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A Behavioral Confirmation and Reduction of the Natural versus Synthetic Drug Bias

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A Behavioral Confirmation and Reduction of the Natural versus Synthetic Drug Bias

Abstract

Research reveals a biased preference for natural v. synthetic drugs; however, this research is based on self-report and has not examined ways to reduce the bias. We examined these issues in 5 studies involving 1125 participants. In a pilot study ($N = 110$), participants rated the term *natural* to be more positive than the term *synthetic*, which reveals a default natural-is-better belief. In studies 1 ($N = 109$) and 2 ($N = 100$), after a supposed personality study, participants were offered a thank you "gift" of a natural or synthetic pain reliever. Approximately 86% (study 1) and 93% (study 2) of participants chose the natural v. synthetic pain reliever, which provides a behavioral choice confirmation of the natural drug bias. In studies 3 ($N = 350$) and 4 ($N = 356$), participants were randomly assigned to a control or experimental condition and were asked to consider a scenario in which they had a medical issue requiring a natural v. synthetic drug. The experimental condition included a stronger (study 3) or weaker (study 4) rational appeal about the natural drug bias and a statement suggesting that natural and synthetic drugs can be good or bad depending on the context. In both studies, the natural bias was reduced in the experimental condition, and perceived safety and effectiveness mediated this effect. Overall, these data indicate a bias for natural over synthetic drugs in preferences and behavioral choices, which might be reduced with a rational appeal.

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A Behavioral Confirmation and Reduction of the Natural versus Synthetic Drug Bias

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Abstract

Research reveals a biased preference for natural versus synthetic drugs; however, this research is based upon self-report and has not examined ways to reduce the bias. We examined these issues in five studies involving 1,125 participants. In a Pilot Study ($N = 110$), participants rated the term natural to be more positive than the term synthetic, which reveals a default natural-is-better belief. In Studies 1 ($N = 109$) and 2 ($N = 100$), after a supposed personality study, participants were offered a thank you "gift" of a natural or synthetic pain reliever. Approximately 86% (Study 1) and 93% (Study 2) of participants chose the natural versus synthetic pain reliever, which provide a behavioral choice confirmation of the natural drug bias. In Studies 3 ($N = 350$) and 4 ($N = 356$), participants were randomly assigned to a control or experimental condition and were asked to consider a scenario in which they had a medical issue requiring a natural versus synthetic drug. The experimental condition included a stronger (Study 3) or weaker (Study 4) rational appeal about the natural drug bias and a statement suggesting that natural and synthetic drugs can be good or bad depending upon the context. In both studies, the natural bias was reduced in the experimental condition, and perceived safety and effectiveness mediated this effect. Overall, these data indicate a bias for natural over synthetic drugs in preferences and behavioral choices, which might be reduced with a rational appeal.

Key Words: natural bias; natural; preference; synthetic; perception; drug choice; health behavior

A Behavioral Confirmation and Reduction of the Natural versus Synthetic Drug Bias

The terms "natural" or "nature" are often used in product names and marketing materials. For example, one can purchase Applegate's Natural Beef Hot Dogs or Truvia's Natural Sweeteners. Manufacturers may use terms related to natural because people seem to assume that natural products are better and safer than unnatural, synthetic, or artificial products. Researchers have shown that people generally consider something to be natural when it lacks additives and processing[1,2]. Rozin et al.[3] showed that people preferred foods described as natural rather than processed or human made. Research has also found a natural bias with such diverse items as cigarettes[4], cultured or grown meat[5], perfumes[6], soda[7], and even hormone replacement therapy among obstetricians and gynecologists[8].

Rozin et al.[3] and others[9] find that a preference for natural items is based upon instrumental and ideational factors. Instrumental factors focus on the attributes of an item (e.g., a natural product is safer), whereas ideational factors focus on the inherent appeal of natural items, such as the idea that they are morally better because they are linked to nature. For example, participants rated natural versions of items such as cigarettes[4] or drugs[9] as safer than the non-natural or synthetic versions. These ratings suggest that natural may be preferred in some cases for instrumental reasons. Yet, the diversity of contexts in which natural is preferred suggests that there is also a natural-is-better default belief that operates in some situations. This view may coincide with the affect heuristic, or the notion that people's decisions may be guided by their emotions in an intuitive or automatic sense[10] . For example, if people have positive feelings associated with the term natural, this may guide them to process information about a natural product in a biased way, or to choose natural even though it may not be the best choice. We examine people's feelings associated with the term natural in a Pilot Study.

Meier and Lappas[11] examined preferences for natural versus synthetic drugs in a medical context. In a series of studies, they found that participants preferred a natural to a synthetic drug for a hypothetical medical condition even though the drugs were described as equally effective and safe. They found this preference for both minor and serious health conditions. Furthermore, some participants even preferred a natural drug when it was described as less safe or less effective than a synthetic drug. Additionally, natural drugs were perceived as safer but less effective than synthetic drugs regardless of the safety and effectiveness information given.

The U.S. Food and Drug Administration[12] does not regulate the term natural and it is therefore used to mean different things[13] such as organic, non-artificial, and derived from plants. Yet, research has shown that it is a term that has positive attributes across European and North American cultures[2]. Although natural products like drugs can be beneficial, it is inaccurate to assume that anything labeled natural is better or safer. For example, botulinum toxin and arsenic are natural, but highly deadly. The findings of Meier and Lappas[11] are concerning given that natural drugs, when marketed as supplements, are not always tested for safety and efficacy and natural drugs have sometimes been shown to have significant toxicities[14,15]. Furthermore, a bias in favor of natural drugs may have consequences for people's medical decision making. For example, people may choose a natural drug for a medical issue rather than a synthetic drug prescribed by their doctor.

