Religiosity and the Naturalness Bias in Drug and Vaccine Choices

In Press at the *Journal of Religion and Health*

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Funding

Financial support for the studies was provided by Gettysburg College and Lebanon Valley College.

Competing Interests

The authors do not have any financial/non-financial interests to disclose.

Author Contributions

Brian P. Meier (all studies), Amanda J. Dillard (Study 1), Li-Jun Ji (Study 2), and Courtney M. Lappas (all studies) contributed to the conceptualization and design of the studies. Material preparation and data collection were performed by Brian P. Meier and Courtney M. Lappas.

Brian P. Meier performed the data analyses with help from Adam K. Fetterman. The manuscript was written by all authors.

Ethics Approval

All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The studies were approved by the Gettysburg College Institutional Review Board.

Informed Consent

Informed consent was obtained from all participants included in the studies.

Data/Material Availability

Data presented in this paper (in SPSS format) and study questionnaires can be found at https://osf.io/mbkfu/.

Abstract

Research reveals a bias for natural versus synthetic drugs. We sought to determine if this bias is associated with religiosity. Three cross-sectional studies (N = 1,399 U.S. participants) were conducted to examine the impact of religiosity on the naturalness bias in the drug and vaccine domains. We assessed measures of religiosity, preferences for natural versus synthetic drugs and vaccines in hypothetical scenarios, and a health-related behavior: COVID-19 vaccination status. The results revealed that participants high versus low in religiosity had stronger preferences for natural versus synthetic drugs and vaccines. Furthermore, participants high versus low in religiosity were less likely to have taken the COVID-19 vaccine, and the natural drug bias was a mediator of this effect. Overall, participants higher in religiosity had a stronger preference for natural versus synthetic drugs and vaccines, and this preference had implications for health behavior.

Key Words: naturalness bias; natural; bias; drug; religion; religiosity; vaccine intentions

Religiosity and the Natural versus Synthetic Drug Bias

Items labeled with the term "natural" are abundant (e.g., natural hot dogs, natural drugs, natural vitamins, natural lawn care, etc.). This term may reflect the ingredients or processes involved in creating or delivering an item, but it also may be used to capitalize on the belief that natural items are better, healthier, or safer than unnatural, synthetic, or artificial items. This belief in the superiority of natural items has been labeled different things such as the naturalness bias or the natural-is-better bias (Baron et al., 1998; Meier et al., 2019a; Rozin et al., 2004), and represents the finding that people often prefer items with a natural label. For example, Rozin et al. (2004) showed that people preferred foods described as natural over foods described as being processed or human made. This naturalness bias has been found in a host of other domains and contexts when natural and non-natural items are compared: cigarettes (Czoli & Hammond, 2014), meat (Siegrist et al., 2018), soda (Skubisz, 2017), colors (Nascimento et al., 2021), and human talent or achievement (Tsay & Banaji, 2011). The naturalness bias occurs even when natural and non-natural items are described as being identical (Meier et al., 2019a).

Research has examined the naturalness bias in the context of medical decision making. Meier and Lappas (2016) examined preferences for natural versus synthetic drugs and found that people preferred a natural to a synthetic drug for both minor and serious hypothetical medical conditions even when the drugs were described as equally safe and effective. These studies also revealed that some people preferred a natural drug even when it was described as less safe or less effective than a synthetic drug. These effects were replicated in behavioral choices, and the authors also found that the natural drug bias could be reduced with a rational appeal (Meier et al., 2019b). The studies examined U.S. participants, but other work has conceptually replicated these

effects in Chinese samples (Cao & Li, 2021; Li & Cao, 2020, 2022). Research has also shown that physicians can be susceptible to the natural drug bias as well (Lappas et al., in press).

Why is the naturalness bias prevalent? Meier et al. (2019a; also see Rozin et al., 2004, Scott & Rozin, 2020) suggested that a naturalness bias may be driven by a default nature-is-good belief as well as the belief that natural items are safer than unnatural items. Natural items might, in fact, be beneficial in some cases. However, it is inaccurate to assume that items with a natural label are always better or safer than unnatural or synthetic items (Meier et al., 2019a; Scott & Rozin, 2020). For example, many natural compounds, such as botulinum toxins and arsenic, are extremely toxic, whereas many synthetic or unnatural items, such as chemotherapeutic or antiviral drugs, are beneficial.

The natural drug bias appears robust, but research has not routinely focused on individual differences in the bias (Meier et al., 2019a). In other words, do people differ in the extent to which they prefer a natural versus synthetic drug? The identification of individual differences allows us to understand who is more versus less likely to be biased towards natural drugs in everyday life. Such biases might have important consequences such as selecting or forgoing treatment because of the naturalness or non-naturalness of a drug in question.

