010$]. This pattern of results fits the Plausibility Hypothesis, with implausible beliefs producing the most robust correlations as in Study 1. For intuitive answers, correlations with Liberal Agenda and Government Agenda did not differ in strength [$z = 0.46, p = .64$], and neither differed with Space-related beliefs [Liberal Agenda: $z = 0.13, p = .90$; Government Agenda beliefs: $z = 0.51, p = .61$].

Figure 9

Correlations between Conspiracy Beliefs and measures on the Cognitive Reflection Test in Study 2. A: Correct responses, which correlated negatively with the implausible categories, and mildly with the plausible Salisbury item, but not the other plausible items.

B: Intuitive wrong answers, which correlated negatively with the implausible categories but not the plausible items. Error band = 95% CI.

Wason Card Task. As in Study 1, correct answers on the Wason Card Task (WCT) were unrelated to items in the Plausible category [Climate Cover-up: $r(140) = .06, p = .49$. Trump & Russia: $r(140) = .03, p = .76$. Salisbury: $r(140) = .05, p = .59$]. Correct answers were also unrelated to the implausible categories [Government Agenda: $r(140) = -.04, p = .63$. Liberal Agenda: $r(140) = -.07, p = .41$. Space-related: $r(140) = -.02, p = .80$], contrasting with the mild negative results from Study 1. In comparing these correlations with exploratory Steiger's Z tests, no differences were found between any combination of correlations [all p 's $> .26$].

Rates of confirmation bias were also not significantly correlated with the Plausible items [Climate Cover-up: $r(140) = -.04, p = .60$; Trump & Russia: $r(140) = -.07, p = .43$; Salisbury: $r(140) = -.14, p = .11$]. Figure 10B shows moderate negative correlations with the Government Agenda [$r(140) = -.24, p = .004$], Liberal Agenda [$r(140) = -.25, p = .003$], and Space-related categories [$r(140) = -.37, p < .001$], which is fairly consistent with Study 1, but in contrast to our hypotheses. In comparing correlations using Steiger's Z tests, Liberal Agenda beliefs were of comparable strength to all three plausible items [Climate Cover-up: $z = 1.75, p = .081$; Trump & Russia: $z = 1.65, p = .10$; Salisbury: $z = 1.13, p = .26$]. Government Agenda beliefs were slightly more strongly correlated with confirmation bias than were beliefs in the Climate Cover-up [$z = 2.04, p = .041$] or Trump & Russia items [$z = 2.06, p = .04$], but not the Salisbury item [$z = 1.27, p = .20$]. Space-Related beliefs were more strongly correlated with confirmation bias than any plausible item [Climate Cover-up: $z = 3.21, p = .001$; Trump & Russia: $z = 3.30, p = .001$; Salisbury: $z = 2.72, p = .007$], and slightly more so than Government Agenda [$z = 2.52, p = .012$] and Liberal Agenda categories [$z = 2.57, p = .0102$].

Figure 10

Correlations between Conspiracy Beliefs and measures on the Wason Card Task in Study 2.

A: correct responses, which were unrelated to any conspiracy beliefs. B: rates of confirmation bias, which were negatively correlated with the implausible categories, but not the plausible items. Error band = 95% CI.

Discussion

In Study 2, as hypothesised, belief in Government Agenda, Liberal Agenda, and Space-Related conspiracy theories was associated with a lowered decision threshold (i.e., reduced sampling) in the Jumping-to-Conclusions (JTC) task, as well as with fewer correct answers and increased intuitive responding in the Cognitive Reflection Test (CRT). For the most part, Study 2 replicated the results from Study 1 despite using a relative-rank method for eliciting conspiracy belief.

Regarding the JTC however, two notable differences with Study 1 emerged. Firstly, belief in two plausible items – Salisbury and Trump & Russia – were negatively correlated with decision threshold (albeit mildly and non-significantly in the latter case). Secondly, perhaps because of this increased effect compared to Study 1, the exploratory comparisons

between correlations with decision threshold revealed less consistent differences between the correlation coefficients of these two items and the implausible categories. The Plausibility Hypothesis – that reasoning style is more relevant to implausible conspiracy theories – does not mean that reduced sampling and preference for intuitive reasoning would never occur alongside more plausible conspiracy beliefs. Were that the case, associations with such items and better reasoning performance would have been observed. Rather, the Plausibility Hypothesis suggests that such biases would be most consistently observed alongside implausible conspiracy beliefs. The results of Study 2 are therefore consistent with this hypothesis and with the results from Study 1.