Overview of Studies, Data Statement, and Power Statement

We conducted five studies to examine three questions, (1) do people prefer natural over synthetic in the absence of a context?; (2) does the natural drug bias occur in behavior?; and (3) can we reduce the natural drug bias? In a Pilot Study, we sought to determine if people believed the term natural is more positive than the term synthetic. In Studies 1 and 2, we sought to

determine if the natural versus synthetic drug bias would occur in a behavioral encounter. Prior work has been based upon hypothetical scenarios, but we used a behavioral decision to determine if the bias is reliable. In Studies 3 and 4, we sought to determine if we could reduce the natural drug bias using a rational appeal. All studies were approved either by the Gettysburg College or Grand Valley State University Institutional Review Boards.

In all of our studies, we report all measures, conditions, data exclusions, and the manner in which we determined sample sizes. We did not include any covariates in our analyses. All study materials and data are available upon request to the first author.

In five studies examining the natural versus synthetic drug bias, Meier and Lappas (2016)[11] found medium to large effect sizes. In their Studies 1a, 1b, and 4, which found the standard natural bias (e.g., would you choose a natural or synthetic drug?), the effect sizes found were Cramer's Phis = .58, .52, and .28 (for interpretation, .50 is large & .30 is medium[16]). In their Studies 2 and 3, they found that manipulations related to safety and efficacy were moderated by whether a drug was described as natural or synthetic (e.g., do people choose a natural or synthetic drug when the natural drug is less safe or less effective?) and the effect sizes for this moderation were medium, Cramer's Phis = .26 and .33. While these studies are not identical to our studies, they are the best effect size estimates available. In order to be conservative, we chose the low end and used a medium effect size estimate (Cramer's Phi = .30) for our a priori power analyses since our hypotheses were tested with a Chi Square test in Studies 1 through 4. In the Pilot Study, we use a dependent-samples t test to examine the hypothesis and we use a medium effect size again to estimate sample size, in this case d (a medium effect size with $d = .50$[16]). These power analyses are presented in the respective sections of the Pilot Study, Studies 1 and 2, and Studies 3 and 4.

Pilot Study

We estimated sample size using a medium effect size ($d = .50$[16]). A dependent-samples *t* test was used to examine the hypothesis that participants would rate "natural" to be more positive than "synthetic". We used G*Power 3.1 and found that a sample of 34 participants was required to reach 80% power. We sought to be conservative and attempted to collect data from 100 participants.

Method

Participants

Participants were 110 individuals (47 females; 61 males 2 non-report) with a mean age of 33.86 ($SD = 11.15$) years. The majority of the participants self-identified as Caucasian (87 or 79.10%), and the remaining participants self-identified as Asian/Pacific Islander (14 or 12.70%), Black (4 or 3.60%), mixed race (2 or 1.80%), Hispanic (1 or .90%), or unknown (1 or .90%). One participant did not report race. We removed five participants who gave the same rating for all words (leaving 105 participants).

Participants came from Amazon's Mechanical Turk (MTurk), a crowdsourcing website with thousands of individuals[17,18]. Participants from MTurk have been shown to be more demographically diverse than typical college student samples and to produce data as reliable as laboratory-based data[11,17]. We recruited people living in the U.S. who were 18 years of age or older (using MTurk's participant selection options). Participants were paid $0.35 for completing the study.

Materials and Procedures

We told participants on the consent form that the purpose of the research "is to learn about people's judgments and perceptions of common things". Participants were also told "you

will be asked to rate a number of words in terms of how negative or positive they are in meaning." Before the ratings started, participants were told to "please rate the words below in terms of their negative or positive meaning". Participants rated the valence (1 = very negative to 5 = neutral to 9 = very positive) of 17 words including natural and synthetic as well as filler words unrelated to these domains in order to disguise our true interest (kiss, region, horror, fireworks, hut, mistake, chart, dirty, fat, beach, cake, barrel, reward, garbage, & pour). Natural and synthetic occurred in the 7th and 14th positions, counter-balanced across participants. Participants were debriefed at the end of the study.

Results and Discussion

Participants rated natural (M = 6.78; SD = 1.28) as much more positive than synthetic (M = 4.50; SD = 1.27), $t(104)$ = 12.01, $p < .001$, d = 1.17. Additionally, the natural rating was significantly above the neutral point of 5, $t(104)$ = 14.29, $p < .001$, d = 1.39, while the synthetic rating was significantly below the neutral point of 5, $t(104)$ = -3.99, $p < .001$, d = -.39. The remaining filler words were rated in a manner consistent with their expected meaning (e.g., garbage was rated as being more negative than kiss). These rating results for natural and synthetic are consistent with a large normed word set that includes these terms[19].

These results suggest that there is an inherent positive belief about natural in a context-free situation. Additionally, the results show that the natural rating was three times farther from the mid-point of the scale than the synthetic rating. Thus, one reason for a natural bias may be due to a default natural-is-better default belief. In other words, people may prefer natural to synthetic, whether the item is food, drugs, beauty products or anything else. In the remaining studies, we specifically examine a behavioral confirmation (Studies 1 and 2) and attempted reduction (Studies 3 and 4) of the natural drug bias.

Study 1

In Studies 1 and 2, we estimated sample sizes using a medium effect size (Cramer's Phi = .30). A Chi-Square test goodness of fit was used to examine the hypothesis that participants would be more likely to choose the natural versus synthetic pain reliever. We used G*Power 3.1 and found that a sample of 88 participants was required to reach 80% power. We again sought to be conservative and attempted to collect data from at least 100 participants in each study.

Method

Participants

Participants were 109 individuals (75 females; 34 males) with a mean age of 22.10 (SD = 9.09) years. They were recruited from the campus of Gettysburg College in Pennsylvania, U.S. The majority of the participants self-identified as Caucasian (90 or 82.60%), and the remaining participants self-identified as Hispanic (10 or 9.20%), Asian/Pacific Islander (5 or 4.60%), or Black (2 or 1.80%). Two (1.80%) participants selected an "other" category.

Materials and Procedure

Due to the inherent challenges of conducting an ethical study examining the actual consumption of a natural versus synthetic drug, we focused on a behavioral choice that appeared real. We contacted participants walking on campus under the guise of a personality study, but we were really interested in whether people would accept a natural or synthetic pain reliever for participating in a study. A research assistant was instructed to walk around campus and look for potential participants who did not appear busy and were walking alone. Once a potential participant was identified, the research assistant approached and said:

"I'm running a psychology study and was wondering if you had 5 minutes to complete a simple questionnaire. I'll give you a chocolate bar for participating."