Religiosity, broadly construed, might be one such individual difference variable. Religiosity's influence on physical and mental health has been examined for some time (Koenig et al., 2012). In specific relation to natural and synthetic drugs, past work has shown that people higher in religiosity have a general distrust of science and scientific authorities (e.g., Chan, 2018; McPhetres & Zuckerman, 2018), and a skepticism of vaccines in general (e.g., Rutjens et al., 2018) and of specific vaccines such as COVID-19 vaccines (e.g., Funk & Gramlich, 2021). This somewhat negative view of science and things associated with the scientific realm (e.g., synthetic

drugs or vaccines) may increase religious people's preference for naturalness, including natural drugs, vaccines, and other items with a natural label. Research has also suggested that some people associate God with nature, natural processes, or the earth (Fetterman et al., 2021; although see Eom et al., 2021, for a more nuanced examination of the link between belief in God and environmental views). Relatedly, the belief that God is associated with nature, natural processes, or the earth might function as a type of "divine protection" belief or the idea that if God created nature, items that come from nature might be safer than items that do not come from nature. These types of ideas led us to hypothesize that people higher in religiosity would have stronger natural drug and vaccine biases.

To the best of our knowledge, only one study has examined religiosity and the preference for natural versus synthetic drugs. Cao and Li (2021) found that more religious Chinese Taoists had a stronger natural drug bias than less religious Chinese atheists. They also found that Taoists were higher in their connection to nature (i.e., trait relatedness to nature) compared to atheists, which coincides with Taoists' beliefs about being in harmony with the natural world. These effects might suggest that religiosity is associated with a stronger natural drug bias among participants in the U.S., but data is lacking in this regard. We sought to examine the extent to which religiosity was predictive of the naturalness bias in three studies We also examined the impact such a bias may have on COVID-19 vaccination status, an important health-related behavior.

Overview of Studies

In three studies (total $N = 1{,}399$), we examined if there was an association between religiosity and the preference for natural versus synthetic drugs and vaccines. In Study 1, we examined belief in God and the natural versus synthetic drug bias. In Study 2, we assessed belief

in God, but changed the drug context to a natural versus synthetic vaccine context. In Study 3, we assessed the natural drug bias and three measures of religiosity, belief in God, religiousness, and religious affiliation. We also sought to determine if the natural drug bias mediated the relationship between religiosity and obtaining the COVID-19 vaccine.

Data Statement and Sample Size Considerations

In all studies, we report all measures, conditions, data exclusions, and the way we determined sample sizes. The studies were approved by the Gettysburg College Institutional Review Board and informed consent was obtained from all participants included in the studies. Study questionnaires and SPSS data files for the data presented in this paper are available at the following website: https://osf.io/mbkfu/.

Participants in all studies were from Prolific.co, which is a crowdsourcing website with tens of thousands of participants used in marketing and behavioral research. Participants were located in the U.S., listed English as their first language, and had U.S. nationality. The three studies were part of larger data-collection sessions and therefore included additional measures that were collected for other purposes. We listed these additional measures in the Appendix.

In all studies, we collected as many participants as possible while considering adequate statistical power to find small effects and the financial resources we had available for each study. We attempted to collect 500 participants in Studies 1 and 3 and 400 participants in Study 2. We ended up with 499 participants in Study 1, 400 participants in Study 2, and 500 participants in Study 3. These sample sizes provide 80% power to detect a correlation coefficient of at least +/- .14 (a small effect size) and a *d* of at least +/- .20 (a small effect size) in a one-sample or paired-samples *t* test.

Study 1

Method

Participants

Four-hundred and ninety-nine participants were recruited from Prolific.co. Participants were paid $1.17 for the study, which took a median of 8.18 minutes to complete. Table 1includes the demographic characteristics of the participants.

Nine participants were removed from data analyses because their study completion times were at least 3 S*D*s from the mean. The final sample size was 490.

Materials and Procedure

After giving informed consent, participants first wrote for four minutes about either a neutral topic, an experienced related to nature, or an experience related to science (for purposes of a separate study). This manipulation did not affect the measures reported below and is not included in further analyses. Participants also answered a question about a hypothetical medical condition based upon past work by Meier and Lappas (2016) and Meier et al. (2019b):

> We are now interested in your preferences for a drug. Imagine that you need to take a drug to treat a medical condition. You have two options to choose from:
>
> **Option 1 is a drug made from synthetic ingredients**. Studies have been conducted on this drug for 20 years. It has been shown to be effective in 85% of users. The drug has also been shown to cause mild side effects on rare occasions and serious side effects in 0.5% of users.
>
> **Option 2 is a drug made from natural ingredients**. Studies have been conducted on this drug for 20 years. It has been shown to be effective in 85% of users. The drug has also been shown to cause mild side effects on rare occasions and serious side effects in 0.5% of users.
>
> Assuming cost is not a concern, please use the scale to rate which drug you would be likely to take.
>
> 1 = I strongly prefer taking the drug made from synthetic ingredients
> 2

3 = I moderately prefer taking the drug made from synthetic ingredients
4
5 = I have no preference between the two drugs
6
7 = I moderately prefer taking the drug made from natural ingredients
8
9 = I strongly prefer taking the drug made from natural ingredients

The drug type and scale endpoints were counterbalanced across participants (e.g., some participants had "synthetic" first and some participants had "natural" first). The safety and effectiveness of the drugs were said to be identical, so a preference for one drug over the other would constitute a bias or preference. Participants also completed a one-item rating of their belief in God: "To what extent do you believe God exists?" (1 = not at all; 4 = moderately; 7 = fully and completely). Participants also completed demographic questions and were then debriefed about the true nature of the study. Other measures included for separate purposes are listed in the Appendix.