Another discrepancy between Study 1 and Study 2 concerns the comparisons between implausible categories. In Study 1, Space-related conspiracy beliefs were more strongly related to both decision threshold and correct CRT answers (but not intuitive answers), compared to Liberal and Government Agenda beliefs. In Study 2, this difference was not found with either CRT measure. The JTC results were intermediate: Space-related beliefs were more strongly associated with decision threshold than Government Agenda but not Liberal Agenda beliefs. Notably, in both studies and the pilot sample, the implausible items were rated similarly (i.e., below midpoint); this may reflect that Implausible/Space-related beliefs were not sufficiently more implausible than the Liberal and Government Agenda items to consistently produce a clear-cut difference. In summary, though the potential differences between implausible categories were inconsistent, the differences between implausible and plausible conspiracy beliefs were stable and robust.

Regarding the Wason Card Task (WCT), correct answers were unrelated to any conspiracy belief, having been mildly negatively correlated with implausible conspiracy beliefs in Study 1. Only 2% of all trials were answered correctly, which might once again indicate a floor effect. In both studies, confirmation bias was unrelated to plausible

conspiracy beliefs, and negatively correlated with implausible beliefs (apart from Government Agenda beliefs, which were unrelated in Study 1). As discussed earlier, confirmation bias as operationalised in the WCT may be an adaptively rational choice to maximise information gain (see Oaksford & Chater, 1994). Any reduced confirmation bias amongst believers in implausible Conspiracy Theories may thus reflect a failure to select the most informative choices. As found in Study 1, however, implausible conspiracy beliefs did not consistently correlate more strongly with confirmation bias than did plausible ones. Results from the WCT in both studies therefore lack the same degree of consistency as those found in the other tasks.

General Discussion

In two studies, we found clear evidence that domain-general reasoning biases are more strongly associated with belief in implausible conspiracy theories than with belief in plausible ones. Specifically, reduced information sampling and increased reliance on intuitive reasoning occurred most strongly and consistently alongside implausible conspiracy beliefs, and only rarely if at all alongside relatively plausible ones.

The present results are consistent with the extant literature in highlighting a connection between conspiracy belief and different reasoning biases (e.g., Brotherton & French, 2014; Swami et al., 2014; Moulding et al., 2016). Our findings add to this work through the inclusion of comparably more plausible “conspiracy theories”. The utility of such distinctions between conspiracy theories (e.g., Cassam, 2019) is demonstrated by our findings, as well as those of Moulding et al (2016) who found reduced information sampling in association with “false” conspiracy beliefs, but not historically true ones. The present findings reinforce the idea that reasoning style is not linked specifically to the “conspiracy” component of Conspiracy Theories (i.e., that groups are engaged in covert goal-directed

planning or action), but to other factors which separate implausible theories from plausible ones.

As suggested by the Overfitting Hypothesis, one key difference between implausible Conspiracy Theories and plausible conspiracy theories is that the former are examples of overfitting. Conspiracy Theories often emerge in times of crisis (see van Prooijen & Douglas, 2017), which on one hand create widespread feelings of uncertainty or threat, but on the other also create a very limited and noisy information environment that is not conducive to ameliorating such feelings. Such environments may incentivise maximising the likelihood of immediate information. In turn, this raises the appeal of implausible Conspiracy Theories, which can maximise the likelihood of small samples and provide relief from anxious states caused by the immediate small sample.