If participants agreed to take part in the study, the research assistant gave the participant a consent form to read and complete. Upon completion of the consent form, the research assistant gave the participant a personality questionnaire with 20 items. This questionnaire was used to reduce suspicions about the true purpose of the study, which was to determine if people would select a natural or synthetic pain reliever. The research assistant gave participants privacy during completion of this questionnaire by stepping back a few feet. When participants completed the personality items, they turned the page over and completed demographic questions. Upon completion of the questionnaire, the research assistant said:

> "Thanks for completing the questionnaire. Here is the candy bar (research assistant reached in a bag). Ahh, actually I forgot to tell you that our department has received several free samples of new non-prescription pain relievers. We decided to give them away to participants. We have two types, and we can give you one today for participating. One is a synthetic drug created in the laboratory by scientists and the other is a natural drug taken from a common plant. Which one would you like?"

We used the descriptions of natural and synthetic drugs created by Meier and Lappas[11]. We did not have actual pain relievers, but we wanted to make participants believe they would be receiving an actual drug. Although we have no way of knowing if participants viewed our cover story as credible, it did place them in a real situation in which a choice was necessary. After participants made a drug choice (no drug, natural, or synthetic), the research assistant debriefed the participants by telling them the true nature of the study. Finally, the research assistant gave participants a Hershey's chocolate bar and recorded participants' drug choices.

Results and Discussion

An unbiased finding would be one in which participants chose the drugs at an equal rate (50% for each drug) given that no additional information was provided. Figure 1 (left side) illustrates the frequency of the three choices, no drug, natural drug, and synthetic drug. Sixty of the 109 participants indicated that they did not want either of the drugs. We examined the data of the remaining 49 participants. Forty-two participants or 85.71% of these 49 participants chose the natural drug whereas 7 or 14.29% of these 49 participants chose the synthetic drug. This difference was statistically different from a 50%-50% split and illustrates a strong natural drug bias for a behavioral choice, χ^2 (1, $N = 49$) = 25.00, $p < .001$, Cramer's Phi = .71.

In Study 2, we sought to replicate Study 1 with a different sample of participants from another location in the U.S. Additionally, we wanted to address two potential issues. First, a large number of participants did not choose a pain reliever in Study 1 and therefore it could be that these participants differ in some way from participants who did choose a pain reliever, making our effect larger than it may be in realty. Therefore, in Study 2, participants who did not want a pain reliever were asked to tell us which one they would choose if they had to take one. Although this question is hypothetical, it allows us to determine if these individuals differ from those who chose a pain reliever. Second, the definitions of natural and synthetic used in Study 1 (a synthetic drug created in the laboratory by scientists; a natural drug taken from a common plant) differed on multiple dimensions. For example, the terms "laboratory", "scientists", and "common plant" were only used in one condition or the other. These differences could have led participants to make a choice that had more to do with the terms rather than preferences related to natural or synthetic. In Study 2, we used definitions for natural and synthetic that only varied on one dimension: a synthetic drug created from ingredients NOT FOUND in nature versus a natural drug created from ingredients FOUND in nature. Both definitions are identical except for

the word "not". This definition also coincides with what people believe natural means such as lacking additives and processing[1,2].

Study 2

Method

Participants

Participants were 100 individuals (71 females; 28 males; 1 reported neither male or female) with a mean age of 20.35 ($SD = 2.51$) years. They were recruited from the campus of Grand Valley State University in Michigan, U.S. The majority of the participants self-identified as Caucasian (84 or 84%), and the remaining participants self-identified as Hispanic (6 or 6%), Black (6 or 6%), Asian/Pacific Islander (2 or 2%), and American India/Alaskan Native (2 or 2%).

Materials and Procedure

We followed the same procedures from Study 1 and also used the same instructions and materials with two exceptions. One, if participants said they did not want a pain reliever, we asked them to tell us which one they would want (natural or synthetic) if they had to choose. Two, we used new definitions of natural and synthetic in our description of the pain relievers:

> "Thanks for completing the questionnaire. Here is the candy bar (research assistant reached in a bag). Ahh, actually I forgot to tell you that our department has received several free samples of new non-prescription pain relievers. We decided to give them away to participants. We have two types, and we can give you one today for participating. One is a synthetic drug made from ingredients not found in nature and one is a natural drug made from ingredients found in nature. Which one would you like?"

After participants made a drug choice, the research assistant debriefed the participants by telling them the true nature of the study. Finally, the research assistant gave participants a Hershey's chocolate bar and recorded participants' drug choices.

Results and Discussion

Figure 1 (right side) illustrates the frequency of the three choices, no drug, natural drug, and synthetic drug. Eleven of the 100 participants indicated that they did not want either of the drugs and were asked the follow-up question. We found that 10 or 90.91% of these 11 participants chose the natural drug, χ^2 (1, $N = 11$) = 7.36, $p = .01$, Cramer's Phi = .82.

The remaining 89 participants chose a pain reliever. Eighty-three or 93.26% of these 89 participants chose the natural drug whereas 6 or 6.74% of these 89 participants chose the synthetic drug. This difference was statistically different from a 50%-50% split and again illustrates a strong natural drug bias for a consequential behavioral choice, χ^2 (1, $N = 89$) = 66.62, $p < .001$, Cramer's Phi = .87.

This study replicates the findings from Study 1 with the new definitions and with participants from a different location. We also showed that participants who did not choose a drug still showed a strong natural drug bias when asked to make a choice. It appears that fewer participants refused a drug in Study 2 (11%) compared to Study 1 (55.05%). It is impossible to determine the exact reason for this apparent difference as there are a number of potential possibilities: the change in participant location (liberal arts college in the Northeast U.S. versus public university in the Midwest U.S.), the use of different research assistants, the change in definitions, or some other unknown variable. We address this issue further in the General Discussion section. In Studies 3 and 4, we used a hypothetical scenario-based design and sought

to determine if we could reduce the natural drug bias with the inclusion of a randomly assigned rational appeal.