Results and Discussion

We first examined if participants were biased in terms of which drug (natural or synthetic) they would choose to take. The drug rating question was scored so that higher numbers represented a stronger likelihood of preferring to take the natural versus synthetic drug. An unbiased finding would be one in which participants had a mean rating that was not different than 5 ("I have no preference between the two drugs"). The participants' mean drug rating (M = 7.12; SD = 1.89) was significantly higher than the scale mid-point of 5, $t(489) = 24.92$, $p < .001$, $d = 1.13$ (95% CI: 1.01, 1.24), indicating a bias for the natural drug.

We next examined the relationship between belief in God (M = 3.84; SD = 2.43) and drug preference. This relationship was positive and significant, $r(488) = .28$ (95% CI: .20, .36), $p <$

.001. As belief in God increased, so did participants preference for the natural versus synthetic drug and vice versa[1].

The results of Study 1 revealed that participants were biased in preferring the natural versus synthetic drug even though the two drugs were said to be identical in terms of safety and effectiveness. This finding replicates past work (e.g., Cao & Li, 2021; Meier & Lappas, 2016; Meier et al., 2019b). More importantly, we extended this work by revealing that belief in God was related to this bias as people who reported a higher belief in God also had a higher natural drug bias, and people who reported a lower belief in God had a lower natural drug bias.

In Study 2, we sought to replicate and extend the findings from Study 1. We changed the context from natural and synthetic drugs to a related but different context, natural and synthetic vaccines. Furthermore, participants rated their preference for taking both the natural and synthetic vaccines in two separate questions rather than in one question. This context change allows us to determine if the effect of religiosity is apparent beyond a drug context. We also asked participants about the safety and effectiveness of the both the natural and synthetic vaccines. We sought to determine if belief in God was related to vaccine preference and safety and efficacy beliefs.

Study 2[2]

Method

Participants

Four hundred participants were recruited from Prolific.co. Participants were paid $.60 for the study, which took a median of 3.63 minutes to complete. Table 1 includes the demographic characteristics of the participants.

Ten participants were removed from data analyses because their study completion times were at least 3 S*D*s from the mean. The final sample size was 390.

Materials and Procedure

After giving informed consent, participants answered a question about a hypothetical virus and vaccine that was meant to be similar to the question used in Study 1:

> Imagine that there is a virus that causes a very painful rash. It most often appears as a single stripe of blisters that wraps around either the left or the right side of your torso, but it can also appear on your face or around your eyes. It's not life-threatening, but it can be very painful. Vaccines can help reduce the risk. Doctors have recommended that you should take a vaccine for it. There are two options:
>
> **Option 1 is a vaccine made from mostly synthetic ingredients NOT FOUND in nature**. Studies have been conducted on this vaccine for 20 years. It has been shown to be effective in 85% of users. The vaccine has also been shown to cause mild side effects on rare occasions and serious side effects in 0.5% of users.
>
> **Option 2 is a vaccine made from mostly natural ingredients FOUND in nature**. Studies have been conducted on this vaccine for 20 years. It has been shown to be effective in 85% of users. The vaccine has also been shown to cause mild side effects on rare occasions and serious side effects in 0.5% of users.

After reading the scenario, participants were asked to rate how likely (1 = not at all likely; 5 = moderately likely; 9 = very likely) they would be to take *each* vaccine type. The vaccine options and the likelihood questions were counterbalanced across participants (i.e., some participants had "synthetic" first and some participants had "natural" first). Participants also rated their perception of the safety and effectiveness of each vaccine on a 9-point scale (1 = not at all safe/effective; 5 = moderately safe/effective; 9 = very/safe effective).

Participants also completed the same one-item rating of belief in God used in Study 1. Participants also completed measures for different purposes other than the current project (see Appendix) and demographic questions. Participants were then debriefed about the true nature of the study.

Results and Discussion

We first examined if people had a bias in terms of the vaccine they would be likely to take. An unbiased finding would be one in which participants rated themselves equally likely to take the natural and synthetic vaccines. Participants' ratings revealed that they would be significantly more likely to take the natural vaccine (M = 7.25; SD = 2.03) versus the synthetic vaccine (M = 4.69; SD = 2.55), $t(389) = 16.18$, $p < .001$, $d = .82$ (95% CI: 70, 93).

We next examined safety and effectiveness ratings. Participants rated the natural vaccine as significantly safer than the synthetic vaccine (M = 7.21; SD = 1.64 versus M = 6.22; SD = 2.22) and the natural vaccine as significantly more effective than the synthetic vaccine (M = 7.24; SD = 1.42 versus M = 7.07; SD = 1.61), safety: $t(389) = 10.53$, $p < .001$, $d = .53$ (95% CI: .43, .63), effectiveness: $t(389) = 2.73$, $p = .007$, $d = .14$ (95% CI: .04, .24).