This short-term adaptiveness does not mean, however, that belief in implausible Conspiracy Theories represents a successful long-term strategy to reduce feelings of uncertainty or threat (Douglas et al., 2017). If anything, the opposite seems to be the case, given positive correlations between conspiracy belief and factors such as state and trait anxiety, psychosocial stress, or paranoia (e.g., Darwin et al, 2011; Grzesiak-Feldman, 2013; Swami et al, 2016). One explanation as to why Conspiracy Theories cannot resolve the states that simultaneously increase their appeal is their poor generalisability to new information. Conspiracy beliefs may reduce anxiety if maintained, but when new information challenges the ability of those beliefs to maximise likelihood, anxious states may be renewed. Thus, for someone with overfitted conspiratorial beliefs, there is much less incentive for continued sampling or deliberation. Reduced information sampling and increased reliance on intuitive reasoning, as found in our studies, may reflect reliance on a cognitive strategy designed to minimise the costs of holding overfitted beliefs. Plausible conspiracy theories, by contrast,

have higher generalisability and will account for new information with less difficulty, so continued reasoning is not discouraged.

Our results are therefore consistent with the Overfitting Hypothesis. We consider the Plausibility Hypothesis – that reasoning biases are more closely related to implausible Conspiracy Theories than plausible ones – as a consequence of the broader Overfitting Hypothesis. If implausible Conspiracy Theories are overfitted, and if reasoning biases reflect a cognitive strategy associated with minimising the costs of holding overfitted beliefs, then those biases should be more closely linked to belief in implausible Conspiracy Theories than with belief in plausible ones with more generalisability. Our data clearly demonstrate such a difference, directly supporting the Plausibility Hypothesis, and in turn meeting a minimal adequacy criterion for the Overfitting Hypothesis.

Some limitations are worth noting. Firstly, this data does not speak to the direction of causality between reasoning biases and conspiracy beliefs. The Overfitting Hypothesis is similarly open to several interpretations. On one hand, as described above, holding overfitted beliefs with low generalisability may reduce incentives for continued sampling, because future information will typically renew uncertainties (i.e., $A \rightarrow B$). On the other hand, if implausible Conspiracy Theories only outperform official accounts when samples are small or noisy, then an initial failure to engage in prolonged sampling might be causally necessary for belief in implausible Conspiracy Theories ($B \rightarrow A$). These two possibilities are not mutually exclusive: Implausible Conspiracy Theories may require small samples in order to outperform alternative accounts, and in turn the costs of holding them may discourage continued reasoning (i.e., $B \rightarrow A \rightarrow B$).

Secondly, we cautiously note the tentative definition of plausibility offered in the introduction, whereby claims are more implausible to the extent that they generalise out of sample. The method by which conspiracy theories were grouped in this study (i.e., according

to ratings of plausibility by a pilot sample) mainly pertained to the popularity of those claims in wider society. We therefore do not claim that this grouping method reflects a complete operationalisation of objective plausibility as a concept, nor of how well these claims objectively fit the available data or generalise beyond that data.

Finally, another potential limitation concerns the use of an all-US sample. Whilst this had the advantage of minimising cultural variation that might have obscured any effects, it also limits the generalisability of these findings. It may be interesting to see whether the same implausible “Conspiracy Theories” produce the same relationship with such biases in countries with different information environments, where those beliefs may be more common and the chances of encountering supportive information (e.g., favourable public opinion) may therefore be higher.

The Overfitting Hypothesis may not only apply to Conspiracy Theories, but also to other types of implausible belief. For instance, a belief in supernatural miracles could be an example of overfitting to awe-inspiring data. Indeed, reasoning biases have been found in association with many other types of implausible belief, including paranormal beliefs (e.g., Rogers et al., 2009, 2011, 2018, 2019), delusional beliefs (e.g., van der Leer et al., 2015, 2017), religious fundamentalism (Bronstein et al., 2020), and acceptance of fake news (Bago et al., 2020; Pennycook & Rand, 2020). Differences based on plausibility have also been reported by Pennycook & Rand (2019) regarding fake news acceptance. It may therefore be interesting to see if similar variations exist with other categories of implausible belief. For instance, in the case of supernatural beliefs, young earth creationism might be more strongly correlated with reasoning biases than generic theism, which is comparably more parsimonious. Such a result would be consistent with the present findings, and also with the account above suggesting that reasoning biases are linked to overfitted beliefs.