Study 3

In Studies 3 and 4, we estimated sample sizes using a medium effect size (Cramer's Phi = .30). A 2 x 2 Chi-Square test for independence was used to examine the hypothesis that participants would be less likely to choose a natural versus synthetic drug when given a rational appeal. G*Power 3.1 does not offer a sample size estimate option for a Chi-Square test for independence when examining an exact effect size. We therefore used estimates from a power table for a Chi-Square test for independence[16]. This information revealed that 87 total participants were needed to reach 80% power. Yet, because we knew that an attempt to reduce the natural bias has not been conducted in the past, and a true effect size was unknown, we sought to collect data from as many participants as possible given our financial resources. We therefore attempted to collect data from at least 350 participants in Studies 3 and 4.

Method

Participants

Participants in Study 3 came from MTurk. We recruited people living in the U.S. who were 18 years of age or older. Participants were paid $0.75 for their participation. Participants were 350 individuals (178 males; 171 females; 1 queer) with a mean age of 34.63 ($SD = 10.37$) years. The majority of the participants self-identified as Caucasian (275 or 78.60%), and the remaining participants self-identified as Hispanic (25 or 7.10%), Asian/Pacific Islander (25 or 7.10%), Black (23 or 6.60%), American Indian/Alaskan Native (1 or .30%), or mixed (1 or .30%). We removed 13 participants who stated that they completed a study before with questions similar to the ones used in Studies 1 and 2. Therefore, we analyzed data from 337 participants.

Materials and Procedure

Participants first gave informed consent and were then told that researchers were interested in their judgments and perceptions about common things like drugs. Participants were randomly assigned to one of two conditions using the scenarios previously published by Meier and Lappas[11]. We used the definitions of natural and synthetic used in Study 1. In both conditions, participants were told to:

"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 created in the laboratory by scientists.

- Option 2 is a natural drug taken from a common plant."

Participants in the control condition received the above question without any additional details and were simply asked to choose one of the two options. Participants in the experimental condition also received the following rational appeal:

"Some people think natural substances are better than synthetic substances. However, many scientists would agree that it is inaccurate to make this assumption. For example, natural substances such as Botulinum Toxin and Arsenic are poisons that can cause death when people are exposed to small amounts. Furthermore, synthetic substances are not inherently bad. Tylenol and many Anti-Cancer Drugs are synthetic substances and are beneficial for humanity. Overall, sometimes natural substances are good or bad and sometimes synthetic substances are good or bad."

We developed this appeal in collaboration with a Ph.D. synthetic and organic chemist to ensure it was scientifically sound. The appeal was purposely written so that participants would know that it is inaccurate to automatically choose a natural drug. After providing their choice and

consistent with the work by Meier and Lappas[11], participants were asked to rate their perceptions

of the safety and effectiveness of each drug using a 1 (not at all) to 9 (very) scale. Participants

also completed the Short Item Need for Cognition scale[20], which was included for exploratory

purposes and was not part of the current project. Finally, participants completed demographic

questions and were debriefed.

Results and Discussion

An unbiased finding would be one in which participants chose the drugs at an equal rate

(50% for each drug) and perceived the drugs as similarly safe and effective. Yet, as found in

Meier and Lappas[11], we predicted that in the control condition, participants would choose the

natural drug more frequently than the synthetic drug and would rate it as safer, but less effective.

However, we expected these effects to be reduced in the experimental condition. These

hypotheses were confirmed. As shown in Figure 2, participants selected the natural drug

significantly more frequently in the control condition (122 of 173 or 70.50% of participants)

compared to the experimental condition (71 of 164 or 43.30% of participants), χ^2 (1, $N = 337$) =

25.51, $p < .001$, Cramer's Phi = .28. Thus, the rational appeal reduced the natural drug bias. We

also examined drug choice within each condition separately. The drug choice was different from

a 50-50% split in the control condition, χ^2 (1, $N = 173$) = 29.14, $p < .001$, Cramer's Phi = .41, but

not in the experimental condition, χ^2 (1, $N = 164$) = 2.95, $p = .09$, Cramer's Phi = .13).

We next examined perceived safety for each drug as a function of condition (Note: one

participant did not complete the safety ratings). We conducted a mixed-model ANOVA with

condition (control versus experimental) as a between-participants variable and safety rating of

drug type (natural versus synthetic) as a within-participants variable. We found a main effect of

drug type such that overall, participants rated the natural drug as safer ($M = 6.45$; $SD = 1.58$)

than the synthetic drug ($M = 5.53$; $SD = 1.96$), $F(1, 334) = 44.79$, $p = < .001$, $\eta^2_p = .12$. However, this main effect was qualified by a significant interaction between condition and drug type, $F(1, 334) = 19.78$, $p = < .001$, $\eta^2_p = .06$. We conducted two paired-samples t tests to examine the safety ratings of the natural versus synthetic drug for each condition. Participants in the control condition rated the natural drug as safer ($M = 6.82$; $SD = 1.49$) than the synthetic drug ($M = 5.32$; $SD = 2.08$), $t(1, 172) = 7.68$, $p < .001$, $d = .58$, but the difference in ratings in the experimental condition between the natural ($M = 6.06$; $SD = 1.58$) and synthetic ($M = 5.75$; $SD = 1.81$) drugs was not significant, $t(1, 162) = 1.64$, $p = .10$, $d = .13$. The main effect of condition was not significant, $F(1, 334) = 1.43$, $p = .23$, $\eta^2_p < .01$. These results suggest that the experimental manipulation reduced the safety-rating bias for natural drugs.