Most importantly, we examined if belief in God (M = 3.67; SD = 2.38) was associated with the likelihood of taking the natural versus synthetic vaccines. We also examined if belief in God was associated with the safety and effectiveness ratings. We used three Linear Mixed Effects Models to examine these effects, one for the likelihood of taking each vaccine, one for the safety ratings, and one for the effectiveness ratings. We followed the recommendations of Barr et al. (2013) by including random effects for participants. We report the fixed effects below.

We first examined the likelihood of taking the vaccines and belief in God. The main effect of vaccine type was significant, $F(1,388) = 277.74$, $p < .001$, partial eta squared = .42 (90% CI: .36, .47). This effect is the same as the one described above. The main effect of belief in God was also significant, $F(1,388) = 24.09$, $p < .001$, partial eta squared = .06 (90% CI: .03, .10), which revealed that people low in belief in God had higher overall vaccine ratings than people high in belief in God (see Figure 1). The interaction between vaccine type and belief in

God was significant, $F(1,388) = 24.60$, $p < .001$, partial eta squared = .06 (90% CI: .03, .10). The estimated likelihood of taking each vaccine for participants low and high in belief in God is shown in Figure 1. Although people low in belief in God preferred to take the natural versus synthetic vaccine, $b = 1.80$, $z = 8.27$, $p < .001$, the effect was almost twice as large for people high in belief in God, $b = 3.32$, $z = 15.29$, $p < .001$[3].

We next examined safety ratings of the vaccines and belief in God. The main effect of vaccine type was significant, $F(1,388) = 123.69$, $p < .001$, partial eta squared = .24 (90% CI: .18, .30). This effect is the same as the one described above. The main effect of belief in God was also significant, $F(1,388) = 28.65$, $p < .001$, partial eta squared = .07 (90% CI: .03, .11), which demonstrated that people low in belief in God had higher overall safety ratings than people high in belief in God (see Figure 2). The interaction between vaccine type and belief in God was significant, $F(1,388) = 45.80$, $p < .001$, partial eta squared = .11 (90% CI: .06, .16). The estimated safety ratings for participants low and high in belief in God are shown in Figure 2. Although people low in belief in God rated the natural vaccine as safer than the synthetic vaccine, $b = .39$, $z = 3.07$, $p = .002$, the effect was almost four times as large for people high in belief in God, $b = 1.59$, $z = 12.65$, $p < .001$[3].

Finally, we examined effectiveness ratings of the vaccines and belief in God. The main effect of vaccine type was significant, $F(1,388) = 7.89$, $p = .005$, partial eta squared = .02 (90% CI: .00, .05). This effect is the same as the one described above. The main effect of belief in God was also significant, $F(1,388) = 24.99$, $p < .001$, partial eta squared = .06 (90% CI: .03, .10), which revealed that people low in belief in God had higher overall effectiveness ratings than people high in belief in God (see Figure 3). The interaction between vaccine type and belief in God was significant, $F(1,388) = 23.23$, $p < .001$, partial eta squared = .06 (90% CI: .02, .10). The

estimated effectiveness ratings for participants low and high in belief in God are shown in Figure 3. People low in belief in God did not rate the effectiveness of the vaccines differently, b = -.12, z = -1.43, p = .154. However, people high in belief in God rated the natural vaccine as more effective than the synthetic vaccine, b = .45, z = 5.40, $p < .001$[3].

The results of Study 2 revealed that participants were biased in preferring a natural versus a synthetic vaccine even though their safety and effectiveness was presented as being identical. Furthermore, participants rated the natural vaccine as both safer and more effective than the synthetic vaccine (again, even though these factors were said to be identical). These effects were stronger for people high versus low in belief in God.

In Study 3, we further sought to replicate and extend the effects from Studies 1 and 2. First, we measured religiosity in a broader manner by focusing on belief in God, self-reports of religiousness, and religious affiliation. These additional assessments of religiosity allow us to consider religiosity in a way that moves beyond belief in God. Second, we sought to determine if religiosity and the natural drug bias had potential implications for understanding an important health behavior related to natural and synthetic concerns, obtaining the COVID-19 vaccine.

Study 3

Method

Participants

Five hundred participants were recruited from Prolific.co. Participants were paid $.45 for the study, which took a median of 2.48 minutes to complete. Table 1 includes the demographic characteristics of the participants.

Eleven participants were removed from data analyses because their study completion times were at least 3 S*D*s from the mean. The final sample size was 489.