Our findings have implications for engaging with conspiracy theories in the wider world. The label “conspiracy theory” has a history of pejorative usage implying mental instability and paranoia on the part of believers (Dentith, 2016), and plausible conspiracy theories are often dismissed through mere use of this label (Husting & Orr, 2007; Dentith & Orr, 2018). Even historically true conspiracy beliefs have been dismissed by critics through mere application of the label, though typically before they are verified as historically true. Our results provide evidence, however, that not all unconfirmed conspiracy beliefs show similar reasoning profiles to one another. In this regard, plausible “conspiracy theories” resemble historically true ones (Moulding et al, 2016). A more nuanced approach to the term “conspiracy theory” may therefore be warranted.

The present work also has implications for strategies to reduce conspiracy beliefs. For instance, some studies have explored the effects of debunking information on conspiracy belief with mixed results (e.g., Swami et al, 2013; Warner & Neville-Shepard, 2014; Orosz et al, 2017). For someone who endorses an overfitted Conspiracy Theory, however, debunking information may only exacerbate anxious feelings. An alternative approach involves displaying empathy for conspiracy believers, through taking their perspective, engaging in active listening, and carefully avoiding ridicule or competitive argumentation (Lewandowsky & Cook, 2020; Lewandowsky et al, 2021). Empathic approaches have worked in related domains such as the de-radicalisation of extremists (see Ponsot et al, 2018). This suggestion fits the Overfitted Hypothesis in two ways. Firstly, if Conspiracy Theories hold more appeal in unsettling contexts, an empathic approach could help detect which states are in play for believers (e.g., anxiety, uncertainty, threat, social identity salience). In turn, debunking attempts may be adjusted to speak more directly to those needs. Secondly, if Conspiracy Theories generalise poorly, and if in turn new information has an increased propensity to

renew anxieties, an empathic approach may help reduce the dissonance that new information might induce.

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Supplementary Materials

The following is included as supplementary material:

- i) Further information on the materials used in the three reasoning tasks
- ii) A summary of the political and religious orientations of the participants from both studies, from the analyses reported in the main text (Table S5)
- iii) Results from the pre-registered analysis plan in Study 2

Study 1 & 2: Reasoning Task Materials

Table S1 contains specific information on the components used in the Jumping-to-Conclusions (JTC) task. Table S2 contains the exact sequences of grades shown to participants in the four trials during the JTC task. Table S3 contains the three items used in the Cognitive Reflection Test (CRT) from Primi et al. (2015). Finally, Table S4 contains the six custom-made items that we used in the Wason Card Task.

Table S1*A summary of components in the Jumping-to-Conclusions (JTC) task*

Component	Details
Sampling Pools	2 high schools
Individual Items	Student Grades
Item properties	Whether the student achieved: Pass Grade Fail Grade
Pool composition	Approx. 20-30% pass grades OR Approx. 70-80% pass grades

Table S2

All possible sequences of student grades that the participant is shown in the Jumping-to-Conclusions task.

Sequence	Study Review Scores (F = Fail; P = Pass)	
Sequence 1. Fail 1	F, P, F, F, P;	F, P, F, F, P;
	F, F, P, F, P;	F, F, P, F, P;
	F, F, P, F, P;	F, P, F, F, P;
	F, P, F, F, P;	F, P, F, F, P;
Sequence 2. Fail 2	P, F, P, F, F;	P, F, P, F, F;
	P, F, F, P, F;	P, F, F, P, F;
	P, F, F, P, F;	P, F, P, F, F;
	P, F, P, F, F;	P, F, P, F, F;
Sequence 3. Pass 1	P, F, P, P, F;	P, F, P, P, F;
	P, P, F, P, F;	P, P, F, P, F;
	P, P, F, P, F;	P, F, P, P, F;
	P, F, P, P, F;	P, F, P, P, F;
Sequence 4. Pass 2	F, P, F, P, P;	F, P, F, P, P;
	F, P, P, F, P;	F, P, P, F, P;
	F, P, P, F, P;	F, P, F, P, P;
	F, P, F, P, P;	F, P, F, P, P;

Table S3

Items from the revised Cognitive Reflection Test (Primi et al., 2015), along with their respective correct and intuitive wrong answers.