We next examined perceived effectiveness for each drug as a function of condition (Note: two participants did not complete the effectiveness ratings). We conducted a mixed-model ANOVA with condition (control versus experimental) as a between-participants variable and effectiveness rating of drug type (natural versus synthetic) as a within-participants variable. We found a main effect of drug type such that overall, participants rated the synthetic drug as more effective ($M = 6.67$; $SD = 1.67$) than the natural drug ($M = 5.99$; $SD = 1.58$), $F(1, 333) = 30.57$, $p = < .001$, $\eta^2_p = .08$. This main effect was qualified by a significant interaction between condition and drug type, $F(1, 333) = 4.87$, $p = .03$, $\eta^2_p = .01$. We ran two paired-samples t tests to examine the effectiveness ratings of the natural versus synthetic drug for each condition. Participants in the control condition rated the synthetic drug as more effective ($M = 6.54$; $SD = 1.77$) than the natural drug ($M = 6.13$; $SD = 1.66$), $t(1, 172) = 2.14$, $p = .03$, $d = .16$. Participants in the experimental condition also rated the synthetic drug as more effective ($M = 6.81$; $SD = 1.53$) than the natural drug ($M = 5.85$; $SD = 1.47$), $t(1, 161) = 6.25$, $p < .001$, $d = .49$, although the

effect size was three times as large. The main effect of condition was not significant, $F < 1$.

These results suggest that the experimental manipulation increased the effectiveness rating of the

synthetic drug relative to the natural drug.

Finally, we examined safety and effectiveness ratings as potential mediators of the effect

between the manipulation and drug choice. In other words, might safety and effectiveness beliefs

be two potential reasons why the rational appeal reduced the choice of a natural drug? To

examine this question, we computed two difference scores by subtracting the synthetic drug

rating from the natural drug rating for both safety and effectiveness. Positive scores mean that

participants rated the natural drug as safer/more effective than the synthetic drug, and negative

scores mean that participants rated the synthetic drug as safer/more effective than the natural

drug. We used Mplus (version 8) to examine mediation and included both the safety and

effectiveness ratings difference scores in the model. The manipulation was coded as -1 (control

condition) and 1 (experimental condition) and drug choice was coded as 1 (synthetic drug) and 2

(natural drug). The results revealed that both difference scores were significantly related to the

manipulation (safety: $\beta = -.24$, $p < .001$; effectiveness: $\beta = -.12$, $p = .03$) and drug choice (safety:

$\beta = .63$, $p < .001$; effectiveness: $\beta = .59$, $p < .001$). In terms of mediation, the indirect effects of

safety ($\beta = -.15$, $p < .001$, 95% CI $= -.21$ to $-.09$) and effectiveness ($\beta = -.07$, $p = .03$, 95% CI $= -$

$.13$ to $-.01$) were both significant and different from zero. These indirect effects suggest that the

link between the manipulation and drug choice was partially driven by perceived safety and

effectiveness.

The results of Study 3 suggest that a rational appeal may reduce the natural drug bias and

two potential mechanisms appeared to be perceived safety and effectiveness. Yet, Study 3 had

some potential issues that we sought to address in Study 4. First, we used the new definitions for

both the natural and synthetic drugs. Second, we used a different rational appeal that was neutral in tone compared to the appeal used in Study 3, which favored the synthetic drug choice. We made this second change to determine if the natural drug bias would be reduced with a less heavy-handed appeal that made our hypothesis potentially less apparent to participants.

Study 4

Method

Participants

Participants in Study 4 came from MTurk. We recruited people living in the U.S. who were 18 years of age or older. Participants were paid $0.50 for their participation. Participants were 356 individuals (172 males; 182 females; 1 non-binary) with a mean age of 37.18 (SD = 13.12) years. The majority of the participants self-identified as Caucasian (260 or 73.00%), and the remaining participants self-identified as Black (36 or 10.10%), Hispanic (21 or 5.90%), American Indian/Alaskan Native (18 or 5.10%), Asian/Pacific Islander (16 or 4.50%), mixed (2 or .60%), or Arab (1 or .30%). As in Study 3, we removed participants who stated that they completed a study before with questions similar to the ones used. Therefore, we removed data from 55 participants leaving us with data from 301 participants.

Materials and Procedure

Participants first gave informed consent and were then told that researchers were interested in their judgments and perceptions about common things like drugs. Participants were randomly assigned to one of two conditions using the same procedures from Study 3 with changes to the response options and rational appeal. In both conditions, participants were told to:

"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 created from ingredients NOT FOUND in nature.

- Option 2 is a natural drug created from ingredients FOUND in nature."

Participants in the control condition received the above question without any additional details and were simply asked to choose one of the two options. Participants in the experimental condition also received the following appeal:

- "Some people have a bias when choosing between natural and synthetic drugs. Yet, it is known that both natural and synthetic drugs may be either helpful or harmful. For example, there are both natural and synthetic poisons that cause death when people are exposed to small amounts. Furthermore, there are both natural and synthetic drugs that are beneficial for human health. Overall, some natural drugs are good and some are bad, and some synthetic drugs are good and some are bad."

This rational appeal included a neutral tone between the benefits and costs of synthetic and natural drugs. This change allowed us to determine if a neutral appeal would reduce the natural drug bias as compared to the stronger appeal used in Study 3. After providing their choice, participants also rated their perceived safety and effectiveness of each drug. Finally, participants completed demographic questions and were debriefed.

Results and Discussion

An unbiased finding would be one in which participants chose the drugs at an equal rate (50% for each drug) and perceived the drugs as similarly safe and effective. Yet, as found in Study 3, we predicted that in the control condition, participants would choose the natural drug more frequently than the synthetic drug and would rate it as safer, but less effective. However, we expected these effects to be reduced in the experimental condition. As shown in Figure 3, participants selected the natural drug significantly more frequently in the control condition (114

of 142 or 80.30% of participants) compared to the experimental condition (113 of 159 or 71.10%

of participants), but this difference was not quite significant at the traditional level, χ^2 (1, $N =$

301) = 3.43, p = .06, Cramer's Phi = .11. The rational appeal appeared to reduce the natural drug

bias, but not significantly. We also examined drug choice within each condition separately. The

drug choice was different from a 50-50% split in the control condition, χ^2 (1, N = 142) = 52.09, p

< .001, Cramer's Phi = .61, and in the experimental condition, χ^2 (1, N = 159) = 28.23, p < .001,

Cramer's Phi = .42).