Materials and Procedure

After giving informed consent, participants answered a question about a hypothetical medical condition that was almost identical to the one used in Study 1. The only difference was in the way the drugs were described (made from ingredients found or not found in nature) and the lack of counterbalancing for the order of the options and the response scale (an oversight):

> Imagine that you learn that you have a medical condition and you need to take a drug to treat it. You have to choose between one of the two options shown below:
>
> **Option 1 is a synthetic drug made from ingredients NOT FOUND in nature**. Studies have been conducted on this drug for 20 years. It has been shown to be effective in 85% of users. The drug has also been shown to cause mild side effects on rare occasions and serious side effects in .5% of users.
>
> **Option 2 is a natural drug made from ingredients FOUND in nature**. Studies have been conducted on this drug for 20 years. It has been shown to be effective in 85% of users. The drug has also been shown to cause mild side effects on rare occasions and serious side effects in .5% of users.
>
> Select a number below that reflects which drug you would prefer to take:
>
> 1 = I strongly prefer the synthetic drug
> 2
> 3 = I moderately prefer the synthetic drug
> 4
> 5 = I have no preference between the two drugs
> 6
> 7 = I moderately prefer the natural drug
> 8
> 9 = I strongly prefer the natural drug

Participants next completed three items that tapped religiosity in different ways. One item assessed their ratings of religiousness: “To what extent are you a religious person”, which was answered on a 7-point scale (1 = not at all religious; 3 = slightly religious; 5 = moderately religious; 7 = very religious). Another item focused on belief in God in a way that varied slightly from Studies 1 and 2: “To what extent do you agree with this statement: I believe God exists”, which was answered on a 7-point scale (1 = do not agree at all; 3 = slightly agree; 5 =

moderately agree; 7 = strongly agree). Finally, participants were asked to "please select the religious descriptor that best describes your preference": agnostic, atheist, Buddhist, Christian, Muslim/Islamic, Hindu, Jewish, or a religious descriptor not listed.

Participants were also asked "Have you received a COVID-19 vaccine?" The response options were "no, I have not received a vaccine" or "yes, I am fully or partially vaccinated". Participants also completed measures for different purposes from the current project (see Appendix) and demographic questions. At the end of the questionnaire, participants were debriefed about the true nature of the study.

Results and Discussion

We first examined if people had a bias in terms of which drug they would prefer. As in Study 1, an unbiased finding would be one in which participants had a mean rating that was not different than 5 ("I have no preference between the two drugs"). We again found that participants' mean drug choice rating (M = 6.92; SD = 1.83) was significantly higher than the scale mid-point of 5, $t(488) = 23.29$, $p < .001$, $d = 1.05$ (95% CI: .94, 1.16), which revealed a bias for the natural drug.

Next, we examined the relationships between the preference for the natural versus synthetic drug and the three measures of religiosity: religiousness (M = 2.83; SD = 2.02), belief in God (M =3.94; SD = 2.39), and religious affiliation (201 Christian, 132 agnostic, 101 atheist, 10 Jewish, 7 Buddhist, 6 Muslim/Islamic, 3 Hindu, and 29 other categories). Religiousness, $r(487) = .16$ (95% CI: .07, .26), $p < .001$, and belief in God, $r(487) = .22$ (95% CI: .13, .30), $p < .001$, were both positively and significantly related to the drug rating. As religiousness or belief in God increased, so did participants preference for the natural versus synthetic drug and vice versa[4]. In order to examine how religious affiliation affected the drug rating, we combined the

agnostic and atheist groups (n = 233) and examined their mean drug choice compared to the combined Christian, Jewish, Buddhist, Muslim/Islamic, and Hindu groups (n = 227). Although these latter religious groups have different underlying beliefs, they are religious affiliations, which allowed us to compare groups who identify less versus more with religion (similar to the work of Cao & Li, 2021). The results are similar when we only compared atheists and agnostics to Christians. We removed participants who reported "other" from the analysis. The participants who reported belonging to a religious affiliation had a stronger natural drug bias (M = 7.13; SD = 1.89) compared to agnostic/atheist participants (M = 6.65; SD = 1.74), $t(458) = 2.86$, $p = .004$, d = .27 (95% CI: .08, .45)[4].

Finally, we examined the links between religiosity, the natural drug bias, and COVID-19 vaccination status. We expected that religiosity would be related to COVID-19 vaccination status and that the natural drug bias would mediate these relationships. Most participants (364 or 74.40%) reported that they had been partially or fully vaccinated. As shown in Table 2, participants who had not been vaccinated versus participants who were fully or partially vaccinated were higher in religiousness, belief in God, and the natural drug bias. Additionally, a higher percentage of atheist and agnostic participants (187 of 233; 80.30%) were vaccinated compared to Christian, Jewish, Buddhist, Muslim/Islamic, and Hindu participants (158 of 227; 69.60%), χ^2 (1, N = 460) = 6.96, p = .008, Cramer's Phi = .12 (95% CI: .03, .23).

We examined if the natural drug bias mediated the relationships between each of the measures of religiosity and COVID-19 vaccination status. We used the Hayes Process Macro for SPSS version 3.5 with 5,000 bootstrap samples (Hayes, 2012). The indirect effect was different than zero with all three measures of religiosity: religiousness, -.03 (95% CI: -.06, -.01), belief in God, -.03 (95% CI: -.06, -.01), and religious affiliation (agnostic/atheist = 1; Christian, Jewish,

Buddhist, Muslim/Islamic, Hindu = 2), -.10 (95% CI: -.21, -.02). Significant mediation occurred in each case[5].