Problem	Correct Answer	Intuitive/Fallacious Answer
If 3 elves can wrap 3 toys in one hour, how many elves are needed to wrap 6 toys in 2 hours?	3	6
Jerry received both the 15 th highest and 15 th lowest mark in the class. How many students are there in the class?	29	30
In an athletics team, tall members are three times more likely to win a medal than short members. This year the team has won 60 medals so far. How many of these have been won by short athletes?	15	20

Table S4

Items used in the Wason Card Task. Cards 1 and 3 represent the correct answer.

Answering Card 1, Card 4, or both Card 1 and 4, represents a case of confirmation bias.

Hypothesis (if p, then q)	Card 1 (p)	Card 2 (not p)	Card 3 (not q)	Card 4 (q)
If the rabbit is brown, they were given lettuce for lunch.	Brown Rabbit	White Rabbit	Carrot	Lettuce
If the Rovers score the first goal against the Wanderers, they will win the game.	Rovers score first	Wanderers score first	Wanderers won	Rovers won
If a chocolate is wrapped in yellow foil, it will contain caramel.	Yellow Foil	Blue Foil	Nougat	Caramel
If it's a Friday, Martha will be on checkout duty.	Friday	Tuesday	Audrey	Martha
If it's a Saturday, the chef's special will be a pork dish.	Saturday	Sunday	Chicken dish	Pork dish
If the train stops in Blackpool, it will stop in Preston.	Stops in Blackpool	Does not stop in Blackpool	Does not stop in Preston	Stops in Preston

Study 1 & 2: Political and Religious Orientations

Table S5 shows the political and religious orientations of participants in Studies 1 and 2.

These were included as demographic questions at the end of each study alongside gender and age. In both studies, most participants identified as either Democrat or Republican, and as either Christian or non-religious.

Table S5

Political and religious orientations of participants, from the analyses reported in the main text.

Study	Measure	Responses
Study 1	Political	97 Democrat, 66 Republican, 13 Independent, 13 withheld,
	Orientation	2 Libertarian, 1 Socialist
	Religious	105 Christian, 75 No religion, 5 Buddhist, 5 withheld, 2
	Orientation	Jewish, 2 Hindu, 1 Wiccan, 1 anti-theist
Study 2 (flexible analysis)	Political	64 Democrat, 54 Republican, 10 withheld, 11 Independent,
	Orientation	1 Libertarian, 1 moderate, 1 independent (lean Republican)
	Religious	85 Christian, 47 No religion, 2 withheld, 2 Agnostic, 2
	Orientation	Jewish, 2 Muslim, 1 Atheist, 1 Buddhist

Study 2: Pre-registered Analyses

Of the 200 participants recruited from Amazon M-Turk, 134 failed the pre-registered attention check (see Main Text for more information on this check), leaving a total of 66 participants (25 Female, 41 Male. Mean age: 36.88. SD: 10.28. See Table S6 for Political and Religious Orientations). This gave 56.9% power of finding a medium effect with alpha at 0.01 (Faul et al, 2007, 2009).

Table S6

Political and religious orientations of the 66 participants in Study 2 who passed the attention check.

Political Orientation	29 Democrat, 28 Republican, 4 withheld, 4 Independent, 1 independent (lean Republican)
Religious Orientation	38 Christian, 26 No religion, 1 Jewish, 1 Buddhist

Results

Figure S1 shows the strength of belief in the twelve individual conspiracy theories and their four respective categories. As in the analyses reported in the main text, mean belief was highest for the plausible category (M: 11.99, 95% CI [10.77, 13.20]), followed by Government Agenda (M: 8.47, 95% CI [7.10, 9.85]) and Liberal Agenda categories (M: 7.26, 95% CI [5.74, 8.79]), and lowest for the Space-related category (M: 6.03, 95% CI [4.45, 7.60]). The four categories were examined for internal reliability using Cronbach's Alpha. Similar to Study 1, the implausible categories all met the pre-registered criteria of 0.7 (Government Agenda, $\alpha = 0.86$; Liberal Agenda, $\alpha = 0.89$; Space Related: $\alpha = 0.94$). The

Plausible category was not sufficiently reliable (Plausible: $\alpha = 0.66$). Plausible items were therefore analysed separately whilst other categories were collapsed.