We next examined perceived safety for each drug as a function of condition. We

conducted a mixed-model ANOVA with condition (control versus experimental) as a between-

participants variable and safety rating of drug type (natural versus synthetic) as a within-

participants variable. We found a main effect of drug type such that overall, participants rated the

natural drug as safer (M = 6.42; SD = 1.63) than the synthetic drug (M = 4.87; SD = 1.85), F(1,

299) = 141.54, p < .001, η^2_p = .32. However, this main effect was qualified by a significant

interaction between condition and drug type, F(1, 299) = 21.77, p < .001, η^2_p = .07. We

conducted two paired-samples t tests to examine the safety ratings of the natural versus synthetic

drug for each condition. Participants in the control condition rated the natural drug as safer (M =

6.54; SD = 1.72) than the synthetic drug (M = 4.33; SD = 1.84), t(141) = 10.09, p < .001, d = .86,

and participants in the experimental condition also rated the natural drug as safer (M = 6.32; SD

= 1.54) than the synthetic drug (M = 5.36; SD = 1.73), t(158) = 6.06, p < .001, d = .54, although

the effect size was smaller. The main effect of condition was also significant, F(1, 299) = 7.86, p

= .01, η^2_p =.03. This effect revealed that participants in the experimental condition gave higher

safety ratings overall (M = 5.84; SD = 1.26) than participants in the control condition (M = 5.43;

SD = 1.25). Overall, these effects suggest that the experimental condition reduced the safety-

rating bias for natural drugs compared to the control condition as in Study 3, but the difference between the safety rating of the natural and synthetic drugs was still significant in the experimental condition.

We next examined perceived effectiveness for each drug as a function of condition. We conducted a mixed-model ANOVA with condition (control versus experimental) as a between-participants variable and effectiveness rating of drug type (natural versus synthetic) as a within-participants variable. None of the effects were significant at the traditional level, main effect of drug type: $F(1, 299) = .02$, $p = .89$, $\eta^2_p < .001$, main effect of condition: $F(1, 299) = 3.87$, $p = .50$, $\eta^2_p = .01$, and the interaction between drug type and condition: $F(1, 299) = 3.70$, $p = .06$, $\eta^2_p = .01$. The means and standard deviations for each condition are shown here: control condition - synthetic drug ($M = 5.97$; $SD = 1.90$) and natural drug ($M = 6.23$; $SD = 1.66$); experimental condition - synthetic drug ($M = 6.52$; $SD = 1.66$) and natural drug ($M = 6.29$; $SD = 1.65$). The results for effectiveness ratings do not follow from Study 3 or past work[11].

Finally, as in Study 3, we examined safety and effectiveness ratings as potential mediators of the effect between the manipulation and drug choice. We again computed two difference scores by subtracting the synthetic drug rating from the natural drug rating for both safety and effectiveness. We used Mplus (version 8) to examine mediation and included both the safety and effectiveness ratings difference scores in the model. The manipulation was coded as -1 (control condition) and 1 (experimental condition) and drug choice was coded as 1 (synthetic drug) and 2 (natural drug). The results revealed that both difference scores were significantly related to the manipulation (safety: $\beta = -.26$, $p < .001$; effectiveness: $\beta = -.11$, $p = .05$) and drug choice (safety: $\beta = .48$, $p < .001$; effectiveness: $\beta = .55$, $p < .001$). In terms of mediation, the indirect effect of safety ($\beta = -.12$, $p < .001$, 95% CI $= -.19$ to $-.05$) was significantly different

from zero, but the indirect effect of effectiveness ($\beta = -.06$, $p = .06$, 95% CI = $-.12$ to $.01$) was

not significantly different from zero although this effect was close to being significant at the

traditional level. These indirect effects replicate the pattern from Study 3 and suggest that the

link between the manipulation and drug choice may be partially driven by safety and

effectiveness.

General Discussion

The results of five studies revealed that participants were biased towards a natural drug in

both a behavioral decision and in a hypothetical scenario. The results of our studies both

replicate and extend past work[11]. For example, they conceptually replicate past work in showing

that participants have a strong bias for natural over synthetic drugs. Our studies extend previous

work by confirming the bias in a behavioral choice and by showing that the bias can be

eliminated with a rational appeal. We discuss these results more thoroughly below.

The Pilot Study revealed that participants rated the term natural as more positive than the

term synthetic. Such results suggest that natural is an inherently positive concept and may be one

reason why people seem to prefer natural drugs and other natural items in different contexts. It

would be informative to determine if the extent to which participants rate natural as positive and

synthetic as negative partially drives the natural drug bias.

Studies 1 and 2 appear to be the first studies to find a confirmation of the natural versus

synthetic drug bias in a behavioral choice context. Past research (and our Studies 3 and 4) has

been based upon hypothetical scenarios, which is necessary to some extent given the ethical

limitations with giving people drugs to consume. Therefore, a confirmation of the natural drug

bias at the behavioral level provides some evidence for the validity of studies involving

hypothetical scenarios. It is noteworthy that the bias found in Studies 1 and 2 was larger than the

bias found in past studies using hypothetical scenarios[11]. These results might suggest that the natural drug bias is even stronger when assessed in behavioral paradigms (although see the discussion of the limitations of these studies below).

We attempted to reduce the natural drug bias in Studies 3 and 4 by randomly assigning participants to a rational appeal that explained the bias. This appeal reduced the bias in both studies, but only significantly in Study 3 (Study 4's effect was marginal). Studies 3 and 4 differed in at least two ways: in Study 4, the new definitions were used as well as the more balanced rational appeal. Creative designs that involve different manipulations such as having participants read an ostensible science article about the natural drug bias may be able to reduce the bias in other ways. Such work is important as we are unaware of any work that has attempted to reduce the natural bias in the drug domain or any other domain. Furthermore, such work could have implications for medication decisions and adherence to pharmacological regimens, not to mention the thoughtless purchases of well-advertised natural supplements. A similar rational appeal may be effective in reducing the natural bias found in other areas mentioned earlier such as cigarettes, meat, perfume, and soda.