Study 3 was perhaps the strongest test of the association between religiosity and the natural drug bias given that multiple measures of religiosity were examined. Furthermore, Study 3 included a measure of an important health-related behavior, COVID-19 vaccination status. We found that people high versus low in all measures of religiosity had a stronger natural drug bias. Furthermore, participants unvaccinated against COVID-19 were higher on all measures of religiosity compared to people vaccinated, and the natural drug bias mediated these relationships.

General Discussion

The results of three studies revealed that participants high versus low on multiple measures of religiosity had a stronger preference for natural versus synthetic drugs and vaccines. Furthermore, participants high versus low on multiple measures of religiosity were less likely to have obtained the COVID-19 vaccine, and the natural drug bias was a mediator of this effect.

Theoretical Implications

The studies replicate past work in showing that the natural drug bias is robust. We found the basic bias in all studies even with different medical scenarios and different response options. The effect size was large in all studies, which coincides with past work (Meier & Lappas, 2016; Meier et al., 2019b; Cao & Li, 2021; Li & Cao, 2020, 2022). More importantly, we extended the work by Cao and Li (2021) who found a stronger natural drug bias among more religious (Taoists) versus less religious (atheists) Chinese participants. The religious individuals examined by Cao and Li (2021) were Chinese Taoists, who the authors contend believe in being in harmony with the natural world. This religion encourages connection with the natural world and rejects unnatural things (e.g., sugar, alcohol, etc.). Cao and Li (2021) found that these individuals

have a stronger naturalness bias with drugs, which seemingly coincides with their religious views. Yet, the current work found that individuals who believe more versus less in God or rate themselves as more versus less religious also were more likely to prefer natural to synthetic drugs and vaccines. These findings suggest that the results of Cao and Li (2021) extend to more general religious beliefs rather than only those that focus on a connection to nature. Future research should examine how other religions make choices in relation to natural and synthetic drugs and vaccines.

Practical Implications

Study 3 revealed that religiosity and the natural drug bias may have practical implications as well. In terms of vaccine usage, past work has shown that religiosity is positively associated with vaccine skepticism (Rutjens et al., 2018) and negatively associated with vaccine uptake (Funk & Gramlich, 2021). Also, research has shown that the natural drug bias is negatively associated with vaccination intentions in relation to COVID-19 (Meier et al., 2021). Study 3 extended this work by revealing that one potential reason that people high versus low in religiosity are less likely to get vaccinated is because they have a bias for natural over synthetic drugs. This effect coincides with findings that show that people higher in religiosity have a more negative view of science (McPhetres & Zuckerman, 2018). Religious individuals may view synthetic drugs and vaccines as created by scientists or unethical scientific processes and therefore these individuals may be less likely to use them. Furthermore, some work has found that the more people believe in the idea that God controls their health, the less likely they were to continue a prescribed medication regimen (Ahmedani et al., 2013). Synthetic versus natural drugs may be viewed as less under God's control. Practically, then, the results of the current

work suggest that religious individuals might be more likely to forgo vaccinations because they perceive vaccines to be unnatural.

The natural drug bias is one of many cognitive biases that affect medical decision making (Saposnik et al., 2016). Because people higher in religiosity have a stronger natural drug bias, religiosity may play a role in the context of more general health behavior even beyond vaccine uptake. For example, in situations in which a natural drug is available as a medical treatment option, people higher in religiosity might prefer that option and be more likely to follow the treatment to completion. This possibility may have either beneficial or detrimental behavioral outcomes. If a drug obtained from natural sources is at least as safe and effective than a synthetic alternative, the bias for the drug would benefit an individual in a health behavioral sense. In these situations, higher religiosity might increase healthy behavior. If, however, a synthetic alternative has a more favorable safety and/or efficacy profile, religious individuals' bias for natural drugs may be detrimental to their health behavior as it could result in an unwise decision to bypass the synthetic drug and take a less safe and/or effective natural option. In these situations, higher religiosity might decrease healthy behavior.

Limitations

The current results are not without limitations. First, as with similar research of the present type, the drug and vaccine scenarios were hypothetical in nature and may not represent behavior. The scenarios illustrate the thought- and decision-making processes of participants, but the decisions were based upon self-report. Yet, past work has demonstrated that the natural drug bias influences behavioral choices (Meier et al., 2019b; Li & Cao, 2022), which provides a behavioral confirmation of the hypothetical scenarios. Second, the studies relied upon single-item measures of religiosity. Although we assessed religiosity in three different ways in Study 3,

the questions were single item in nature and therefore did not tap religiosity in a comprehensive manner. Single-items scales have been shown to be reliable and valid (e.g., Dollinger & Malmquist, 2009; Konrath et al., 2014, 2018), but it would be useful to examine the ideas in the current studies with more extensive measures and facets of religiosity. Furthermore, many participants in the studies appeared to believe in an Abrahamic religion. Therefore, it would be useful to determine how the naturalness bias with drugs and vaccines extends beyond such beliefs (although see the discussion of Cao & Li, 2021, above). Finally, the mediation results in Study 3 were cross-sectional, observational, and correlational in nature, and some have suggested caution in interpreting these types of analyses in a causal manner (e.g., Rohrer, 2018).