Figure S1

Mean (+/- 95% CI) degree of belief in the four categories of conspiracy theories and the twelve individual conspiracy theories, with overlaid violin plot, from the 66 participants in Study 2 who passed the pre-registered attention check. Left-most (darkest) columns in each plot indicate the full category, and the three lighter columns represent the individual conspiracy theories that constitute the category. Belief was highest for the plausible category and lowest for the space-related items.

Jumping-to-Conclusions task. Figure S2 displays significant negative correlations between Decision Threshold and Government Agenda [$r(64) = -.48, p < .001$], Liberal Agenda [$r(64) = -.40, p < .001$], and Space-related categories [$r(64) = -.48, p < .001$]. For the Plausible items, Climate Cover-up was unrelated to Decision Threshold [$r(64) = -.05, p = .68$]. Belief in the Trump & Russia item was mildly correlated with Decision Threshold [$r(64) = -.24, p = .051$] as was belief in the Salisbury item [$r(64) = -.28, p = .025$], though neither was significant at the pre-registered alpha level.

Comparing correlations using exploratory Steiger's Z tests, beliefs in Space-Related conspiracy theories were more strongly correlated with decision threshold than was belief in the Climate Cover-up item [$z = 2.92, p = .003$], but were no differently correlated than were other Plausible items [Trump & Russia: $z = 1.87, p = .061$; Salisbury: $z = 1.66, p = .10$]. Liberal Agenda beliefs were more strongly correlated with decision threshold than was the Climate Cover-up item, though mildly [$z = 2.14, p = .033$], but not reliably stronger than the other Plausible items [Trump & Russia: $z = 1.07, p = .29$; Salisbury: $z = 0.94, p = .34$] Belief in Government Agenda conspiracy theories was more strongly correlated with decision threshold than was belief in the Climate Cover-up item [$z = 3.33, p = .001$], but no differently than was belief in the Salisbury item [$z = 2.07, p = .039$], but no differently than was belief in the Salisbury item [$z = 0.94, p = .34$]. These results were the only notable difference with those in the main task, though they were underpowered.

Figure S2

Correlations between Conspiracy Beliefs and Decision Threshold in the Jumping-to-Conclusions task in Study 2, from the 66 participants who passed the pre-registered attention check. The top row contains the three implausible categories; belief in these conspiracy theories was negatively correlated with decision threshold. The bottom row contains individual plausible items. Belief in the Salisbury item was also negatively correlated with Decision Threshold, Trump & Russia was mildly correlated, and Climate Cover-up belief did not correlate with decision threshold. Error band = 95% CI.

Cognitive Reflection Test. Figure S3A displays strong negative correlations between correct responses and Government Agenda [$r(64) = -.50, p < .001$], Liberal Agenda [$r(64) = -.61, p < .001$], and Space-related conspiracy beliefs [$r(64) = -.59, p < .001$]. There was no correlation between correct CRT responses and Climate Cover-up [$r(64) = .07, p = .56$] or Trump & Russia [$r(64) = -.09, p = 0.50$]. Belief in the Salisbury item was negatively associated with correct responses [$r(64) = -.21, p = .093$].

Comparing correlations with exploratory Steiger's Z tests, beliefs in Space-related conspiracy theories were more strongly correlated with correct responses than any plausible item [Climate Cover-up: $z = 4.60, p < .001$; Trump & Russia: $z = 3.94, p < .001$; Salisbury: $z = 3.13, p = .002$], as were beliefs in Liberal Agenda conspiracy theories [Climate Cover-up: $z = 4.44, p < .001$; Trump & Russia: $z = 3.64, p < .001$; Salisbury: $z = 3.22, p = .001$]. Belief in Government Agenda conspiracy theories were more strongly correlated with correct responses than were beliefs in the Trump & Russia [$z = 3.45, p < .001$] and Climate Cover-up items [$z = 4.39, p < .001$], but only mildly stronger than was belief in the Salisbury item [$z = 2.44, p = .015$]. The implausible categories were no different from one another in their correlation strength with correct responses [all p 's $> .16$].