In Studies 3 and 4, the perception of the safety and effectiveness of natural and synthetic drugs was affected by the rational appeal. The appeal reduced the safety rating of the natural drug, but also boosted the effectiveness rating of the synthetic drug at least in Study 3. Additionally, safety was a significant mediator in both studies and effectiveness was a significant mediator in one study and marginally significant in the other. These findings suggest that perceptions of safety and effectiveness might be mechanisms involved in both producing and reducing the natural drug bias although we recognize that other mechanisms are possible. Of note, Meier and Lappas[11] also found that natural drugs were perceived as safer but less effective

than synthetic drugs when all else was equal, and people still showed a natural drug bias. This possible disconnect between safety and effectiveness should be examined. It appears that safety might be most important to the natural drug bias and thus interventions to reduce the bias need only focus on safety. Of course it may also depend on the context in relation to the medical decision of interest. Future work will be necessary to fully examine this possibility as well as other consequences that may result from a bias in favor of natural drugs.

Limitations

Our studies are not without limitations. First, it is possible that some participants did not believe the cover story regarding pain relievers in Studies 1 and 2. Some participants may not have believed that the research assistant actually had pain relievers to distribute. We are unable to shed light on this possibility as we did not ask follow-up questions in regards to the believability of the cover story. While it is not uncommon to receive free products when participating in a study, future researchers should use a design that is less susceptible to this criticism such as one in which two pain relievers are actually shown to participants (but not actually given once a choice is made).

Second, it is possible that some of our designs introduced a demand characteristic or a desire for participants to behave according to how they thought researchers wanted them to act. Research has commonly asked people to choose or rate items described as natural versus synthetic, artificial, processed, etc.[1-7]. Therefore, it seems unlikely that a choice task (natural versus synthetic) introduced a demand response. Yet, the rational appeal used in Study 3 was heavy handed against natural drugs and therefore may have led to a reduction in the bias due to a demand explanation rather than due to an actual understanding of the natural versus synthetic bias. Study 4 seems less likely to involve such a possibility given that the rational appeal was

evenly balanced between natural and synthetic. Future researchers should consider demand-related issues when designing manipulations to reduce the natural bias.

Conclusion

In five studies, we found that participants preferred a natural versus a synthetic drug in a behavioral context and in hypothetical medical scenarios. The bias was reduced with a rational appeal and perceived safety and effectiveness were possible mediators. The overall results indicate that the bias for natural drugs is strong, but it may be reduced with a rational appeal.

References

1. Scott, SE, Rozin, P. re additives unnatural? Generality and mechanisms of additivity dominance. Judgm Decis Mak. 2017;12:572-583.

2. Rozin P, Fischler C, Shields-Argeles C. European and American perspectives on the meaning of natural. Appetite. 2012;59:448-455.

3. Rozin P, Spranca M, Krieger Z, Neuhaus R, Surrillo, D et al. Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines. Appetite. 2004;43:147-154.

4. Czoli CD, Hammond D. Cigarette packaging: Youth perceptions of "natural" cigarettes, filter references, and contraband tobacco. J Adol Heal. 2014;54:33-39.

5. Siegrist, M, Sutterlin, B, Hartmann, C. Perceived naturalness and evoked disgust influence acceptance of cultured meat. Meat Sci. 2018;139: 213-219.

6. Apaolaza, V, Hartmann, P, Lopez, C, Barrutia, JM, Echebarria, C. Natural ingredients claim's halo effect on hedonic sensory experiences of perfumes. Food Qual Pref. 2014;36: 81-86.

7. Skubisz, C. Naturally good: Front-of-package claims as message cues. Appetite. 2017;108: 506-511.

8. Baron, J, Holzman, GB, Schulkin, J. Attitudes of obstetricians and gynecologists toward hormone replacement therapy. Med Decis Making. 1998;18:406-411.

9. Li, M, Chapman, GB. Why do people like natural? Instrumental and ideational bases for the naturalness preference. J of App Psych. 2014;42:2859-2878.

10. Slovic, P, Finucane, ML, Peters, E, MacGregor, DG. The affect heuristic. Eur J Oper Res. 2007;177:1333-1352.

11. Meier, BP, Lappas, CM. The influence of safety, efficacy, and medical condition severity on natural versus synthetic drug preference. Med Decis Making. 2016;36:1011-1019.

12. Food and Drug Administration (*Internet*). Natural on food labeling (cited 2018 April 6th). Available from www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm456090.htm.

13. Abrams, KM, Meyers, CA, Irani, TA. Naturally confused: Consumers' perceptions of all-natural and organic pork products. Agric Human Values. 2010;3:365-374.

14. Dunnick JK, Nyska A. The toxicity and pathology of selected dietary herbal medicines Toxicol Pathol. 2013;41:374-386.

15. Bonkovsky HL. Chinese green tea (*Camellia sinensis*)-containing supplements and hepatotoxicity: case report and brief review. Ann Intern Med. 2006;144:68-71.

16. Aron, A, Coups, EJ, Aron, AN. Statistics for Psychology (6th Edition). 2013;Pearson Education.

17. Stewart, N, Ungemach, C, Harris, AJL, Bartels, DM, Newell, BR, et al. The average laboratory samples a population of 7,300 Amazon Mechanical Turk workers. Judgm Decis Mak. 2015;10:479-491.

18. Buhrmester M, Kwang T, Gosling S. Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data? Pers Psych Sci. 2011;6:3-5.

19. Warriner, AB, Kuperman, V, Brysbaert, M. Norms of valence, arousal, and dominance for 13,915 English lemmas. Behav Res Methods, 2013;45:1191-1207.