Conclusion

Overall, our results reveal that more versus less religious participants had a stronger preference for natural versus synthetic drugs and vaccines, and this preference appeared to have implications for COVID-19 vaccine uptake. We conclude that the preference for natural drugs could have important implications for the medical decision making of religious individuals in terms of drug and vaccine usage.

Endnotes

[1]The relationship between drug choice and belief in God remained significant when controlling for age, gender, and race in a multiple regression analysis, Beta = .23, $t = 5.20$, $p < .001$.

[2]Some of the data from this study (the non-religious aspects) were examined in another paper that compares cross-cultural naturalness bias effects (Ji et al., in press).

[3]In order to determine if the relationships between belief in God and drug choice, drug safety ratings, and drug effectiveness ratings remained significant after controlling for age, gender, and race, we created difference scores for the drug ratings by subtracting natural ratings from synthetic ratings. Positive (negative) numbers mean that participants preferred the natural (synthetic) drug in terms of choice, safety, and effectiveness. The relationships between belief in God and drug choice, Beta = .23, $t = 4.54$, $p < .001$, drug safety ratings, Beta = .33, $t = 6.67$, $p < .001$, and drug effectiveness ratings, Beta = .24, $t = 4.74$, $p < .001$, remained significant when controlling for age, gender, and race in three separate multiple regression analyses.

[4]The relationships between drug choice and religiousness, Beta = .13, $t = 2.94$, $p = .003$, belief in God, Beta = .20, $t = 4.27$, $p < .001$, and religious affiliation (atheist or agnostic versus Christian, Jewish, Buddhist, Muslim/Islamic, or Hindu), Beta = .11, $t = 2.36$, $p = .019$, remained significant when controlling for age, gender, and race in three separate multiple regression analyses.

[5]The results were similar when age, gender, and race were entered as covariates in three mediation analyses (i.e., the indirect effects remained different than zero).

Appendix

Additional Measures Completed in Each Study

Study 1

Questions about writing experiences in general, a one-item happiness measure, a six-item trait humility scale, a one-item political orientation measure, and suspicion and attention checks based upon the priming manipulation.

Study 2

Questions about beliefs about vaccines in general, one question about neighborhood app/website usage, two questions about perceptions of violent and non-violent crime in participants' neighborhoods, a four-item trait neuroticism scale, a one-item self-location (brain or heart) scale, education level, and a one-item political orientation measure.

Study 3

Questions about healthcare, trust in medicine, a trait mindfulness scale, and a question that asked how much money participants would donate to a charity.

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Table 1. *Participant Demographic Characteristics*

	Study		
Variable	Study 1	Study 2	Study 3
N	499	400	500
Age (Years)	*M* = 39.55 (*SD* = 14.85)	*M* = 34.34 (*SD* = 12.46)	*M* = 34.43 (*SD* = 12.23)
Gender (*N*)			
Female	305	193	237
Male	180	200	252
Non-Binary	8	3	7
Other Categories	6	4	4
Race (*N*)			
Caucasian	375	305	379
Asian/Pacific Islander	40	41	39
Black/African American	35	20	38
Multi-Racial	26	10	20
Hispanic/Latino	20	23	24
Other Categories	3	1	0

Table 2. *Comparisons of the Continuous Measures of Religiosity and the Natural Drug Bias for Vaccinated and Unvaccinated Participants*

	Statistics by Sample Type				
Variable	Unvaccinated	Vaccinated	*t*	*p*	*d*
Religiousness	*M* = 3.25 (*SD* = 2.09)	*M* = 2.69 (*SD* = 1.97)	2.69	.007	.28 (95% CI: .07, .48)
Belief in God	*M* = 4.68 (*SD* = 2.34)	*M* = 3.69 (*SD* = 2.36)	4.07	<.001	.42 (95% CI: .22, .63)
Natural Drug Bias	*M* = 7.42 (*SD* = 1.77)	*M* = 6.75 (*SD* = 1.82)	3.55	<.001	.37 (95% CI: .16, .57)

Note: All differences remain significant when controlling for age, gender, and race, *ps* < .021.

Figure 1. *Estimated Means for the Likelihood of Taking Each Vaccine by Belief in God*