For intuitive responses in the CRT, Supplementary Figure 3B shows a significant positive correlations with Government Agenda [$r(64) = .38, p = .002$], Liberal Agenda [$r(64) = .47, p < .001$], and Space-Related conspiracy beliefs [$r(64) = .45, p < .001$]. No significant correlations were found with the plausible items [Climate Cover-up: $r(64) = .05, p = .70$; Trump & Russia: $r(64) = .08, p = .51$; Salisbury: $r(64) = .15, p = .22$].

Comparing correlations with Steiger's Z tests, we found that intuitive responses were correlated slightly more with belief in Government Agenda conspiracy theories than they were with any belief in any plausible item [Climate Cover-up: $z = 2.50, p = .012$; Salisbury: $z = 2.42, p = .015$; Salisbury: $z = 1.86, p = .063$]. Belief in Liberal Agenda conspiracy theories was more

strongly correlated with intuitive answers than was belief in the Climate Cover-up item [$z = 2.60, p = .009$], and slightly more so than were beliefs in either the Trump & Russia [$z = 2.51, p = .012$] or Salisbury items [$z = 2.34, p = .019$]. Belief in Space-related conspiracy theories was more strongly correlated with intuitive answers than were belief in either the Climate-Cover up [$z = 2.70, p = .007$] or Trump & Russia items [$z = 2.75, p = .006$], and slightly more so than was the Salisbury item [$z = 2.32, p = .020$]. The three implausible categories did not differ from one another in their correlation strength with intuitive answers [all p 's $> .34$].

Figure S3

Correlations between Conspiracy Beliefs and measures on the Cognitive Reflection Test in Study 2, from the 66 participants who passed the pre-registered attention check. A: Correct responses, which correlated negatively with the implausible categories, and mildly with the plausible Salisbury item, but not the other plausible items. B: Intuitive wrong answers, which correlated negatively with the implausible categories but not the plausible items. Error band = 95% CI.

Wason Card Task. Correct answers on the Wason Card Task (WCT) were unrelated to endorsement of items in the Plausible category [Climate Cover-up: $r(64) = .03, p = .82$. Trump & Russia: $r(64) = .13, p = .28$. Salisbury: $r(64) = .15, p = .22$]. Correct answers were also unrelated to belief in the implausible categories of conspiracy belief [Government Agenda: $r(64) = -.03, p = .82$. Liberal Agenda: $r(64) = -.11, p = .38$. Space-related: $r(64) = -.06, p = .65$]. In comparing these correlations with exploratory Steiger's Z tests, no differences were found between any combination of correlations [all p 's $> .07$].

Rates of confirmation bias were also not significantly correlated with belief in the Plausible items [Climate Cover-up: $r(64) = -.05, p = .70$. Trump & Russia: $r(64) = -.23, p = .068$; Salisbury: $r(64) = -.23, p = .065$]. Figure S4 shows negative correlations with belief in Government Agenda [$r(64) = -.34, p = .005$], Liberal Agenda [$r(64) = -.37, p = .002$], and Space-related conspiracy theories [$r(64) = -.43, p < .001$]. In comparing correlations using Steiger's Z tests, belief in the Climate Cover-up item was slightly less strongly correlated with rates of confirmation bias than was belief in any implausible category [Government Agenda: $z = 2.16, p = .031$; Liberal Agenda: $z = 1.98, p = .047$; Space-related: $z = 2.53, p = .012$]. No other differences were found between any other combination of correlations [all p 's $> .12$].

Figure S4

Correlations between Conspiracy Beliefs and measures on the Wason Card Task in Study 2, from the 66 participants who passed the pre-registered attention check. A: correct responses, which were unrelated to any conspiracy beliefs. B: rates of confirmation bias, which were negatively correlated with the implausible categories, but not the plausible items.

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