20. Cacioppo, JT, Petty, RE, Kao, CF. The efficient assessment of need for cognition. J Pers Assess. 1984;48:306-307.

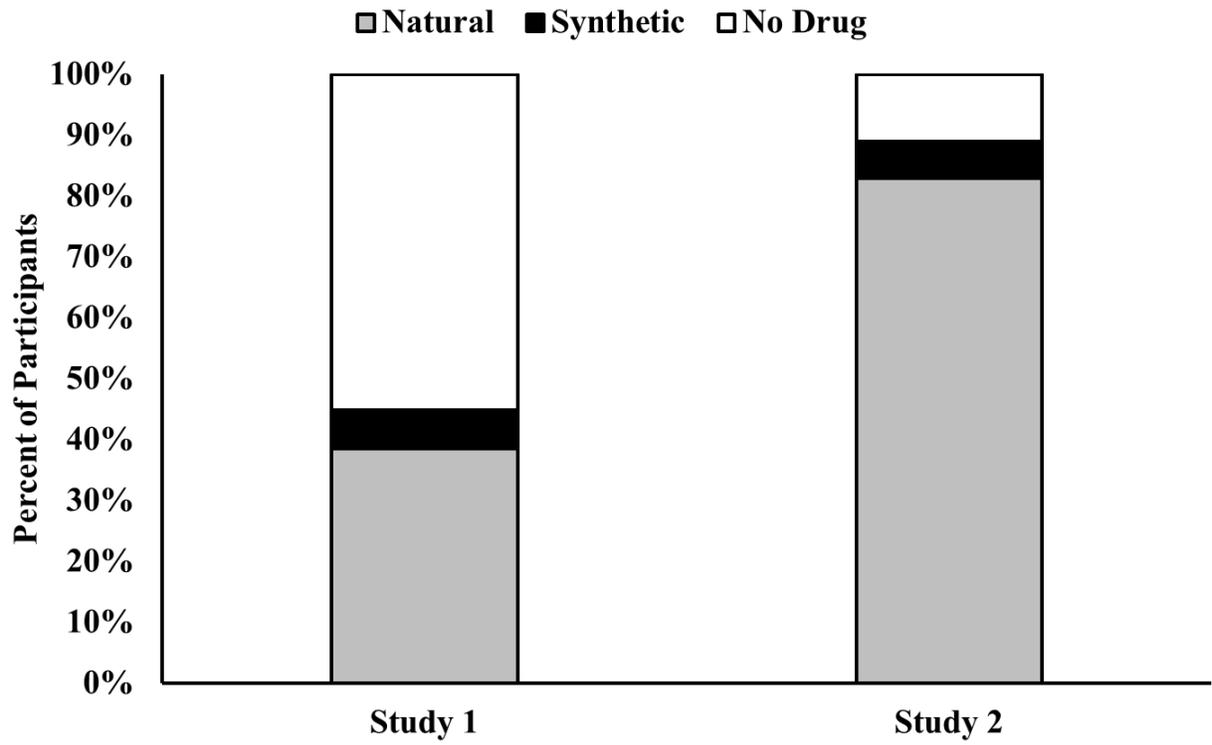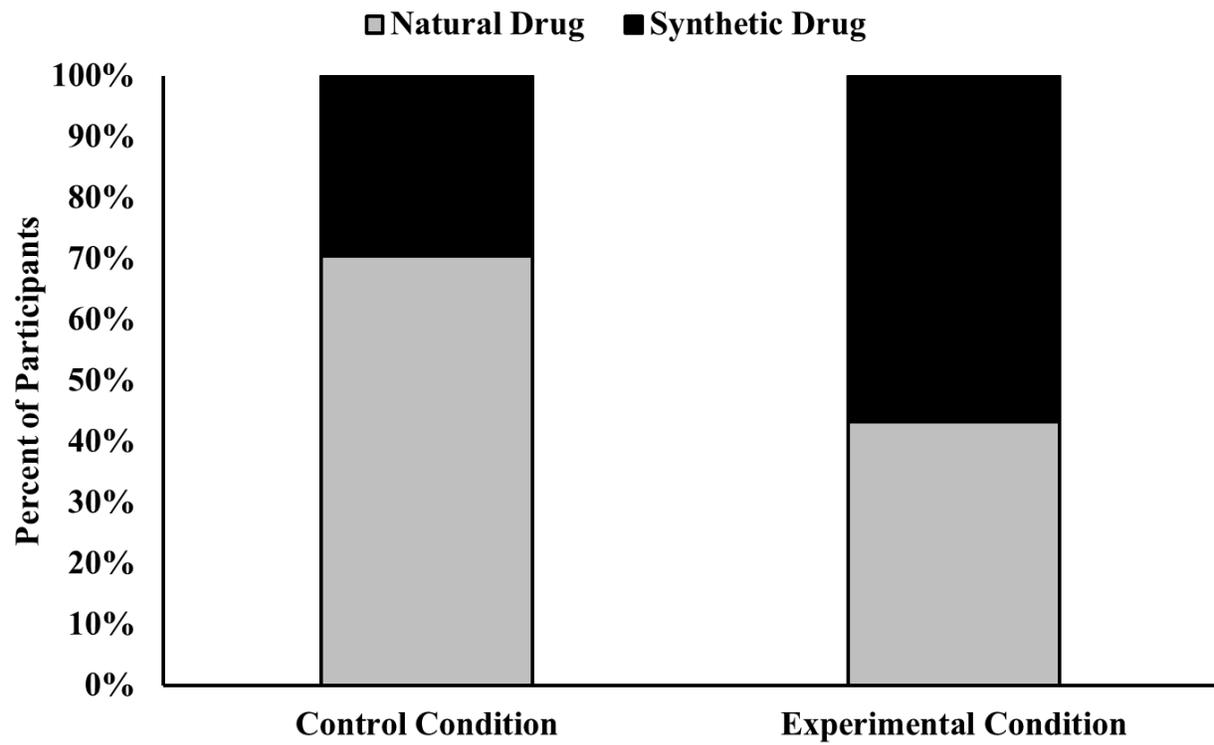**Fig. 1.** Frequency of Drug Choice in Studies 1 and 2

Fig. 2. Frequency of Drug Choice by Condition in Study 3

Fig. 3. Frequency of Drug Choice by Condition in Study 4