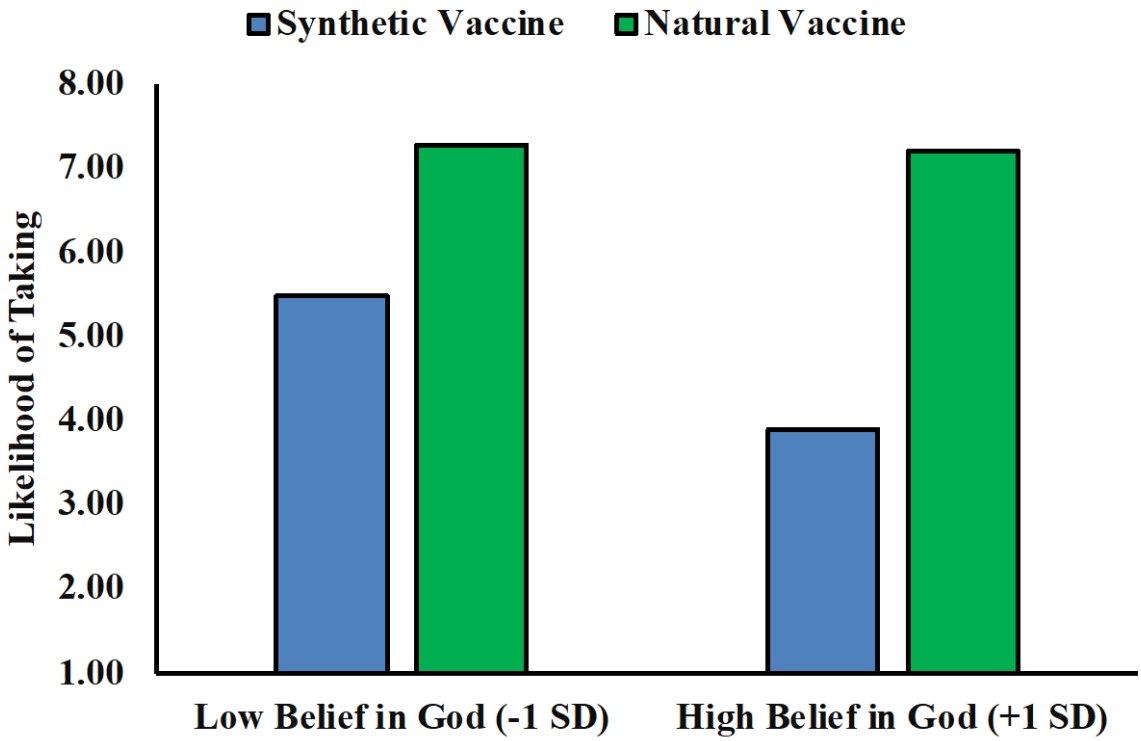

Figure 2. *Estimated Means for the Safety Rating of Each Vaccine by Belief in God*

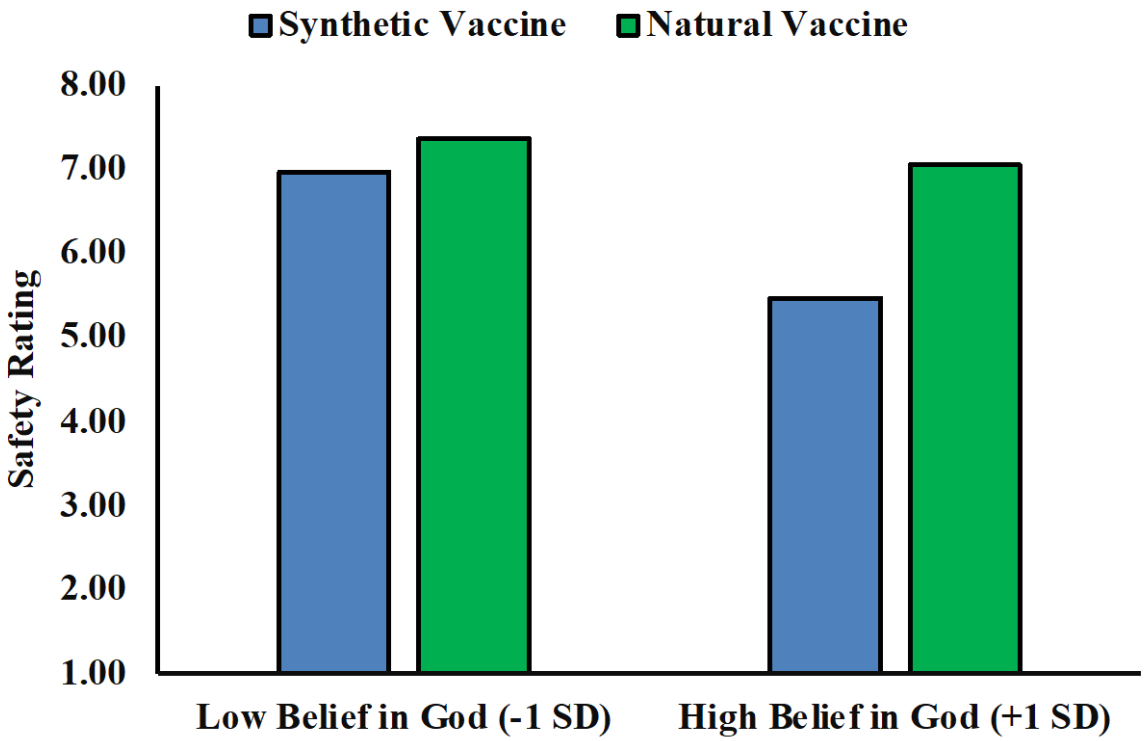

Figure 3. *Estimated Means for the Effectiveness Rating of Each Vaccine by Belief in God*